

***“The Jidoka system investigates the modification of the injection machine used for recycling plastic material by mixing MHD controlled by mathematical WSA approaches.”***

.

Sincerely

Injection Speed*Injection pressure*	-31.6706
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	-150.435
Viscosity*Screw speed	
Injection Speed*Melting temperature*	-26.3302
Viscosity*Screw speed	
Injection pressure*	-12.5025
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.794096
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.376637
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	3.01998
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.397534
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	0.158603
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	5.12168
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	-0.0695079
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

## Effects Pareto for Bubbles

\* NOTE \* Some factors have more than 2 levels, no alias table was printed.

## Response Optimization

Parameters

	Goal	Lower	Target	Upper	Weight	Import
Hard fitting	Target	7	9	12	1	1
Black dots	Target	6	13	18	1	1
Bubbles	Target	3	7	8	1	1

Global Solution

Flow rate	=	219.323
Injection Sp	=	2.31867

Injection pr = 7.77778  
Melting temp = 42.4949  
Viscosity = 5.99556  
Screw speed = 19.6013

#### Predicted Responses

Hard fitting = 8.9631 , desirability = 0.981555  
Black dots = 13.2648 , desirability = 0.947032  
Bubbles = 7.0370 , desirability = 0.963010

Composite Desirability = 0.963763

### Optimization Plot

---

**9/12/2022 3:16:32 PM**

---

Welcome to Minitab, press F1 for help.

Retrieving project from file: 'D:\0 RESEARHES\0 NOW 2021\0 JIDOKA\MINITAB  
6-09-2022.MPJ'

### Response Optimization

#### Parameters

	Goal	Lower	Target	Upper	Weight	Import
Hard fitting	Target	2	3	4	1	1
Black dots	Target	2	3	4	1	1
Bubbles	Target	2	3	4	1	1

#### Global Solution

Flow rate = 87.3145  
Injection Sp = 2.06233  
Injection pr = 4.52892  
Melting temp = 35  
Viscosity = 4.24242  
Screw speed = 7.90555

#### Predicted Responses

Hard fitting = 3.00000 , desirability = 1.000000  
Black dots = 3.00000 , desirability = 1.000000  
Bubbles = 3.00000 , desirability = 1.000000

Composite Desirability = 1.000000

### Optimization Plot

---

**12/30/2022 6:44:39 PM**

---

Welcome to Minitab, press F1 for help.  
 Retrieving project from file: 'D:\0 RESEARHES\0 NOW 2021\0 JIDOKA\MINITAB  
 6-09-2022.MPJ'

## Factorial Fit: Bubbles versus Flow rate, Injection Speed, ...

\* NOTE \* This design has some botched runs. It will be analyzed using a regression approach.

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef	SE Coef	T
Constant		44688006	322226422	0.14
Flow rate	56053984	28026992	195388284	0.14
Injection Speed	248892	124446	4085062	0.03
Injection pressure	12032543	6016272	19424977	0.31
Melting temperature	-2717999	-1358999	11527861	-0.12
Viscosity	-12385855	-6192928	146902465	-0.04
Screw speed	-100049050	-50024525	513771691	-0.10
Flow rate*Injection Speed	130738	65369	2476507	0.03
Flow rate*Injection pressure	7223442	3611721	11779420	0.31
Flow rate*Melting temperature	-1717478	-858739	6990484	-0.12
Flow rate*Viscosity	-6524850	-3262425	89048800	-0.04
Flow rate*Screw speed	-59193833	-29596917	311280402	-0.10
Injection Speed*Injection pressure	-212331	-106166	244822	-0.43
Injection Speed*Melting temperature	-15324	-7662	145940	-0.05
Injection Speed*Viscosity	739222	369611	1860777	0.20
Injection Speed*Screw speed	2593127	1296563	6290614	0.21
Injection pressure* Melting temperature	-501836	-250918	697145	-0.36
Injection pressure*Viscosity	11542009	5771004	9072196	0.64
Injection pressure*Screw speed	34445196	17222598	30750272	0.56
Melting temperature*Viscosity	718351	359176	5288627	0.07
Melting temperature*Screw speed	4661467	2330733	18225705	0.13
Viscosity*Screw speed	-131644140	-65822070	209104528	-0.31
Flow rate*Injection Speed* Injection pressure	-127921	-63961	148410	-0.43
Flow rate*Injection Speed* Melting temperature	-8540	-4270	88479	-0.05
Flow rate*Injection pressure* Melting temperature	-301562	-150781	422792	-0.36
Flow rate*Injection Speed*Viscosity	437376	218688	1127729	0.19
Flow rate*Injection pressure* Viscosity	6961316	3480658	5501467	0.63
Flow rate*Melting temperature* Viscosity	398781	199391	3205977	0.06
Flow rate*Injection Speed* Screw speed	1561362	780681	3810164	0.20
Flow rate*Injection pressure* Screw speed	20890258	10445129	18661146	0.56
Flow rate*Melting temperature* Screw speed	2770026	1385013	11046130	0.13
Flow rate*Viscosity*Screw speed	-78942383	-39471192	126659324	-0.31
Injection Speed*Injection pressure* Melting temperature	8488	4244	8774	0.48
Injection Speed*Injection pressure* Viscosity	-168216	-84108	113796	-0.74
Injection Speed*Melting temperature* Viscosity	-30042	-15021	66860	-0.22

Injection Speed*Injection pressure* Screw speed	-438085	-219043	374011	-0.59
Injection Speed*Melting temperature* Screw speed	-108626	-54313	223016	-0.24
Injection Speed*Viscosity* Screw speed	2211295	1105647	2603280	0.42
Injection pressure* Melting temperature*Viscosity	-452455	-226228	328594	-0.69
Injection pressure* Melting temperature*Screw speed	-1388584	-694292	1074520	-0.65
Injection pressure*Viscosity* Screw speed	25264944	12632472	13264101	0.95
Melting temperature*Viscosity* Screw speed	5329651	2664826	7446529	0.36
Flow rate*Injection Speed* Injection pressure* Melting temperature	5116	2558	5319	0.48
Flow rate*Injection Speed* Injection pressure*Viscosity	-101567	-50783	68987	-0.74
Flow rate*Injection Speed* Melting temperature*Viscosity	-17811	-8905	40523	-0.22
Flow rate*Injection pressure* Melting temperature*Viscosity	-272944	-136472	199280	-0.68
Flow rate*Injection Speed* Injection pressure*Screw speed	-265868	-132934	226997	-0.59
Flow rate*Injection Speed* Melting temperature*Screw speed	-65439	-32720	135126	-0.24
Flow rate*Injection pressure* Melting temperature*Screw speed	-842012	-421006	652378	-0.65
Flow rate*Injection Speed*Viscosity* Screw speed	1333282	666641	1576300	0.42
Flow rate*Injection pressure* Viscosity*Screw speed	15315357	7657679	8058816	0.95
Flow rate*Melting temperature* Viscosity*Screw speed	3198060	1599030	4512462	0.35
Injection Speed*Injection pressure* Melting temperature*Viscosity	6508	3254	4115	0.79
Injection Speed*Injection pressure* Melting temperature*Screw speed	17703	8852	13124	0.67
Injection Speed*Injection pressure* Viscosity*Screw speed	-313338	-156669	164741	-0.95
Injection Speed*Melting temperature* Viscosity*Screw speed	-87861	-43931	92676	-0.47
Injection pressure* Melting temperature*Viscosity* Screw speed	-989549	-494775	468048	-1.06
Flow rate*Injection Speed* Injection pressure* Melting temperature*Viscosity	3930	1965	2495	0.79
Flow rate*Injection Speed* Injection pressure* Melting temperature*Screw speed	10742	5371	7970	0.67
Flow rate*Injection Speed* Injection pressure*Viscosity* Screw speed	-190016	-95008	100116	-0.95
Flow rate*Injection Speed* Melting temperature*Viscosity* Screw speed	-52986	-26493	56141	-0.47
Flow rate*Injection pressure* Melting temperature*Viscosity* Screw speed	-599802	-299901	284528	-1.05
Injection Speed*Injection pressure* Melting temperature*Viscosity*	12309	6154	5851	1.05

Screw speed				
Flow rate*Injection Speed*	7464	3732	3558	1.05
Injection pressure*				
Melting temperature*Viscosity*				
Screw speed				

Term	P
Constant	0.893
Flow rate	0.889
Injection Speed	0.976
Injection pressure	0.764
Melting temperature	0.909
Viscosity	0.967
Screw speed	0.925
Flow rate*Injection Speed	0.980
Flow rate*Injection pressure	0.766
Flow rate*Melting temperature	0.905
Flow rate*Viscosity	0.972
Flow rate*Screw speed	0.926
Injection Speed*Injection pressure	0.675
Injection Speed*Melting temperature	0.959
Injection Speed*Viscosity	0.847
Injection Speed*Screw speed	0.841
Injection pressure*	0.727
Melting temperature	
Injection pressure*Viscosity	0.541
Injection pressure*Screw speed	0.589
Melting temperature*Viscosity	0.947
Melting temperature*Screw speed	0.901
Viscosity*Screw speed	0.760
Flow rate*Injection Speed*	0.677
Injection pressure	
Flow rate*Injection Speed*	0.963
Melting temperature	
Flow rate*Injection pressure*	0.730
Melting temperature	
Flow rate*Injection Speed*Viscosity	0.851
Flow rate*Injection pressure*	0.543
Viscosity	
Flow rate*Melting temperature*	0.952
Viscosity	
Flow rate*Injection Speed*	0.842
Screw speed	
Flow rate*Injection pressure*	0.589
Screw speed	
Flow rate*Melting temperature*	0.903
Screw speed	
Flow rate*Viscosity*Screw speed	0.762
Injection Speed*Injection pressure*	0.640
Melting temperature	
Injection Speed*Injection pressure*	0.479
Viscosity	
Injection Speed*Melting temperature*	0.827
Viscosity	
Injection Speed*Injection pressure*	0.572
Screw speed	
Injection Speed*Melting temperature*	0.813
Screw speed	
Injection Speed*Viscosity*	0.681
Screw speed	
Injection pressure*	0.509
Melting temperature*Viscosity	
Injection pressure*	0.534

Melting temperature*Screw speed	
Injection pressure*Viscosity*	0.366
Screw speed	
Melting temperature*Viscosity*	0.729
Screw speed	
Flow rate*Injection Speed*	0.642
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	0.480
Injection pressure*Viscosity	
Flow rate*Injection Speed*	0.831
Melting temperature*Viscosity	
Flow rate*Injection pressure*	0.511
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.573
Injection pressure*Screw speed	
Flow rate*Injection Speed*	0.814
Melting temperature*Screw speed	
Flow rate*Injection pressure*	0.535
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	0.682
Screw speed	
Flow rate*Injection pressure*	0.367
Viscosity*Screw speed	
Flow rate*Melting temperature*	0.731
Viscosity*Screw speed	
Injection Speed*Injection pressure*	0.449
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	0.517
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	0.366
Viscosity*Screw speed	
Injection Speed*Melting temperature*	0.647
Viscosity*Screw speed	
Injection pressure*	0.318
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.451
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.517
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	0.367
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.648
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	0.319
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	0.320
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.322
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

S = 5.97507      PRESS = 2885981  
 R-Sq = 96.20%    R-Sq(pred) = 0.00%    R-Sq(adj) = 69.63%

Analysis of Variance for Bubbles (coded units)

Source	DF
Main Effects	6
Flow rate	1
Injection Speed	1
Injection pressure	1
Melting temperature	1
Viscosity	1
Screw speed	1
2-Way Interactions	15
Flow rate*Injection Speed	1
Flow rate*Injection pressure	1
Flow rate*Melting temperature	1
Flow rate*Viscosity	1
Flow rate*Screw speed	1
Injection Speed*Injection pressure	1
Injection Speed*Melting temperature	1
Injection Speed*Viscosity	1
Injection Speed*Screw speed	1
Injection pressure*Melting temperature	1
Injection pressure*Viscosity	1
Injection pressure*Screw speed	1
Melting temperature*Viscosity	1
Melting temperature*Screw speed	1
Viscosity*Screw speed	1
3-Way Interactions	20
Flow rate*Injection Speed*Injection pressure	1
Flow rate*Injection Speed*Melting temperature	1
Flow rate*Injection pressure*Melting temperature	1
Flow rate*Injection Speed*Viscosity	1

Flow rate\*Injection pressure\*Viscosity  
 1  
 Flow rate\*Melting temperature\*Viscosity  
 1  
 Flow rate\*Injection Speed\*Screw speed  
 1  
 Flow rate\*Injection pressure\*Screw speed  
 1  
 Flow rate\*Melting temperature\*Screw speed  
 1  
 Flow rate\*Viscosity\*Screw speed  
 1  
 Injection Speed\*Injection pressure\*Melting temperature  
 1  
 Injection Speed\*Injection pressure\*Viscosity  
 1  
 Injection Speed\*Melting temperature\*Viscosity  
 1  
 Injection Speed\*Injection pressure\*Screw speed  
 1  
 Injection Speed\*Melting temperature\*Screw speed  
 1  
 Injection Speed\*Viscosity\*Screw speed  
 1  
 Injection pressure\*Melting temperature\*Viscosity  
 1  
 Injection pressure\*Melting temperature\*Screw speed  
 1  
 Injection pressure\*Viscosity\*Screw speed  
 1  
 Melting temperature\*Viscosity\*Screw speed  
 1  
 4-Way Interactions  
 15  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 1  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 1  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 1  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 1  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 1  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 1  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 1  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 1  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 1  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 1  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 1  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 1  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 1  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 1



```

Injection pressure*Melting temperature*Viscosity*Screw speed
1
5-Way Interactions
6
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed
1
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed
1
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed
1
6-Way Interactions
1
Flow rate*Injection Speed*Injection pressure*Melting
temperature*Viscosity*Screw speed 1
Residual Error
9
Total
72

```

```

Source
Seq SS
Main Effects
1281.56
Flow rate
375.84
Injection Speed
1.28
Injection pressure
286.37
Melting temperature
326.25
Viscosity
26.13
Screw speed
265.71
2-Way Interactions
1406.68
Flow rate*Injection Speed
1.20
Flow rate*Injection pressure
89.38
Flow rate*Melting temperature
245.33
Flow rate*Viscosity
14.15
Flow rate*Screw speed
56.88
Injection Speed*Injection pressure
16.49
Injection Speed*Melting temperature
64.52
Injection Speed*Viscosity
170.92
Injection Speed*Screw speed
17.28
Injection pressure*Melting temperature
201.38

```

Injection pressure*Viscosity	151.64
Injection pressure*Screw speed	156.84
Melting temperature*Viscosity	1.62
Melting temperature*Screw speed	14.16
Viscosity*Screw speed	204.89
3-Way Interactions	3627.68
Flow rate*Injection Speed*Injection pressure	128.92
Flow rate*Injection Speed*Melting temperature	6.39
Flow rate*Injection pressure*Melting temperature	431.22
Flow rate*Injection Speed*Viscosity	78.77
Flow rate*Injection pressure*Viscosity	31.71
Flow rate*Melting temperature*Viscosity	1226.08
Flow rate*Injection Speed*Screw speed	129.12
Flow rate*Injection pressure*Screw speed	15.66
Flow rate*Melting temperature*Screw speed	143.52
Flow rate*Viscosity*Screw speed	86.02
Injection Speed*Injection pressure*Melting temperature	374.08
Injection Speed*Injection pressure*Viscosity	375.68
Injection Speed*Melting temperature*Viscosity	211.98
Injection Speed*Injection pressure*Screw speed	23.84
Injection Speed*Melting temperature*Screw speed	1.45
Injection Speed*Viscosity*Screw speed	189.16
Injection pressure*Melting temperature*Viscosity	0.08
Injection pressure*Melting temperature*Screw speed	39.42
Injection pressure*Viscosity*Screw speed	81.58
Melting temperature*Viscosity*Screw speed	53.01
4-Way Interactions	1356.54
Flow rate*Injection Speed*Injection pressure*Melting temperature	55.27
Flow rate*Injection Speed*Injection pressure*Viscosity	32.84
Flow rate*Injection Speed*Melting temperature*Viscosity	143.40
Flow rate*Injection pressure*Melting temperature*Viscosity	11.93

Flow rate*Injection Speed*Injection pressure*Screw speed	
20.91	
Flow rate*Injection Speed*Melting temperature*Screw speed	
1.59	
Flow rate*Injection pressure*Melting temperature*Screw speed	
16.60	
Flow rate*Injection Speed*Viscosity*Screw speed	
28.37	
Flow rate*Injection pressure*Viscosity*Screw speed	
5.23	
Flow rate*Melting temperature*Viscosity*Screw speed	
767.85	
Injection Speed*Injection pressure*Melting temperature*Viscosity	
34.57	
Injection Speed*Injection pressure*Melting temperature*Screw speed	
13.60	
Injection Speed*Injection pressure*Viscosity*Screw speed	
115.97	
Injection Speed*Melting temperature*Viscosity*Screw speed	
97.49	
Injection pressure*Melting temperature*Viscosity*Screw speed	
10.94	
5-Way Interactions	
431.71	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
39.51	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
10.04	
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
376.81	
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
2.42	
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.43	
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
2.49	
6-Way Interactions	
39.28	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	39.28
Residual Error	
321.31	
Total	
8464.77	

Source	
Adj SS	
Main Effects	
382.37	
Flow rate	
0.73	
Injection Speed	
0.03	
Injection pressure	
3.42	
Melting temperature	
0.50	
Viscosity	
0.06	
Screw speed	
0.34	
2-Way Interactions	
1302.58	

Flow rate\*Injection Speed  
 0.02  
 Flow rate\*Injection pressure  
 3.36  
 Flow rate\*Melting temperature  
 0.54  
 Flow rate\*Viscosity  
 0.05  
 Flow rate\*Screw speed  
 0.32  
 Injection Speed\*Injection pressure  
 6.71  
 Injection Speed\*Melting temperature  
 0.10  
 Injection Speed\*Viscosity  
 1.41  
 Injection Speed\*Screw speed  
 1.52  
 Injection pressure\*Melting temperature  
 4.62  
 Injection pressure\*Viscosity  
 14.45  
 Injection pressure\*Screw speed  
 11.20  
 Melting temperature\*Viscosity  
 0.16  
 Melting temperature\*Screw speed  
 0.58  
 Viscosity\*Screw speed  
 3.54  
 3-Way Interactions  
 1799.09  
 Flow rate\*Injection Speed\*Injection pressure  
 6.63  
 Flow rate\*Injection Speed\*Melting temperature  
 0.08  
 Flow rate\*Injection pressure\*Melting temperature  
 4.54  
 Flow rate\*Injection Speed\*Viscosity  
 1.34  
 Flow rate\*Injection pressure\*Viscosity  
 14.29  
 Flow rate\*Melting temperature\*Viscosity  
 0.14  
 Flow rate\*Injection Speed\*Screw speed  
 1.50  
 Flow rate\*Injection pressure\*Screw speed  
 11.19  
 Flow rate\*Melting temperature\*Screw speed  
 0.56  
 Flow rate\*Viscosity\*Screw speed  
 3.47  
 Injection Speed\*Injection pressure\*Melting temperature  
 8.35  
 Injection Speed\*Injection pressure\*Viscosity  
 19.50  
 Injection Speed\*Melting temperature\*Viscosity  
 1.80  
 Injection Speed\*Injection pressure\*Screw speed  
 12.25  
 Injection Speed\*Melting temperature\*Screw speed  
 2.12

Injection Speed*Viscosity*Screw speed	
6.44	
Injection pressure*Melting temperature*Viscosity	
16.92	
Injection pressure*Melting temperature*Screw speed	
14.91	
Injection pressure*Viscosity*Screw speed	
32.38	
Melting temperature*Viscosity*Screw speed	
4.57	
4-Way Interactions	
1440.69	
Flow rate*Injection Speed*Injection pressure*Melting temperature	
8.26	
Flow rate*Injection Speed*Injection pressure*Viscosity	
19.35	
Flow rate*Injection Speed*Melting temperature*Viscosity	
1.72	
Flow rate*Injection pressure*Melting temperature*Viscosity	
16.74	
Flow rate*Injection Speed*Injection pressure*Screw speed	
12.24	
Flow rate*Injection Speed*Melting temperature*Screw speed	
2.09	
Flow rate*Injection pressure*Melting temperature*Screw speed	
14.87	
Flow rate*Injection Speed*Viscosity*Screw speed	
6.39	
Flow rate*Injection pressure*Viscosity*Screw speed	
32.24	
Flow rate*Melting temperature*Viscosity*Screw speed	
4.48	
Injection Speed*Injection pressure*Melting temperature*Viscosity	
22.33	
Injection Speed*Injection pressure*Melting temperature*Screw speed	
16.24	
Injection Speed*Injection pressure*Viscosity*Screw speed	
32.29	
Injection Speed*Melting temperature*Viscosity*Screw speed	
8.02	
Injection pressure*Melting temperature*Viscosity*Screw speed	
39.90	
5-Way Interactions	
461.98	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
22.15	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
16.22	
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
32.15	
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
7.95	
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
39.66	
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
39.50	
6-Way Interactions	
39.28	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	39.28
Residual Error	
321.31	
Total	

Source  
 Adj MS  
 Main Effects  
 63.7277  
     Flow rate  
 0.7346  
     Injection Speed  
 0.0331  
     Injection pressure  
 3.4247  
     Melting temperature  
 0.4962  
     Viscosity  
 0.0634  
     Screw speed  
 0.3385  
 2-Way Interactions  
 86.8390  
     Flow rate\*Injection Speed  
 0.0249  
     Flow rate\*Injection pressure  
 3.3563  
     Flow rate\*Melting temperature  
 0.5388  
     Flow rate\*Viscosity  
 0.0479  
     Flow rate\*Screw speed  
 0.3228  
     Injection Speed\*Injection pressure  
 6.7135  
     Injection Speed\*Melting temperature  
 0.0984  
     Injection Speed\*Viscosity  
 1.4086  
     Injection Speed\*Screw speed  
 1.5167  
     Injection pressure\*Melting temperature  
 4.6249  
     Injection pressure\*Viscosity  
 14.4465  
     Injection pressure\*Screw speed  
 11.1991  
     Melting temperature\*Viscosity  
 0.1647  
     Melting temperature\*Screw speed  
 0.5839  
     Viscosity\*Screw speed  
 3.5375  
 3-Way Interactions  
 89.9543  
     Flow rate\*Injection Speed\*Injection pressure  
 6.6311  
     Flow rate\*Injection Speed\*Melting temperature  
 0.0831  
     Flow rate\*Injection pressure\*Melting temperature  
 4.5407  
     Flow rate\*Injection Speed\*Viscosity  
 1.3425  
     Flow rate\*Injection pressure\*Viscosity  
 14.2906  
     Flow rate\*Melting temperature\*Viscosity  
 0.1381

Flow rate\*Injection Speed\*Screw speed  
 1.4988  
 Flow rate\*Injection pressure\*Screw speed  
 11.1850  
 Flow rate\*Melting temperature\*Screw speed  
 0.5613  
 Flow rate\*Viscosity\*Screw speed  
 3.4671  
 Injection Speed\*Injection pressure\*Melting temperature  
 8.3528  
 Injection Speed\*Injection pressure\*Viscosity  
 19.5032  
 Injection Speed\*Melting temperature\*Viscosity  
 1.8019  
 Injection Speed\*Injection pressure\*Screw speed  
 12.2455  
 Injection Speed\*Melting temperature\*Screw speed  
 2.1175  
 Injection Speed\*Viscosity\*Screw speed  
 6.4399  
 Injection pressure\*Melting temperature\*Viscosity  
 16.9222  
 Injection pressure\*Melting temperature\*Screw speed  
 14.9053  
 Injection pressure\*Viscosity\*Screw speed  
 32.3822  
 Melting temperature\*Viscosity\*Screw speed  
 4.5721  
 4-Way Interactions  
 96.0460  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 8.2551  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 19.3464  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 1.7242  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 16.7434  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 12.2438  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 2.0933  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 14.8684  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 6.3855  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 32.2357  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 4.4830  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 22.3256  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 16.2398  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 32.2884  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 8.0221  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 39.8951  
 5-Way Interactions  
 76.9969

Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
22.1465  
Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
16.2157  
Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
32.1510  
Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
7.9504  
Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
39.6637  
Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
39.5016  
6-Way Interactions  
39.2804  
Flow rate\*Injection Speed\*Injection pressure\*Melting  
temperature\*Viscosity\*Screw speed 39.2804  
Residual Error  
35.7014  
Total

Source

F

Main Effects

1.79

Flow rate

0.02

Injection Speed

0.00

Injection pressure

0.10

Melting temperature

0.01

Viscosity

0.00

Screw speed

0.01

2-Way Interactions

2.43

Flow rate\*Injection Speed

0.00

Flow rate\*Injection pressure

0.09

Flow rate\*Melting temperature

0.02

Flow rate\*Viscosity

0.00

Flow rate\*Screw speed

0.01

Injection Speed\*Injection pressure

0.19

Injection Speed\*Melting temperature

0.00

Injection Speed\*Viscosity

0.04

Injection Speed\*Screw speed

0.04

Injection pressure\*Melting temperature

0.13

Injection pressure\*Viscosity

0.40

Injection pressure\*Screw speed

0.31



Melting temperature\*Viscosity  
 0.00  
 Melting temperature\*Screw speed  
 0.02  
 Viscosity\*Screw speed  
 0.10  
 3-Way Interactions  
 2.52  
 Flow rate\*Injection Speed\*Injection pressure  
 0.19  
 Flow rate\*Injection Speed\*Melting temperature  
 0.00  
 Flow rate\*Injection pressure\*Melting temperature  
 0.13  
 Flow rate\*Injection Speed\*Viscosity  
 0.04  
 Flow rate\*Injection pressure\*Viscosity  
 0.40  
 Flow rate\*Melting temperature\*Viscosity  
 0.00  
 Flow rate\*Injection Speed\*Screw speed  
 0.04  
 Flow rate\*Injection pressure\*Screw speed  
 0.31  
 Flow rate\*Melting temperature\*Screw speed  
 0.02  
 Flow rate\*Viscosity\*Screw speed  
 0.10  
 Injection Speed\*Injection pressure\*Melting temperature  
 0.23  
 Injection Speed\*Injection pressure\*Viscosity  
 0.55  
 Injection Speed\*Melting temperature\*Viscosity  
 0.05  
 Injection Speed\*Injection pressure\*Screw speed  
 0.34  
 Injection Speed\*Melting temperature\*Screw speed  
 0.06  
 Injection Speed\*Viscosity\*Screw speed  
 0.18  
 Injection pressure\*Melting temperature\*Viscosity  
 0.47  
 Injection pressure\*Melting temperature\*Screw speed  
 0.42  
 Injection pressure\*Viscosity\*Screw speed  
 0.91  
 Melting temperature\*Viscosity\*Screw speed  
 0.13  
 4-Way Interactions  
 2.69  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 0.23  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 0.54  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 0.05  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 0.47  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 0.34  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 0.06

	Flow rate*Injection pressure*Melting temperature*Screw speed	
0.42		
	Flow rate*Injection Speed*Viscosity*Screw speed	
0.18		
	Flow rate*Injection pressure*Viscosity*Screw speed	
0.90		
	Flow rate*Melting temperature*Viscosity*Screw speed	
0.13		
	Injection Speed*Injection pressure*Melting temperature*Viscosity	
0.63		
	Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.45		
	Injection Speed*Injection pressure*Viscosity*Screw speed	
0.90		
	Injection Speed*Melting temperature*Viscosity*Screw speed	
0.22		
	Injection pressure*Melting temperature*Viscosity*Screw speed	
1.12		
	5-Way Interactions	
2.16		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
0.62		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.45		
	Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
0.90		
	Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
0.22		
	Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
1.11		
	Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
1.11		
	6-Way Interactions	
1.10		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	1.10
	Residual Error	
	Total	
	Source	
	P	
	Main Effects	
0.209		
	Flow rate	
0.889		
	Injection Speed	
0.976		
	Injection pressure	
0.764		
	Melting temperature	
0.909		
	Viscosity	
0.967		
	Screw speed	
0.925		
	2-Way Interactions	
0.090		
	Flow rate*Injection Speed	
0.980		
	Flow rate*Injection pressure	
0.766		
	Flow rate*Melting temperature	
0.905		

Flow rate\*Viscosity  
 0.972  
 Flow rate\*Screw speed  
 0.926  
 Injection Speed\*Injection pressure  
 0.675  
 Injection Speed\*Melting temperature  
 0.959  
 Injection Speed\*Viscosity  
 0.847  
 Injection Speed\*Screw speed  
 0.841  
 Injection pressure\*Melting temperature  
 0.727  
 Injection pressure\*Viscosity  
 0.541  
 Injection pressure\*Screw speed  
 0.589  
 Melting temperature\*Viscosity  
 0.947  
 Melting temperature\*Screw speed  
 0.901  
 Viscosity\*Screw speed  
 0.760  
 3-Way Interactions  
 0.078  
 Flow rate\*Injection Speed\*Injection pressure  
 0.677  
 Flow rate\*Injection Speed\*Melting temperature  
 0.963  
 Flow rate\*Injection pressure\*Melting temperature  
 0.730  
 Flow rate\*Injection Speed\*Viscosity  
 0.851  
 Flow rate\*Injection pressure\*Viscosity  
 0.543  
 Flow rate\*Melting temperature\*Viscosity  
 0.952  
 Flow rate\*Injection Speed\*Screw speed  
 0.842  
 Flow rate\*Injection pressure\*Screw speed  
 0.589  
 Flow rate\*Melting temperature\*Screw speed  
 0.903  
 Flow rate\*Viscosity\*Screw speed  
 0.762  
 Injection Speed\*Injection pressure\*Melting temperature  
 0.640  
 Injection Speed\*Injection pressure\*Viscosity  
 0.479  
 Injection Speed\*Melting temperature\*Viscosity  
 0.827  
 Injection Speed\*Injection pressure\*Screw speed  
 0.572  
 Injection Speed\*Melting temperature\*Screw speed  
 0.813  
 Injection Speed\*Viscosity\*Screw speed  
 0.681  
 Injection pressure\*Melting temperature\*Viscosity  
 0.509  
 Injection pressure\*Melting temperature\*Screw speed  
 0.534

```

Injection pressure*Viscosity*Screw speed
0.366
Melting temperature*Viscosity*Screw speed
0.729
4-Way Interactions
0.069
Flow rate*Injection Speed*Injection pressure*Melting temperature
0.642
Flow rate*Injection Speed*Injection pressure*Viscosity
0.480
Flow rate*Injection Speed*Melting temperature*Viscosity
0.831
Flow rate*Injection pressure*Melting temperature*Viscosity
0.511
Flow rate*Injection Speed*Injection pressure*Screw speed
0.573
Flow rate*Injection Speed*Melting temperature*Screw speed
0.814
Flow rate*Injection pressure*Melting temperature*Screw speed
0.535
Flow rate*Injection Speed*Viscosity*Screw speed
0.682
Flow rate*Injection pressure*Viscosity*Screw speed
0.367
Flow rate*Melting temperature*Viscosity*Screw speed
0.731
Injection Speed*Injection pressure*Melting temperature*Viscosity
0.449
Injection Speed*Injection pressure*Melting temperature*Screw speed
0.517
Injection Speed*Injection pressure*Viscosity*Screw speed
0.366
Injection Speed*Melting temperature*Viscosity*Screw speed
0.647
Injection pressure*Melting temperature*Viscosity*Screw speed
0.318
5-Way Interactions
0.144
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity
0.451
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed
0.517
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed
0.367
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed
0.648
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed
0.319
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed
0.320
6-Way Interactions
0.322
Flow rate*Injection Speed*Injection pressure*Melting
temperature*Viscosity*Screw speed 0.322
Residual Error
Total

```

#### Unusual Observations for Bubbles

Obs	StdOrder	Bubbles	Fit	SE Fit	Residual	St Resid
1	1	12.0000	12.0689	5.9749	-0.0689	-1.60 X
2	2	7.0000	7.1238	5.9457	-0.1238	-0.21 X

4	4	18.0000	17.7294	5.9676	0.2706	0.90 X
5	5	36.0000	36.0631	5.9715	-0.0631	-0.31 X
7	7	61.0000	61.2714	5.9624	-0.2714	-0.70 X
19	19	14.0000	13.8145	5.9641	0.1855	0.51 X
38	38	6.0000	6.2876	5.9664	-0.2876	-0.89 X
56	56	14.0000	14.1289	5.9640	-0.1289	-0.35 X
57	57	25.0000	25.0907	5.9622	-0.0907	-0.23 X
58	58	24.0000	24.1095	5.9712	-0.1095	-0.51 X
59	59	54.0000	55.0375	5.9470	-1.0375	-1.79 X
60	60	12.0000	11.9197	5.9746	0.0803	1.05 X
61	61	19.0000	18.8777	5.9735	0.1223	0.88 X
62	62	25.5000	26.1653	5.9539	-0.6653	-1.32 X
63	63	25.8000	25.6073	5.9728	0.1927	1.18 X
68	68	3.0000	2.3392	5.9656	0.6608	1.97 X
69	69	2.0000	2.4124	5.9692	-0.4124	-1.56 X
70	70	15.0000	14.8044	5.9726	0.1956	1.14 X
71	71	3.0000	2.5089	5.9708	0.4911	2.18RX
72	72	13.0000	13.2481	5.9594	-0.2481	-0.57 X
73	73	8.4286	8.4776	5.9748	-0.0490	-0.95 X

R denotes an observation with a large standardized residual.  
X denotes an observation whose X value gives it large leverage.

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	1087013
Flow rate	-679531
Injection Speed	-55903.4
Injection pressure	-30482.3
Melting temperature	-4805.48
Viscosity	-480293
Screw speed	-51863
Flow rate*Injection Speed	31247.4
Flow rate*Injection pressure	14040.0
Flow rate*Melting temperature	3023.52
Flow rate*Viscosity	235659
Flow rate*Screw speed	59997.0
Injection Speed*Injection pressure	1333.76
Injection Speed*Melting temperature	248.483
Injection Speed*Viscosity	26894.7
Injection Speed*Screw speed	3160.95
Injection pressure* Melting temperature	134.984
Injection pressure*Viscosity	13587.0
Injection pressure*Screw speed	2523.27
Melting temperature*Viscosity	2122.84
Melting temperature*Screw speed	232.030
Viscosity*Screw speed	3055.5
Flow rate*Injection Speed* Injection pressure	-603.691
Flow rate*Injection Speed* Melting temperature	-139.633
Flow rate*Injection pressure* Melting temperature	-62.6456
Flow rate*Injection Speed*Viscosity	-11073.3
Flow rate*Injection pressure* Viscosity	-5188.71
Flow rate*Melting temperature* Viscosity	-1063.97
Flow rate*Injection Speed* Screw speed	-2909.95

Flow rate*Injection pressure*	-1403.87
Screw speed	
Flow rate*Melting temperature*	-266.186
Screw speed	
Flow rate*Viscosity*Screw speed	-14581.0
Injection Speed*Injection pressure*	-5.94377
Melting temperature	
Injection Speed*Injection pressure*	-596.81
Viscosity	
Injection Speed*Melting temperature*	-119.761
Viscosity	
Injection Speed*Injection pressure*	-114.431
Screw speed	
Injection Speed*Melting temperature*	-14.1078
Screw speed	
Injection Speed*Viscosity*	-799.14
Screw speed	
Injection pressure*	-60.4542
Melting temperature*Viscosity	
Injection pressure*	-11.1278
Melting temperature*Screw speed	
Injection pressure*Viscosity*	-845.27
Screw speed	
Melting temperature*Viscosity*	-18.579
Screw speed	
Flow rate*Injection Speed*	2.70807
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	214.345
Injection pressure*Viscosity	
Flow rate*Injection Speed*	50.4216
Melting temperature*Viscosity	
Flow rate*Injection pressure*	23.5212
Melting temperature*Viscosity	
Flow rate*Injection Speed*	63.1461
Injection pressure*Screw speed	
Flow rate*Injection Speed*	12.9078
Melting temperature*Screw speed	
Flow rate*Injection pressure*	6.21556
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	831.69
Screw speed	
Flow rate*Injection pressure*	444.595
Viscosity*Screw speed	
Flow rate*Melting temperature*	67.374
Viscosity*Screw speed	
Injection Speed*Injection pressure*	2.68018
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	0.506340
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	40.4386
Viscosity*Screw speed	
Injection Speed*Melting temperature*	3.7533
Viscosity*Screw speed	
Injection pressure*	3.80000
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	-0.98357
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	-0.279989
Injection pressure*	
Melting temperature*Screw speed	

Flow rate*Injection Speed*	-20.4577
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	-3.80623
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	-2.01462
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	-0.182488
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.0929005
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

## Effects Pareto for Bubbles

\* NOTE \* Some factors have more than 2 levels, no alias table was printed.

## Factorial Fit: Hard fitting versus Flow rate, Injection Speed, ...

\* NOTE \* This design has some botched runs. It will be analyzed using a regression approach.

Estimated Effects and Coefficients for Hard fitting (coded units)

Term	Effect	Coef	SE Coef	T
Constant		676089693	289352422	2.34
Flow rate	820447079	410223540	175454492	2.34
Injection Speed	-16696764	-8348382	3668298	-2.28
Injection pressure	-59558319	-29779160	17443213	-1.71
Melting temperature	-49972005	-24986002	10351772	-2.41
Viscosity	675659242	337829621	131915266	2.56
Screw speed	1429652426	714826213	461355969	1.55
Flow rate*Injection Speed	-10132996	-5066498	2223851	-2.28
Flow rate*Injection pressure	-36136329	-18068164	10577666	-1.71
Flow rate*Melting temperature	-30321316	-15160658	6277305	-2.42
Flow rate*Viscosity	409924232	204962116	79963914	2.56
Flow rate*Screw speed	869901501	434950751	279523131	1.56
Injection Speed*Injection pressure	742234	371117	219845	1.69
Injection Speed*Melting temperature	616778	308389	131051	2.35
Injection Speed*Viscosity	-8320819	-4160409	1670938	-2.49
Injection Speed*Screw speed	-18561847	-9280923	5648837	-1.64
Injection pressure*	2209167	1104583	626021	1.76
Melting temperature				
Injection pressure*Viscosity	-29928977	-14964489	8146637	-1.84
Injection pressure*Screw speed	29410841	14705421	27613086	0.53
Melting temperature*Viscosity	-24955148	-12477574	4749073	-2.63
Melting temperature*Screw speed	-56474167	-28237083	16366293	-1.73
Viscosity*Screw speed	744345049	372172525	187771385	1.98
Flow rate*Injection Speed*	450449	225224	133269	1.69
Injection pressure				
Flow rate*Injection Speed*	374316	187158	79452	2.36
Melting temperature				
Flow rate*Injection pressure*	1340396	670198	379658	1.77

Melting temperature				
Flow rate*Injection Speed*Viscosity	-5049173	-2524586	1012676	-2.49
Flow rate*Injection pressure*	-18156712	-9078356	4940199	-1.84
Viscosity				
Flow rate*Melting temperature*	-15140482	-7570241	2878899	-2.63
Viscosity				
Flow rate*Injection Speed*	-11295556	-5647778	3421446	-1.65
Screw speed				
Flow rate*Injection pressure*	17809250	8904625	16757310	0.53
Screw speed				
Flow rate*Melting temperature*	-34358022	-17179011	9919188	-1.73
Screw speed				
Flow rate*Viscosity*Screw speed	452712825	226356412	113737359	1.99
Injection Speed*Injection pressure*	-27529	-13765	7879	-1.75
Melting temperature				
Injection Speed*Injection pressure*	371150	185575	102187	1.82
Viscosity				
Injection Speed*Melting temperature*	307230	153615	60039	2.56
Viscosity				
Injection Speed*Injection pressure*	-206095	-103047	335853	-0.31
Screw speed				
Injection Speed*Melting temperature*	727162	363581	200264	1.82
Screw speed				
Injection Speed*Viscosity*	-9593946	-4796973	2337690	-2.05
Screw speed				
Injection pressure*	1109045	554523	295070	1.88
Melting temperature*Viscosity				
Injection pressure*	-800656	-400328	964896	-0.41
Melting temperature*Screw speed				
Injection pressure*Viscosity*	9811125	4905563	11910879	0.41
Screw speed				
Melting temperature*Viscosity*	-29121127	-14560563	6686824	-2.18
Screw speed				
Flow rate*Injection Speed*	-16707	-8353	4777	-1.75
Injection pressure*				
Melting temperature				
Flow rate*Injection Speed*	225206	112603	61949	1.82
Injection pressure*Viscosity				
Flow rate*Injection Speed*	186432	93216	36389	2.56
Melting temperature*Viscosity				
Flow rate*Injection pressure*	672815	336407	178949	1.88
Melting temperature*Viscosity				
Flow rate*Injection Speed*	-124354	-62177	203839	-0.31
Injection pressure*Screw speed				
Flow rate*Injection Speed*	442445	221222	121340	1.82
Melting temperature*Screw speed				
Flow rate*Injection pressure*	-484310	-242155	585821	-0.41
Melting temperature*Screw speed				
Flow rate*Injection Speed*Viscosity*	-5835617	-2917809	1415484	-2.06
Screw speed				
Flow rate*Injection pressure*	5945009	2972504	7236644	0.41
Viscosity*Screw speed				
Flow rate*Melting temperature*	-17709944	-8854972	4052094	-2.19
Viscosity*Screw speed				
Injection Speed*Injection pressure*	-13756	-6878	3695	-1.86
Melting temperature*Viscosity				
Injection Speed*Injection pressure*	4332	2166	11785	0.18
Melting temperature*Screw speed				
Injection Speed*Injection pressure*	-49104	-24552	147934	-0.17
Viscosity*Screw speed				
Injection Speed*Melting temperature*	372822	186411	83221	2.24
Viscosity*Screw speed				
Injection pressure*	-235229	-117614	420297	-0.28



Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	-8347	-4173	2240	-1.86
Injection pressure*				
Melting temperature*Viscosity				
Flow rate*Injection Speed*	2601	1301	7157	0.18
Injection pressure*				
Melting temperature*Screw speed				
Flow rate*Injection Speed*	-29589	-14795	89902	-0.16
Injection pressure*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	226753	113376	50413	2.25
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection pressure*	-142348	-71174	255500	-0.28
Melting temperature*Viscosity*				
Screw speed				
Injection Speed*Injection pressure*	349	175	5254	0.03
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	203	102	3195	0.03
Injection pressure*				
Melting temperature*Viscosity*				
Screw speed				

Term	P
Constant	0.044
Flow rate	0.044
Injection Speed	0.049
Injection pressure	0.122
Melting temperature	0.039
Viscosity	0.031
Screw speed	0.156
Flow rate*Injection Speed	0.049
Flow rate*Injection pressure	0.122
Flow rate*Melting temperature	0.039
Flow rate*Viscosity	0.031
Flow rate*Screw speed	0.154
Injection Speed*Injection pressure	0.126
Injection Speed*Melting temperature	0.043
Injection Speed*Viscosity	0.034
Injection Speed*Screw speed	0.135
Injection pressure*	0.111
Melting temperature	
Injection pressure*Viscosity	0.099
Injection pressure*Screw speed	0.607
Melting temperature*Viscosity	0.027
Melting temperature*Screw speed	0.119
Viscosity*Screw speed	0.079
Flow rate*Injection Speed*	0.125
Injection pressure	
Flow rate*Injection Speed*	0.043
Melting temperature	
Flow rate*Injection pressure*	0.111
Melting temperature	
Flow rate*Injection Speed*Viscosity	0.034
Flow rate*Injection pressure*	0.099
Viscosity	
Flow rate*Melting temperature*	0.027
Viscosity	
Flow rate*Injection Speed*	0.133
Screw speed	
Flow rate*Injection pressure*	0.608

Screw speed	
Flow rate*Melting temperature*	0.117
Screw speed	
Flow rate*Viscosity*Screw speed	0.078
Injection Speed*Injection pressure*	0.115
Melting temperature	
Injection Speed*Injection pressure*	0.103
Viscosity	
Injection Speed*Melting temperature*	0.031
Viscosity	
Injection Speed*Injection pressure*	0.766
Screw speed	
Injection Speed*Melting temperature*	0.103
Screw speed	
Injection Speed*Viscosity*	0.070
Screw speed	
Injection pressure*	0.093
Melting temperature*Viscosity	
Injection pressure*	0.688
Melting temperature*Screw speed	
Injection pressure*Viscosity*	0.690
Screw speed	
Melting temperature*Viscosity*	0.057
Screw speed	
Flow rate*Injection Speed*	0.114
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	0.102
Injection pressure*Viscosity	
Flow rate*Injection Speed*	0.031
Melting temperature*Viscosity	
Flow rate*Injection pressure*	0.093
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.767
Injection pressure*Screw speed	
Flow rate*Injection Speed*	0.102
Melting temperature*Screw speed	
Flow rate*Injection pressure*	0.689
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	0.069
Screw speed	
Flow rate*Injection pressure*	0.691
Viscosity*Screw speed	
Flow rate*Melting temperature*	0.057
Viscosity*Screw speed	
Injection Speed*Injection pressure*	0.096
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	0.858
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	0.872
Viscosity*Screw speed	
Injection Speed*Melting temperature*	0.052
Viscosity*Screw speed	
Injection pressure*	0.786
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.095
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.860
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	0.873

Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.051
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	0.787
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	0.974
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.975
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

S = 5.36548      PRESS = 3048194  
 R-Sq = 89.30%    R-Sq(pred) = 0.00%    R-Sq(adj) = 14.40%

#### Analysis of Variance for Hard fitting (coded units)

Source	
DF	
Main Effects	
6	
Flow rate	
1	
Injection Speed	
1	
Injection pressure	
1	
Melting temperature	
1	
Viscosity	
1	
Screw speed	
1	
2-Way Interactions	
15	
Flow rate*Injection Speed	
1	
Flow rate*Injection pressure	
1	
Flow rate*Melting temperature	
1	
Flow rate*Viscosity	
1	
Flow rate*Screw speed	
1	
Injection Speed*Injection pressure	
1	
Injection Speed*Melting temperature	
1	
Injection Speed*Viscosity	
1	
Injection Speed*Screw speed	
1	
Injection pressure*Melting temperature	
1	
Injection pressure*Viscosity	
1	

```

Injection pressure*Screw speed
1
Melting temperature*Viscosity
1
Melting temperature*Screw speed
1
Viscosity*Screw speed
1
3-Way Interactions
20
Flow rate*Injection Speed*Injection pressure
1
Flow rate*Injection Speed*Melting temperature
1
Flow rate*Injection pressure*Melting temperature
1
Flow rate*Injection Speed*Viscosity
1
Flow rate*Injection pressure*Viscosity
1
Flow rate*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Screw speed
1
Flow rate*Injection pressure*Screw speed
1
Flow rate*Melting temperature*Screw speed
1
Flow rate*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature
1
Injection Speed*Injection pressure*Viscosity
1
Injection Speed*Melting temperature*Viscosity
1
Injection Speed*Injection pressure*Screw speed
1
Injection Speed*Melting temperature*Screw speed
1
Injection Speed*Viscosity*Screw speed
1
Injection pressure*Melting temperature*Viscosity
1
Injection pressure*Melting temperature*Screw speed
1
Injection pressure*Viscosity*Screw speed
1
Melting temperature*Viscosity*Screw speed
1
4-Way Interactions
15
Flow rate*Injection Speed*Injection pressure*Melting temperature
1
Flow rate*Injection Speed*Injection pressure*Viscosity
1
Flow rate*Injection Speed*Melting temperature*Viscosity
1
Flow rate*Injection pressure*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Injection pressure*Screw speed
1

```

```

Flow rate*Injection Speed*Melting temperature*Screw speed
1
Flow rate*Injection pressure*Melting temperature*Screw speed
1
Flow rate*Injection Speed*Viscosity*Screw speed
1
Flow rate*Injection pressure*Viscosity*Screw speed
1
Flow rate*Melting temperature*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Injection Speed*Injection pressure*Viscosity*Screw speed
1
Injection Speed*Melting temperature*Viscosity*Screw speed
1
Injection pressure*Melting temperature*Viscosity*Screw speed
1
5-Way Interactions
6
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed
1
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed
1
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed
1
6-Way Interactions
1
Flow rate*Injection Speed*Injection pressure*Melting
temperature*Viscosity*Screw speed 1
Residual Error
9
Total
72

Source
Seq SS
Main Effects
432.96
Flow rate
57.68
Injection Speed
126.48
Injection pressure
23.83
Melting temperature
72.99
Viscosity
1.81
Screw speed
150.18
2-Way Interactions
374.88
Flow rate*Injection Speed
12.42

```

Flow rate\*Injection pressure  
 65.46  
 Flow rate\*Melting temperature  
 3.34  
 Flow rate\*Viscosity  
 0.65  
 Flow rate\*Screw speed  
 2.13  
 Injection Speed\*Injection pressure  
 41.04  
 Injection Speed\*Melting temperature  
 3.55  
 Injection Speed\*Viscosity  
 46.88  
 Injection Speed\*Screw speed  
 97.23  
 Injection pressure\*Melting temperature  
 18.75  
 Injection pressure\*Viscosity  
 61.54  
 Injection pressure\*Screw speed  
 0.00  
 Melting temperature\*Viscosity  
 7.31  
 Melting temperature\*Screw speed  
 13.35  
 Viscosity\*Screw speed  
 1.23  
 3-Way Interactions  
 695.00  
 Flow rate\*Injection Speed\*Injection pressure  
 49.56  
 Flow rate\*Injection Speed\*Melting temperature  
 9.32  
 Flow rate\*Injection pressure\*Melting temperature  
 23.89  
 Flow rate\*Injection Speed\*Viscosity  
 31.50  
 Flow rate\*Injection pressure\*Viscosity  
 0.04  
 Flow rate\*Melting temperature\*Viscosity  
 3.27  
 Flow rate\*Injection Speed\*Screw speed  
 32.74  
 Flow rate\*Injection pressure\*Screw speed  
 29.57  
 Flow rate\*Melting temperature\*Screw speed  
 1.24  
 Flow rate\*Viscosity\*Screw speed  
 10.13  
 Injection Speed\*Injection pressure\*Melting temperature  
 2.06  
 Injection Speed\*Injection pressure\*Viscosity  
 1.22  
 Injection Speed\*Melting temperature\*Viscosity  
 109.98  
 Injection Speed\*Injection pressure\*Screw speed  
 151.73  
 Injection Speed\*Melting temperature\*Screw speed  
 28.32  
 Injection Speed\*Viscosity\*Screw speed  
 47.45

Injection pressure*Melting temperature*Viscosity	
41.02	
Injection pressure*Melting temperature*Screw speed	
1.78	
Injection pressure*Viscosity*Screw speed	
119.98	
Melting temperature*Viscosity*Screw speed	
0.19	
4-Way Interactions	
362.07	
Flow rate*Injection Speed*Injection pressure*Melting temperature	
6.90	
Flow rate*Injection Speed*Injection pressure*Viscosity	
1.64	
Flow rate*Injection Speed*Melting temperature*Viscosity	
26.42	
Flow rate*Injection pressure*Melting temperature*Viscosity	
11.05	
Flow rate*Injection Speed*Injection pressure*Screw speed	
14.25	
Flow rate*Injection Speed*Melting temperature*Screw speed	
38.67	
Flow rate*Injection pressure*Melting temperature*Screw speed	
0.08	
Flow rate*Injection Speed*Viscosity*Screw speed	
16.56	
Flow rate*Injection pressure*Viscosity*Screw speed	
1.60	
Flow rate*Melting temperature*Viscosity*Screw speed	
33.41	
Injection Speed*Injection pressure*Melting temperature*Viscosity	
15.88	
Injection Speed*Injection pressure*Melting temperature*Screw speed	
42.76	
Injection Speed*Injection pressure*Viscosity*Screw speed	
70.29	
Injection Speed*Melting temperature*Viscosity*Screw speed	
24.32	
Injection pressure*Melting temperature*Viscosity*Screw speed	
58.26	
5-Way Interactions	
297.47	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
0.00	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.06	
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
77.20	
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
127.49	
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
92.28	
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.44	
6-Way Interactions	
0.03	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	0.03
Residual Error	
259.10	
Total	
2421.51	

Source  
 Adj SS  
 Main Effects  
 363.084  
     Flow rate  
 157.373  
     Injection Speed  
 149.105  
     Injection pressure  
 83.905  
     Melting temperature  
 167.719  
     Viscosity  
 188.809  
     Screw speed  
 69.111  
 2-Way Interactions  
 487.207  
     Flow rate\*Injection Speed  
 149.425  
     Flow rate\*Injection pressure  
 83.997  
     Flow rate\*Melting temperature  
 167.922  
     Flow rate\*Viscosity  
 189.137  
     Flow rate\*Screw speed  
 69.705  
     Injection Speed\*Injection pressure  
 82.036  
     Injection Speed\*Melting temperature  
 159.416  
     Injection Speed\*Viscosity  
 178.471  
     Injection Speed\*Screw speed  
 77.711  
     Injection pressure\*Melting temperature  
 89.626  
     Injection pressure\*Viscosity  
 97.137  
     Injection pressure\*Screw speed  
 8.165  
     Melting temperature\*Viscosity  
 198.728  
     Melting temperature\*Screw speed  
 85.695  
     Viscosity\*Screw speed  
 113.096  
 3-Way Interactions  
 589.527  
     Flow rate\*Injection Speed\*Injection pressure  
 82.222  
     Flow rate\*Injection Speed\*Melting temperature  
 159.742  
     Flow rate\*Injection pressure\*Melting temperature  
 89.710  
     Flow rate\*Injection Speed\*Viscosity  
 178.919  
     Flow rate\*Injection pressure\*Viscosity  
 97.217  
     Flow rate\*Melting temperature\*Viscosity  
 199.060



Flow rate\*Injection Speed\*Screw speed  
 78.443  
 Flow rate\*Injection pressure\*Screw speed  
 8.129  
 Flow rate\*Melting temperature\*Screw speed  
 86.350  
 Flow rate\*Viscosity\*Screw speed  
 114.024  
 Injection Speed\*Injection pressure\*Melting temperature  
 87.867  
 Injection Speed\*Injection pressure\*Viscosity  
 94.944  
 Injection Speed\*Melting temperature\*Viscosity  
 188.460  
 Injection Speed\*Injection pressure\*Screw speed  
 2.710  
 Injection Speed\*Melting temperature\*Screw speed  
 94.889  
 Injection Speed\*Viscosity\*Screw speed  
 121.221  
 Injection pressure\*Melting temperature\*Viscosity  
 101.673  
 Injection pressure\*Melting temperature\*Screw speed  
 4.956  
 Injection pressure\*Viscosity\*Screw speed  
 4.883  
 Melting temperature\*Viscosity\*Screw speed  
 136.500  
 4-Way Interactions  
 478.964  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 88.047  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 95.116  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 188.915  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 101.739  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 2.679  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 95.690  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 4.919  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 122.327  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 4.857  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 137.478  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 99.755  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.972  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.793  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 144.444  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 2.254  
 5-Way Interactions  
 294.998

Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 99.913  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.951  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.780  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 145.605  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 2.234  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.032  
 6-Way Interactions  
 0.029  
 Flow rate\*Injection Speed\*Injection pressure\*Melting  
 temperature\*Viscosity\*Screw speed 0.029  
 Residual Error  
 259.096  
 Total

Source  
 Adj MS  
 Main Effects  
 60.514  
 Flow rate  
 157.373  
 Injection Speed  
 149.105  
 Injection pressure  
 83.905  
 Melting temperature  
 167.719  
 Viscosity  
 188.809  
 Screw speed  
 69.111  
 2-Way Interactions  
 32.480  
 Flow rate\*Injection Speed  
 149.425  
 Flow rate\*Injection pressure  
 83.997  
 Flow rate\*Melting temperature  
 167.922  
 Flow rate\*Viscosity  
 189.137  
 Flow rate\*Screw speed  
 69.705  
 Injection Speed\*Injection pressure  
 82.036  
 Injection Speed\*Melting temperature  
 159.416  
 Injection Speed\*Viscosity  
 178.471  
 Injection Speed\*Screw speed  
 77.711  
 Injection pressure\*Melting temperature  
 89.626  
 Injection pressure\*Viscosity  
 97.137  
 Injection pressure\*Screw speed  
 8.165

Melting temperature\*Viscosity  
198.728  
Melting temperature\*Screw speed  
85.695  
Viscosity\*Screw speed  
113.096  
3-Way Interactions  
29.476  
Flow rate\*Injection Speed\*Injection pressure  
82.222  
Flow rate\*Injection Speed\*Melting temperature  
159.742  
Flow rate\*Injection pressure\*Melting temperature  
89.710  
Flow rate\*Injection Speed\*Viscosity  
178.919  
Flow rate\*Injection pressure\*Viscosity  
97.217  
Flow rate\*Melting temperature\*Viscosity  
199.060  
Flow rate\*Injection Speed\*Screw speed  
78.443  
Flow rate\*Injection pressure\*Screw speed  
8.129  
Flow rate\*Melting temperature\*Screw speed  
86.350  
Flow rate\*Viscosity\*Screw speed  
114.024  
Injection Speed\*Injection pressure\*Melting temperature  
87.867  
Injection Speed\*Injection pressure\*Viscosity  
94.944  
Injection Speed\*Melting temperature\*Viscosity  
188.460  
Injection Speed\*Injection pressure\*Screw speed  
2.710  
Injection Speed\*Melting temperature\*Screw speed  
94.889  
Injection Speed\*Viscosity\*Screw speed  
121.221  
Injection pressure\*Melting temperature\*Viscosity  
101.673  
Injection pressure\*Melting temperature\*Screw speed  
4.956  
Injection pressure\*Viscosity\*Screw speed  
4.883  
Melting temperature\*Viscosity\*Screw speed  
136.500  
4-Way Interactions  
31.931  
Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
88.047  
Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
95.116  
Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
188.915  
Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
101.739  
Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
2.679  
Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
95.690

Flow rate*Injection pressure*Melting temperature*Screw speed	
4.919	
Flow rate*Injection Speed*Viscosity*Screw speed	
122.327	
Flow rate*Injection pressure*Viscosity*Screw speed	
4.857	
Flow rate*Melting temperature*Viscosity*Screw speed	
137.478	
Injection Speed*Injection pressure*Melting temperature*Viscosity	
99.755	
Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.972	
Injection Speed*Injection pressure*Viscosity*Screw speed	
0.793	
Injection Speed*Melting temperature*Viscosity*Screw speed	
144.444	
Injection pressure*Melting temperature*Viscosity*Screw speed	
2.254	
5-Way Interactions	
49.166	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
99.913	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.951	
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
0.780	
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
145.605	
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
2.234	
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.032	
6-Way Interactions	
0.029	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	0.029
Residual Error	
28.788	
Total	
Source	
F	
Main Effects	
2.10	
Flow rate	
5.47	
Injection Speed	
5.18	
Injection pressure	
2.91	
Melting temperature	
5.83	
Viscosity	
6.56	
Screw speed	
2.40	
2-Way Interactions	
1.13	
Flow rate*Injection Speed	
5.19	
Flow rate*Injection pressure	
2.92	

Flow rate\*Melting temperature  
 5.83  
 Flow rate\*Viscosity  
 6.57  
 Flow rate\*Screw speed  
 2.42  
 Injection Speed\*Injection pressure  
 2.85  
 Injection Speed\*Melting temperature  
 5.54  
 Injection Speed\*Viscosity  
 6.20  
 Injection Speed\*Screw speed  
 2.70  
 Injection pressure\*Melting temperature  
 3.11  
 Injection pressure\*Viscosity  
 3.37  
 Injection pressure\*Screw speed  
 0.28  
 Melting temperature\*Viscosity  
 6.90  
 Melting temperature\*Screw speed  
 2.98  
 Viscosity\*Screw speed  
 3.93  
 3-Way Interactions  
 1.02  
 Flow rate\*Injection Speed\*Injection pressure  
 2.86  
 Flow rate\*Injection Speed\*Melting temperature  
 5.55  
 Flow rate\*Injection pressure\*Melting temperature  
 3.12  
 Flow rate\*Injection Speed\*Viscosity  
 6.21  
 Flow rate\*Injection pressure\*Viscosity  
 3.38  
 Flow rate\*Melting temperature\*Viscosity  
 6.91  
 Flow rate\*Injection Speed\*Screw speed  
 2.72  
 Flow rate\*Injection pressure\*Screw speed  
 0.28  
 Flow rate\*Melting temperature\*Screw speed  
 3.00  
 Flow rate\*Viscosity\*Screw speed  
 3.96  
 Injection Speed\*Injection pressure\*Melting temperature  
 3.05  
 Injection Speed\*Injection pressure\*Viscosity  
 3.30  
 Injection Speed\*Melting temperature\*Viscosity  
 6.55  
 Injection Speed\*Injection pressure\*Screw speed  
 0.09  
 Injection Speed\*Melting temperature\*Screw speed  
 3.30  
 Injection Speed\*Viscosity\*Screw speed  
 4.21  
 Injection pressure\*Melting temperature\*Viscosity  
 3.53

	Injection pressure*Melting temperature*Screw speed	
0.17		
	Injection pressure*Viscosity*Screw speed	
0.17		
	Melting temperature*Viscosity*Screw speed	
4.74		
4-Way Interactions		
1.11		
	Flow rate*Injection Speed*Injection pressure*Melting temperature	
3.06		
	Flow rate*Injection Speed*Injection pressure*Viscosity	
3.30		
	Flow rate*Injection Speed*Melting temperature*Viscosity	
6.56		
	Flow rate*Injection pressure*Melting temperature*Viscosity	
3.53		
	Flow rate*Injection Speed*Injection pressure*Screw speed	
0.09		
	Flow rate*Injection Speed*Melting temperature*Screw speed	
3.32		
	Flow rate*Injection pressure*Melting temperature*Screw speed	
0.17		
	Flow rate*Injection Speed*Viscosity*Screw speed	
4.25		
	Flow rate*Injection pressure*Viscosity*Screw speed	
0.17		
	Flow rate*Melting temperature*Viscosity*Screw speed	
4.78		
	Injection Speed*Injection pressure*Melting temperature*Viscosity	
3.47		
	Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.03		
	Injection Speed*Injection pressure*Viscosity*Screw speed	
0.03		
	Injection Speed*Melting temperature*Viscosity*Screw speed	
5.02		
	Injection pressure*Melting temperature*Viscosity*Screw speed	
0.08		
5-Way Interactions		
1.71		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
3.47		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.03		
	Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
0.03		
	Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
5.06		
	Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.08		
	Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.00		
6-Way Interactions		
0.00		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	0.00
Residual Error		
Total		
Source		
P		
Main Effects		
0.152		

Flow rate  
0.044  
Injection Speed  
0.049  
Injection pressure  
0.122  
Melting temperature  
0.039  
Viscosity  
0.031  
Screw speed  
0.156  
2-Way Interactions  
0.442  
Flow rate\*Injection Speed  
0.049  
Flow rate\*Injection pressure  
0.122  
Flow rate\*Melting temperature  
0.039  
Flow rate\*Viscosity  
0.031  
Flow rate\*Screw speed  
0.154  
Injection Speed\*Injection pressure  
0.126  
Injection Speed\*Melting temperature  
0.043  
Injection Speed\*Viscosity  
0.034  
Injection Speed\*Screw speed  
0.135  
Injection pressure\*Melting temperature  
0.111  
Injection pressure\*Viscosity  
0.099  
Injection pressure\*Screw speed  
0.607  
Melting temperature\*Viscosity  
0.027  
Melting temperature\*Screw speed  
0.119  
Viscosity\*Screw speed  
0.079  
3-Way Interactions  
0.513  
Flow rate\*Injection Speed\*Injection pressure  
0.125  
Flow rate\*Injection Speed\*Melting temperature  
0.043  
Flow rate\*Injection pressure\*Melting temperature  
0.111  
Flow rate\*Injection Speed\*Viscosity  
0.034  
Flow rate\*Injection pressure\*Viscosity  
0.099  
Flow rate\*Melting temperature\*Viscosity  
0.027  
Flow rate\*Injection Speed\*Screw speed  
0.133  
Flow rate\*Injection pressure\*Screw speed  
0.608

Flow rate\*Melting temperature\*Screw speed  
 0.117  
 Flow rate\*Viscosity\*Screw speed  
 0.078  
 Injection Speed\*Injection pressure\*Melting temperature  
 0.115  
 Injection Speed\*Injection pressure\*Viscosity  
 0.103  
 Injection Speed\*Melting temperature\*Viscosity  
 0.031  
 Injection Speed\*Injection pressure\*Screw speed  
 0.766  
 Injection Speed\*Melting temperature\*Screw speed  
 0.103  
 Injection Speed\*Viscosity\*Screw speed  
 0.070  
 Injection pressure\*Melting temperature\*Viscosity  
 0.093  
 Injection pressure\*Melting temperature\*Screw speed  
 0.688  
 Injection pressure\*Viscosity\*Screw speed  
 0.690  
 Melting temperature\*Viscosity\*Screw speed  
 0.057  
 4-Way Interactions  
 0.453  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 0.114  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 0.102  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 0.031  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 0.093  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 0.767  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 0.102  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 0.689  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 0.069  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 0.691  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 0.057  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.096  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.858  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.872  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 0.052  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.786  
 5-Way Interactions  
 0.226  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.095  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.860



Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
0.873  
Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
0.051  
Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
0.787  
Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
0.974  
6-Way Interactions  
0.975  
Flow rate\*Injection Speed\*Injection pressure\*Melting  
temperature\*Viscosity\*Screw speed 0.975  
Residual Error  
Total

#### Unusual Observations for Hard fitting

Obs	StdOrder	Hard fitting	Fit	SE Fit	Residual	St Resid
1	1	16.0000	16.0845	5.3653	-0.0845	-2.18RX
2	2	15.0000	14.8886	5.3391	0.1114	0.21 X
4	4	19.0000	18.7430	5.3588	0.2570	0.96 X
5	5	22.0000	22.3113	5.3623	-0.3113	-1.69 X
7	7	8.0000	7.7749	5.3541	0.2251	0.64 X
8	8	13.0000	14.7095	5.3063	-1.7095	-2.15R
17	17	12.0000	13.5435	5.3103	-1.5435	-2.01R
19	19	8.0000	7.6176	5.3557	0.3824	1.18 X
38	38	14.0000	13.9225	5.3577	0.0775	0.27 X
43	43	11.0000	12.8690	5.2900	-1.8690	-2.08R
44	44	17.0000	14.1696	5.1766	2.8304	2.01R
45	45	7.0000	12.1805	4.7792	-5.1805	-2.12R
56	56	23.0000	22.7839	5.3556	0.2161	0.66 X
57	57	18.0000	18.2628	5.3539	-0.2628	-0.75 X
58	58	12.0000	11.9945	5.3620	0.0055	0.03 X
59	59	10.0000	10.8072	5.3403	-0.8072	-1.55 X
60	60	5.0000	5.0424	5.3650	-0.0424	-0.62 X
61	61	12.0000	12.0074	5.3640	-0.0074	-0.06 X
62	62	13.0000	13.4985	5.3464	-0.4985	-1.10 X
63	63	12.0000	11.7664	5.3635	0.2336	1.59 X
64	64	30.0000	22.8827	4.4204	7.1173	2.34R
65	65	8.0000	12.3766	4.9740	-4.3766	-2.18R
68	68	22.0000	21.5236	5.3570	0.4764	1.58 X
69	69	23.0000	23.1495	5.3602	-0.1495	-0.63 X
70	70	13.0000	12.9725	5.3633	0.0275	0.18 X
71	71	19.0000	18.8872	5.3617	0.1128	0.56 X
72	72	13.0000	13.0875	5.3514	-0.0875	-0.23 X
73	73	18.0000	18.0204	5.3653	-0.0204	-0.44 X

R denotes an observation with a large standardized residual.  
X denotes an observation whose X value gives it large leverage.

#### Estimated Coefficients for Hard fitting using data in uncoded units

Term	Coef
Constant	-2048417
Flow rate	590591
Injection Speed	102326
Injection pressure	-30422.3
Melting temperature	9654.62
Viscosity	1047958
Screw speed	289067

Flow rate*Injection Speed	-31035.3
Flow rate*Injection pressure	13577.8
Flow rate*Melting temperature	-2892.25
Flow rate*Viscosity	-189540
Flow rate*Screw speed	-121079
Injection Speed*Injection pressure	1122.31
Injection Speed*Melting temperature	-476.377
Injection Speed*Viscosity	-54724.5
Injection Speed*Screw speed	-13691.9
Injection pressure*	119.150
Melting temperature	
Injection pressure*Viscosity	23310.1
Injection pressure*Screw speed	-46.40
Melting temperature*Viscosity	-5153.25
Melting temperature*Screw speed	-1288.94
Viscosity*Screw speed	-161646
Flow rate*Injection Speed*	-506.951
Injection pressure	
Flow rate*Injection Speed*	148.611
Melting temperature	
Flow rate*Injection pressure*	-53.7409
Melting temperature	
Flow rate*Injection Speed*Viscosity	11487.2
Flow rate*Injection pressure*	-11771.2
Viscosity	
Flow rate*Melting temperature*	1097.75
Viscosity	
Flow rate*Injection Speed*	5714.43
Screw speed	
Flow rate*Injection pressure*	109.043
Screw speed	
Flow rate*Melting temperature*	540.006
Screw speed	
Flow rate*Viscosity*Screw speed	61566.2
Injection Speed*Injection pressure*	-4.31904
Melting temperature	
Injection Speed*Injection pressure*	-873.173
Viscosity	
Injection Speed*Melting temperature*	262.995
Viscosity	
Injection Speed*Injection pressure*	16.034
Screw speed	
Injection Speed*Melting temperature*	60.8614
Screw speed	
Injection Speed*Viscosity*	7821.21
Screw speed	
Injection pressure*	-91.3063
Melting temperature*Viscosity	
Injection pressure*	0.8269
Melting temperature*Screw speed	
Injection pressure*Viscosity*	-256.02
Screw speed	
Melting temperature*Viscosity*	730.672
Screw speed	
Flow rate*Injection Speed*	1.97837
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	459.567
Injection pressure*Viscosity	
Flow rate*Injection Speed*	-61.5089
Melting temperature*Viscosity	
Flow rate*Injection pressure*	46.8316
Melting temperature*Viscosity	

Flow rate*Injection Speed*	-10.6129
Injection pressure*Screw speed	
Flow rate*Injection Speed*	-25.4087
Melting temperature*Screw speed	
Flow rate*Injection pressure*	-0.72464
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	-2958.76
Screw speed	
Flow rate*Injection pressure*	149.368
Viscosity*Screw speed	
Flow rate*Melting temperature*	-280.245
Viscosity*Screw speed	
Injection Speed*Injection pressure*	3.36993
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	-0.096594
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	0.8146
Viscosity*Screw speed	
Injection Speed*Melting temperature*	-35.1546
Viscosity*Screw speed	
Injection pressure*	0.61390
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	-1.81302
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.056873
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	-2.6844
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	13.3880
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	-0.43444
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	0.017615
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.0025316
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

### Effects Pareto for Hard fitting

\* NOTE \* Some factors have more than 2 levels, no alias table was printed.

### Factorial Fit: Black dots versus Flow rate, Injection Speed, ...

\* NOTE \* This design has some botched runs. It will be analyzed using a regression approach.

Estimated Effects and Coefficients for Black dots (coded units)

Term	Effect	Coef	SE Coef	T
Constant		581454020	438953401	1.32
Flow rate	705699139	352849570	266167967	1.33
Injection Speed	-14150962	-7075481	5564881	-1.27
Injection pressure	-56799611	-28399805	26461702	-1.07
Melting temperature	-42273422	-21136711	15703845	-1.35
Viscosity	529828450	264914225	200118091	1.32
Screw speed	1822606892	911303446	699886215	1.30
Flow rate*Injection Speed	-8589564	-4294782	3373626	-1.27
Flow rate*Injection pressure	-34473415	-17236707	16046531	-1.07
Flow rate*Melting temperature	-25654047	-12827024	9522797	-1.35
Flow rate*Viscosity	321556030	160778015	121306854	1.33
Flow rate*Screw speed	1107544406	553772203	424042169	1.31
Injection Speed*Injection pressure	700512	350256	333509	1.05
Injection Speed*Melting temperature	514483	257242	198808	1.29
Injection Speed*Viscosity	-6437276	-3218638	2534847	-1.27
Injection Speed*Screw speed	-23015588	-11507794	8569398	-1.34
Injection pressure* Melting temperature	2052834	1026417	949687	1.08
Injection pressure*Viscosity	-23980353	-11990176	12358612	-0.97
Injection pressure*Screw speed	-66823561	-33411780	41889602	-0.80
Melting temperature*Viscosity	-19265744	-9632872	7204439	-1.34
Melting temperature*Screw speed	-67722781	-33861391	24827993	-1.36
Viscosity*Screw speed	829176076	414588038	284852940	1.46
Flow rate*Injection Speed* Injection pressure	425300	212650	202172	1.05
Flow rate*Injection Speed* Melting temperature	312299	156150	120531	1.30
Flow rate*Injection pressure* Melting temperature	1245959	622979	575949	1.08
Flow rate*Injection Speed*Viscosity	-3907804	-1953902	1536250	-1.27
Flow rate*Injection pressure* Viscosity	-14557161	-7278581	7494381	-0.97
Flow rate*Melting temperature* Viscosity	-11692843	-5846422	4367347	-1.34
Flow rate*Injection Speed* Screw speed	-13990368	-6995184	5190402	-1.35
Flow rate*Injection pressure* Screw speed	-40600623	-20300311	25421173	-0.80
Flow rate*Melting temperature* Screw speed	-41155947	-20577973	15047607	-1.37
Flow rate*Viscosity*Screw speed	503966040	251983020	172541844	1.46
Injection Speed*Injection pressure* Melting temperature	-25341	-12671	11952	-1.06
Injection Speed*Injection pressure* Viscosity	296027	148014	155019	0.95
Injection Speed*Melting temperature* Viscosity	234108	117054	91080	1.29
Injection Speed*Injection pressure* Screw speed	950020	475010	509496	0.93
Injection Speed*Melting temperature* Screw speed	853620	426810	303804	1.40
Injection Speed*Viscosity* Screw speed	-10456270	-5228135	3546322	-1.47
Injection pressure* Melting temperature*Viscosity	865788	432894	447628	0.97
Injection pressure* Melting temperature*Screw speed	2509167	1254584	1463766	0.86
Injection pressure*Viscosity* Screw speed	-27563629	-13781814	18069041	-0.76
Melting temperature*Viscosity* Screw speed	-30816862	-15408431	10144045	-1.52
Flow rate*Injection Speed*	-15386	-7693	7246	-1.06

Injection pressure*				
Melting temperature				
Flow rate*Injection Speed*	179762	89881	93977	0.96
Injection pressure*Viscosity				
Flow rate*Injection Speed*	142122	71061	55202	1.29
Melting temperature*Viscosity				
Flow rate*Injection pressure*	525583	262792	271470	0.97
Melting temperature*Viscosity				
Flow rate*Injection Speed*	577527	288764	309227	0.93
Injection pressure*Screw speed				
Flow rate*Injection Speed*	518917	259459	184075	1.41
Melting temperature*Screw speed				
Flow rate*Injection pressure*	1524694	762347	888703	0.86
Melting temperature*Screw speed				
Flow rate*Injection Speed*Viscosity*	-6357205	-3178603	2147317	-1.48
Screw speed				
Flow rate*Injection pressure*	-16754742	-8377371	10978134	-0.76
Viscosity*Screw speed				
Flow rate*Melting temperature*	-18731420	-9365710	6147108	-1.52
Viscosity*Screw speed				
Injection Speed*Injection pressure*	-10699	-5350	5605	-0.95
Melting temperature*Viscosity				
Injection Speed*Injection pressure*	-35492	-17746	17879	-0.99
Melting temperature*Screw speed				
Injection Speed*Injection pressure*	400469	200234	224419	0.89
Viscosity*Screw speed				
Injection Speed*Melting temperature*	387870	193935	126247	1.54
Viscosity*Screw speed				
Injection pressure*	1037371	518685	637599	0.81
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	-6497	-3249	3398	-0.96
Injection pressure*				
Melting temperature*Viscosity				
Flow rate*Injection Speed*	-21578	-10789	10857	-0.99
Injection pressure*				
Melting temperature*Screw speed				
Flow rate*Injection Speed*	243550	121775	136384	0.89
Injection pressure*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	235831	117916	76478	1.54
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection pressure*	630641	315321	387598	0.81
Melting temperature*Viscosity*				
Screw speed				
Injection Speed*Injection pressure*	-14980	-7490	7970	-0.94
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	-9111	-4556	4847	-0.94
Injection pressure*				
Melting temperature*Viscosity*				
Screw speed				

Term	P
Constant	0.218
Flow rate	0.218
Injection Speed	0.235
Injection pressure	0.311
Melting temperature	0.211
Viscosity	0.218
Screw speed	0.225
Flow rate*Injection Speed	0.235

Flow rate*Injection pressure	0.311
Flow rate*Melting temperature	0.211
Flow rate*Viscosity	0.218
Flow rate*Screw speed	0.224
Injection Speed*Injection pressure	0.321
Injection Speed*Melting temperature	0.228
Injection Speed*Viscosity	0.236
Injection Speed*Screw speed	0.212
Injection pressure*	0.308
Melting temperature	
Injection pressure*Viscosity	0.357
Injection pressure*Screw speed	0.446
Melting temperature*Viscosity	0.214
Melting temperature*Screw speed	0.206
Viscosity*Screw speed	0.180
Flow rate*Injection Speed*	0.320
Injection pressure	
Flow rate*Injection Speed*	0.227
Melting temperature	
Flow rate*Injection pressure*	0.308
Melting temperature	
Flow rate*Injection Speed*Viscosity	0.235
Flow rate*Injection pressure*	0.357
Viscosity	
Flow rate*Melting temperature*	0.214
Viscosity	
Flow rate*Injection Speed*	0.211
Screw speed	
Flow rate*Injection pressure*	0.445
Screw speed	
Flow rate*Melting temperature*	0.205
Screw speed	
Flow rate*Viscosity*Screw speed	0.178
Injection Speed*Injection pressure*	0.317
Melting temperature	
Injection Speed*Injection pressure*	0.365
Viscosity	
Injection Speed*Melting temperature*	0.231
Viscosity	
Injection Speed*Injection pressure*	0.376
Screw speed	
Injection Speed*Melting temperature*	0.194
Screw speed	
Injection Speed*Viscosity*	0.175
Screw speed	
Injection pressure*	0.359
Melting temperature*Viscosity	
Injection pressure*	0.414
Melting temperature*Screw speed	
Injection pressure*Viscosity*	0.465
Screw speed	
Melting temperature*Viscosity*	0.163
Screw speed	
Flow rate*Injection Speed*	0.316
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	0.364
Injection pressure*Viscosity	
Flow rate*Injection Speed*	0.230
Melting temperature*Viscosity	
Flow rate*Injection pressure*	0.358
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.375

Injection pressure*Screw speed	
Flow rate*Injection Speed*	0.192
Melting temperature*Screw speed	
Flow rate*Injection pressure*	0.413
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	0.173
Screw speed	
Flow rate*Injection pressure*	0.465
Viscosity*Screw speed	
Flow rate*Melting temperature*	0.162
Viscosity*Screw speed	
Injection Speed*Injection pressure*	0.365
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	0.347
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	0.395
Viscosity*Screw speed	
Injection Speed*Melting temperature*	0.159
Viscosity*Screw speed	
Injection pressure*	0.437
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.364
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.346
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	0.395
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.158
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	0.437
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	0.372
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.372
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

S = 8.13954      PRESS = 8335907  
 R-Sq = 88.25%    R-Sq(pred) = 0.00%    R-Sq(adj) = 6.03%

#### Analysis of Variance for Black dots (coded units)

Source	
DF	
Main Effects	
6	
Flow rate	
1	
Injection Speed	
1	
Injection pressure	
1	

```

    Melting temperature
1
    Viscosity
1
    Screw speed
1
2-Way Interactions
15
    Flow rate*Injection Speed
1
    Flow rate*Injection pressure
1
    Flow rate*Melting temperature
1
    Flow rate*Viscosity
1
    Flow rate*Screw speed
1
    Injection Speed*Injection pressure
1
    Injection Speed*Melting temperature
1
    Injection Speed*Viscosity
1
    Injection Speed*Screw speed
1
    Injection pressure*Melting temperature
1
    Injection pressure*Viscosity
1
    Injection pressure*Screw speed
1
    Melting temperature*Viscosity
1
    Melting temperature*Screw speed
1
    Viscosity*Screw speed
1
3-Way Interactions
20
    Flow rate*Injection Speed*Injection pressure
1
    Flow rate*Injection Speed*Melting temperature
1
    Flow rate*Injection pressure*Melting temperature
1
    Flow rate*Injection Speed*Viscosity
1
    Flow rate*Injection pressure*Viscosity
1
    Flow rate*Melting temperature*Viscosity
1
    Flow rate*Injection Speed*Screw speed
1
    Flow rate*Injection pressure*Screw speed
1
    Flow rate*Melting temperature*Screw speed
1
    Flow rate*Viscosity*Screw speed
1
    Injection Speed*Injection pressure*Melting temperature
1

```



```

Injection Speed*Injection pressure*Viscosity
1
Injection Speed*Melting temperature*Viscosity
1
Injection Speed*Injection pressure*Screw speed
1
Injection Speed*Melting temperature*Screw speed
1
Injection Speed*Viscosity*Screw speed
1
Injection pressure*Melting temperature*Viscosity
1
Injection pressure*Melting temperature*Screw speed
1
Injection pressure*Viscosity*Screw speed
1
Melting temperature*Viscosity*Screw speed
1
4-Way Interactions
15
Flow rate*Injection Speed*Injection pressure*Melting temperature
1
Flow rate*Injection Speed*Injection pressure*Viscosity
1
Flow rate*Injection Speed*Melting temperature*Viscosity
1
Flow rate*Injection pressure*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Injection pressure*Screw speed
1
Flow rate*Injection Speed*Melting temperature*Screw speed
1
Flow rate*Injection pressure*Melting temperature*Screw speed
1
Flow rate*Injection Speed*Viscosity*Screw speed
1
Flow rate*Injection pressure*Viscosity*Screw speed
1
Flow rate*Melting temperature*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Injection Speed*Injection pressure*Viscosity*Screw speed
1
Injection Speed*Melting temperature*Viscosity*Screw speed
1
Injection pressure*Melting temperature*Viscosity*Screw speed
1
5-Way Interactions
6
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed
1
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed
1
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed
1

```

```

Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed
1
6-Way Interactions
1
Flow rate*Injection Speed*Injection pressure*Melting
temperature*Viscosity*Screw speed 1
Residual Error
9
Total
72

Source
Seq SS
Main Effects
1081.30
Flow rate
5.47
Injection Speed
313.45
Injection pressure
693.84
Melting temperature
31.50
Viscosity
0.00
Screw speed
37.03
2-Way Interactions
1058.98
Flow rate*Injection Speed
8.24
Flow rate*Injection pressure
300.43
Flow rate*Melting temperature
71.75
Flow rate*Viscosity
2.04
Flow rate*Screw speed
24.33
Injection Speed*Injection pressure
24.48
Injection Speed*Melting temperature
79.02
Injection Speed*Viscosity
14.12
Injection Speed*Screw speed
22.25
Injection pressure*Melting temperature
41.34
Injection pressure*Viscosity
50.32
Injection pressure*Screw speed
20.09
Melting temperature*Viscosity
26.56
Melting temperature*Screw speed
355.80
Viscosity*Screw speed
18.21
3-Way Interactions
1346.63
Flow rate*Injection Speed*Injection pressure
72.72

```

Flow rate\*Injection Speed\*Melting temperature  
 1.49  
 Flow rate\*Injection pressure\*Melting temperature  
 379.03  
 Flow rate\*Injection Speed\*Viscosity  
 0.06  
 Flow rate\*Injection pressure\*Viscosity  
 4.50  
 Flow rate\*Melting temperature\*Viscosity  
 30.25  
 Flow rate\*Injection Speed\*Screw speed  
 163.77  
 Flow rate\*Injection pressure\*Screw speed  
 143.39  
 Flow rate\*Melting temperature\*Screw speed  
 31.40  
 Flow rate\*Viscosity\*Screw speed  
 215.74  
 Injection Speed\*Injection pressure\*Melting temperature  
 33.08  
 Injection Speed\*Injection pressure\*Viscosity  
 169.13  
 Injection Speed\*Melting temperature\*Viscosity  
 7.97  
 Injection Speed\*Injection pressure\*Screw speed  
 2.48  
 Injection Speed\*Melting temperature\*Screw speed  
 31.41  
 Injection Speed\*Viscosity\*Screw speed  
 13.51  
 Injection pressure\*Melting temperature\*Viscosity  
 16.98  
 Injection pressure\*Melting temperature\*Screw speed  
 15.85  
 Injection pressure\*Viscosity\*Screw speed  
 13.20  
 Melting temperature\*Viscosity\*Screw speed  
 0.65  
 4-Way Interactions  
 664.92  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 4.54  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 68.90  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 2.20  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 70.78  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 3.39  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 54.02  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 17.60  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 141.58  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 54.77  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 3.78  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 24.19

Injection Speed*Injection pressure*Melting temperature*Screw speed	0.35
Injection Speed*Injection pressure*Viscosity*Screw speed	102.88
Injection Speed*Melting temperature*Viscosity*Screw speed	24.52
Injection pressure*Melting temperature*Viscosity*Screw speed	91.42
5-Way Interactions	269.57
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	29.68
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	65.38
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	9.72
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	116.81
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	47.97
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	0.01
6-Way Interactions	58.53
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	58.53
Residual Error	596.27
Total	5076.22

Source	
Adj SS	
Main Effects	257.66
Flow rate	116.43
Injection Speed	107.10
Injection pressure	76.31
Melting temperature	120.02
Viscosity	116.10
Screw speed	112.32
2-Way Interactions	593.32
Flow rate*Injection Speed	107.37
Flow rate*Injection pressure	76.44
Flow rate*Melting temperature	120.21
Flow rate*Viscosity	116.38
Flow rate*Screw speed	112.99
Injection Speed*Injection pressure	73.07
Injection Speed*Melting temperature	110.92

Injection Speed\*Viscosity  
 106.82  
 Injection Speed\*Screw speed  
 119.48  
 Injection pressure\*Melting temperature  
 77.39  
 Injection pressure\*Viscosity  
 62.36  
 Injection pressure\*Screw speed  
 42.15  
 Melting temperature\*Viscosity  
 118.44  
 Melting temperature\*Screw speed  
 123.23  
 Viscosity\*Screw speed  
 140.34  
 3-Way Interactions  
 947.90  
 Flow rate\*Injection Speed\*Injection pressure  
 73.30  
 Flow rate\*Injection Speed\*Melting temperature  
 111.20  
 Flow rate\*Injection pressure\*Melting temperature  
 77.51  
 Flow rate\*Injection Speed\*Viscosity  
 107.17  
 Flow rate\*Injection pressure\*Viscosity  
 62.49  
 Flow rate\*Melting temperature\*Viscosity  
 118.73  
 Flow rate\*Injection Speed\*Screw speed  
 120.34  
 Flow rate\*Injection pressure\*Screw speed  
 42.25  
 Flow rate\*Melting temperature\*Screw speed  
 123.90  
 Flow rate\*Viscosity\*Screw speed  
 141.30  
 Injection Speed\*Injection pressure\*Melting temperature  
 74.45  
 Injection Speed\*Injection pressure\*Viscosity  
 60.40  
 Injection Speed\*Melting temperature\*Viscosity  
 109.43  
 Injection Speed\*Injection pressure\*Screw speed  
 57.59  
 Injection Speed\*Melting temperature\*Screw speed  
 130.76  
 Injection Speed\*Viscosity\*Screw speed  
 143.99  
 Injection pressure\*Melting temperature\*Viscosity  
 61.96  
 Injection pressure\*Melting temperature\*Screw speed  
 48.67  
 Injection pressure\*Viscosity\*Screw speed  
 38.54  
 Melting temperature\*Viscosity\*Screw speed  
 152.86  
 4-Way Interactions  
 785.12  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 74.67

Flow rate*Injection Speed*Injection pressure*Viscosity	60.60
Flow rate*Injection Speed*Melting temperature*Viscosity	109.79
Flow rate*Injection pressure*Melting temperature*Viscosity	62.08
Flow rate*Injection Speed*Injection pressure*Screw speed	57.77
Flow rate*Injection Speed*Melting temperature*Screw speed	131.63
Flow rate*Injection pressure*Melting temperature*Screw speed	48.75
Flow rate*Injection Speed*Viscosity*Screw speed	145.17
Flow rate*Injection pressure*Viscosity*Screw speed	38.58
Flow rate*Melting temperature*Viscosity*Screw speed	153.79
Injection Speed*Injection pressure*Melting temperature*Viscosity	60.35
Injection Speed*Injection pressure*Melting temperature*Screw speed	65.27
Injection Speed*Injection pressure*Viscosity*Screw speed	52.74
Injection Speed*Melting temperature*Viscosity*Screw speed	156.34
Injection pressure*Melting temperature*Viscosity*Screw speed	43.84
5-Way Interactions	318.28
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	60.54
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	65.43
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	52.82
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	157.50
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	43.85
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	58.51
6-Way Interactions	58.53
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	58.53
Residual Error	596.27
Total	
Source	
Adj MS	
Main Effects	42.94
Flow rate	116.43
Injection Speed	107.10
Injection pressure	76.31
Melting temperature	120.02

Viscosity  
 116.10  
 Screw speed  
 112.32  
 2-Way Interactions  
 39.55  
 Flow rate\*Injection Speed  
 107.37  
 Flow rate\*Injection pressure  
 76.44  
 Flow rate\*Melting temperature  
 120.21  
 Flow rate\*Viscosity  
 116.38  
 Flow rate\*Screw speed  
 112.99  
 Injection Speed\*Injection pressure  
 73.07  
 Injection Speed\*Melting temperature  
 110.92  
 Injection Speed\*Viscosity  
 106.82  
 Injection Speed\*Screw speed  
 119.48  
 Injection pressure\*Melting temperature  
 77.39  
 Injection pressure\*Viscosity  
 62.36  
 Injection pressure\*Screw speed  
 42.15  
 Melting temperature\*Viscosity  
 118.44  
 Melting temperature\*Screw speed  
 123.23  
 Viscosity\*Screw speed  
 140.34  
 3-Way Interactions  
 47.40  
 Flow rate\*Injection Speed\*Injection pressure  
 73.30  
 Flow rate\*Injection Speed\*Melting temperature  
 111.20  
 Flow rate\*Injection pressure\*Melting temperature  
 77.51  
 Flow rate\*Injection Speed\*Viscosity  
 107.17  
 Flow rate\*Injection pressure\*Viscosity  
 62.49  
 Flow rate\*Melting temperature\*Viscosity  
 118.73  
 Flow rate\*Injection Speed\*Screw speed  
 120.34  
 Flow rate\*Injection pressure\*Screw speed  
 42.25  
 Flow rate\*Melting temperature\*Screw speed  
 123.90  
 Flow rate\*Viscosity\*Screw speed  
 141.30  
 Injection Speed\*Injection pressure\*Melting temperature  
 74.45  
 Injection Speed\*Injection pressure\*Viscosity  
 60.40

Injection Speed\*Melting temperature\*Viscosity  
 109.43  
 Injection Speed\*Injection pressure\*Screw speed  
 57.59  
 Injection Speed\*Melting temperature\*Screw speed  
 130.76  
 Injection Speed\*Viscosity\*Screw speed  
 143.99  
 Injection pressure\*Melting temperature\*Viscosity  
 61.96  
 Injection pressure\*Melting temperature\*Screw speed  
 48.67  
 Injection pressure\*Viscosity\*Screw speed  
 38.54  
 Melting temperature\*Viscosity\*Screw speed  
 152.86  
 4-Way Interactions  
 52.34  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 74.67  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 60.60  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 109.79  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 62.08  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 57.77  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 131.63  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 48.75  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 145.17  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 38.58  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 153.79  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 60.35  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 65.27  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 52.74  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 156.34  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 43.84  
 5-Way Interactions  
 53.05  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 60.54  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 65.43  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 52.82  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 157.50  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 43.85  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 58.51



```

6-Way Interactions
58.53
  Flow rate*Injection Speed*Injection pressure*Melting
temperature*Viscosity*Screw speed  58.53
Residual Error
66.25
Total

Source
F
Main Effects
0.65
  Flow rate
1.76
  Injection Speed
1.62
  Injection pressure
1.15
  Melting temperature
1.81
  Viscosity
1.75
  Screw speed
1.70
2-Way Interactions
0.60
  Flow rate*Injection Speed
1.62
  Flow rate*Injection pressure
1.15
  Flow rate*Melting temperature
1.81
  Flow rate*Viscosity
1.76
  Flow rate*Screw speed
1.71
  Injection Speed*Injection pressure
1.10
  Injection Speed*Melting temperature
1.67
  Injection Speed*Viscosity
1.61
  Injection Speed*Screw speed
1.80
  Injection pressure*Melting temperature
1.17
  Injection pressure*Viscosity
0.94
  Injection pressure*Screw speed
0.64
  Melting temperature*Viscosity
1.79
  Melting temperature*Screw speed
1.86
  Viscosity*Screw speed
2.12
3-Way Interactions
0.72
  Flow rate*Injection Speed*Injection pressure
1.11
  Flow rate*Injection Speed*Melting temperature
1.68

```

Flow rate\*Injection pressure\*Melting temperature  
 1.17  
 Flow rate\*Injection Speed\*Viscosity  
 1.62  
 Flow rate\*Injection pressure\*Viscosity  
 0.94  
 Flow rate\*Melting temperature\*Viscosity  
 1.79  
 Flow rate\*Injection Speed\*Screw speed  
 1.82  
 Flow rate\*Injection pressure\*Screw speed  
 0.64  
 Flow rate\*Melting temperature\*Screw speed  
 1.87  
 Flow rate\*Viscosity\*Screw speed  
 2.13  
 Injection Speed\*Injection pressure\*Melting temperature  
 1.12  
 Injection Speed\*Injection pressure\*Viscosity  
 0.91  
 Injection Speed\*Melting temperature\*Viscosity  
 1.65  
 Injection Speed\*Injection pressure\*Screw speed  
 0.87  
 Injection Speed\*Melting temperature\*Screw speed  
 1.97  
 Injection Speed\*Viscosity\*Screw speed  
 2.17  
 Injection pressure\*Melting temperature\*Viscosity  
 0.94  
 Injection pressure\*Melting temperature\*Screw speed  
 0.73  
 Injection pressure\*Viscosity\*Screw speed  
 0.58  
 Melting temperature\*Viscosity\*Screw speed  
 2.31  
 4-Way Interactions  
 0.79  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 1.13  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 0.91  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 1.66  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 0.94  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 0.87  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 1.99  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 0.74  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 2.19  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 0.58  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 2.32  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.91  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.99

Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.80  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 2.36  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.66  
 5-Way Interactions  
 0.80  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.91  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.99  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.80  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 2.38  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.66  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.88  
 6-Way Interactions  
 0.88  
 Flow rate\*Injection Speed\*Injection pressure\*Melting  
 temperature\*Viscosity\*Screw speed 0.88  
 Residual Error  
 Total

Source  
 P  
 Main Effects  
 0.692  
 Flow rate  
 0.218  
 Injection Speed  
 0.235  
 Injection pressure  
 0.311  
 Melting temperature  
 0.211  
 Viscosity  
 0.218  
 Screw speed  
 0.225  
 2-Way Interactions  
 0.819  
 Flow rate\*Injection Speed  
 0.235  
 Flow rate\*Injection pressure  
 0.311  
 Flow rate\*Melting temperature  
 0.211  
 Flow rate\*Viscosity  
 0.218  
 Flow rate\*Screw speed  
 0.224  
 Injection Speed\*Injection pressure  
 0.321  
 Injection Speed\*Melting temperature  
 0.228  
 Injection Speed\*Viscosity  
 0.236  
 Injection Speed\*Screw speed  
 0.212

Injection pressure\*Melting temperature  
 0.308  
 Injection pressure\*Viscosity  
 0.357  
 Injection pressure\*Screw speed  
 0.446  
 Melting temperature\*Viscosity  
 0.214  
 Melting temperature\*Screw speed  
 0.206  
 Viscosity\*Screw speed  
 0.180  
 3-Way Interactions  
 0.746  
 Flow rate\*Injection Speed\*Injection pressure  
 0.320  
 Flow rate\*Injection Speed\*Melting temperature  
 0.227  
 Flow rate\*Injection pressure\*Melting temperature  
 0.308  
 Flow rate\*Injection Speed\*Viscosity  
 0.235  
 Flow rate\*Injection pressure\*Viscosity  
 0.357  
 Flow rate\*Melting temperature\*Viscosity  
 0.214  
 Flow rate\*Injection Speed\*Screw speed  
 0.211  
 Flow rate\*Injection pressure\*Screw speed  
 0.445  
 Flow rate\*Melting temperature\*Screw speed  
 0.205  
 Flow rate\*Viscosity\*Screw speed  
 0.178  
 Injection Speed\*Injection pressure\*Melting temperature  
 0.317  
 Injection Speed\*Injection pressure\*Viscosity  
 0.365  
 Injection Speed\*Melting temperature\*Viscosity  
 0.231  
 Injection Speed\*Injection pressure\*Screw speed  
 0.376  
 Injection Speed\*Melting temperature\*Screw speed  
 0.194  
 Injection Speed\*Viscosity\*Screw speed  
 0.175  
 Injection pressure\*Melting temperature\*Viscosity  
 0.359  
 Injection pressure\*Melting temperature\*Screw speed  
 0.414  
 Injection pressure\*Viscosity\*Screw speed  
 0.465  
 Melting temperature\*Viscosity\*Screw speed  
 0.163  
 4-Way Interactions  
 0.670  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 0.316  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 0.364  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 0.230

Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 0.358  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 0.375  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 0.192  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 0.413  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 0.173  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 0.465  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 0.162  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.365  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.347  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.395  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 0.159  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.437  
 5-Way Interactions  
 0.593  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.364  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.346  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.395  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 0.158  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.437  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.372  
 6-Way Interactions  
 0.372  
 Flow rate\*Injection Speed\*Injection pressure\*Melting  
 temperature\*Viscosity\*Screw speed 0.372  
 Residual Error  
 Total

#### Unusual Observations for Black dots

Obs	StdOrder	Black dots	Fit	SE Fit	Residual	St Resid
1	1	13.0000	13.1343	8.1393	-0.1343	-2.29RX
2	2	22.0000	21.1108	8.0996	0.8892	1.10 X
4	4	18.0000	18.0532	8.1293	-0.0532	-0.13 X
5	5	32.0000	32.1230	8.1347	-0.1230	-0.44 X
7	7	9.0000	8.9726	8.1223	0.0274	0.05 X
19	19	4.0000	3.1653	8.1246	0.8347	1.70 X
36	36	34.0000	28.8611	7.8994	5.1389	2.62R
38	38	19.0000	19.4668	8.1277	-0.4668	-1.06 X
41	41	12.0000	18.8870	7.5292	-6.8870	-2.23R
46	46	9.0000	21.9366	5.2388	-12.9366	-2.08R
56	56	22.0101	22.3179	8.1245	-0.3078	-0.62 X
57	57	22.0000	22.0270	8.1220	-0.0270	-0.05 X
58	58	28.0000	27.8626	8.1342	0.1374	0.47 X
59	59	24.0000	24.5517	8.1013	-0.5517	-0.70 X

60	60	16.0000	16.0368	8.1389	-0.0368	-0.35 X
61	61	23.0000	23.0571	8.1374	-0.0571	-0.30 X
62	62	17.0000	18.1700	8.1107	-1.1700	-1.71 X
63	63	6.0000	5.8443	8.1365	0.1557	0.70 X
68	68	7.0000	5.9893	8.1267	1.0107	2.21RX
69	69	26.0000	26.4986	8.1315	-0.4986	-1.38 X
70	70	45.0000	44.7613	8.1362	0.2387	1.03 X
71	71	5.0000	4.4397	8.1338	0.5603	1.83 X
72	72	8.0000	8.8166	8.1182	-0.8166	-1.39 X
73	73	3.0000	3.0722	8.1392	-0.0722	-1.03 X

R denotes an observation with a large standardized residual.

X denotes an observation whose X value gives it large leverage.

Estimated Coefficients for Black dots using data in uncoded units

Term	Coef
Constant	-2520966
Flow rate	797581
Injection Speed	124942
Injection pressure	8772.8
Melting temperature	11196.5
Viscosity	1793642
Screw speed	247267
Flow rate*Injection Speed	-39304.0
Flow rate*Injection pressure	-1317.4
Flow rate*Melting temperature	-3549.25
Flow rate*Viscosity	-623369
Flow rate*Screw speed	-93272.2
Injection Speed*Injection pressure	-696.93
Injection Speed*Melting temperature	-552.095
Injection Speed*Viscosity	-89627.6
Injection Speed*Screw speed	-11824.8
Injection pressure*	-42.427
Melting temperature	
Injection pressure*Viscosity	-8431.0
Injection pressure*Screw speed	-1269.47
Melting temperature*Viscosity	-7980.14
Melting temperature*Screw speed	-1078.15
Viscosity*Screw speed	-179524
Flow rate*Injection Speed*	166.342
Injection pressure	
Flow rate*Injection Speed*	173.854
Melting temperature	
Flow rate*Injection pressure*	7.2552
Melting temperature	
Flow rate*Injection Speed*Viscosity	30692.8
Flow rate*Injection pressure*	2527.8
Viscosity	
Flow rate*Melting temperature*	2770.69
Viscosity	
Flow rate*Injection Speed*	4370.04
Screw speed	
Flow rate*Injection pressure*	403.19
Screw speed	
Flow rate*Melting temperature*	405.415
Screw speed	
Flow rate*Viscosity*Screw speed	72491.1
Injection Speed*Injection pressure*	3.1949
Melting temperature	
Injection Speed*Injection pressure*	583.51
Viscosity	

Injection Speed*Melting temperature* Viscosity	396.641
Injection Speed*Injection pressure* Screw speed	74.592
Injection Speed*Melting temperature* Screw speed	51.4613
Injection Speed*Viscosity* Screw speed	8643.08
Injection pressure* Melting temperature*Viscosity	39.873
Injection pressure* Melting temperature*Screw speed	5.6339
Injection pressure*Viscosity* Screw speed	1230.83
Melting temperature*Viscosity* Screw speed	783.289
Flow rate*Injection Speed* Injection pressure* Melting temperature	-0.78003
Flow rate*Injection Speed* Injection pressure*Viscosity	-183.795
Flow rate*Injection Speed* Melting temperature*Viscosity	-135.704
Flow rate*Injection pressure* Melting temperature*Viscosity	-12.0989
Flow rate*Injection Speed* Injection pressure*Screw speed	-23.9743
Flow rate*Injection Speed* Melting temperature*Screw speed	-18.9610
Flow rate*Injection pressure* Melting temperature*Screw speed	-1.78809
Flow rate*Injection Speed*Viscosity* Screw speed	-3405.01
Flow rate*Injection pressure* Viscosity*Screw speed	-491.212
Flow rate*Melting temperature* Viscosity*Screw speed	-314.823
Injection Speed*Injection pressure* Melting temperature*Viscosity	-2.66271
Injection Speed*Injection pressure* Melting temperature*Screw speed	-0.328170
Injection Speed*Injection pressure* Viscosity*Screw speed	-67.558
Injection Speed*Melting temperature* Viscosity*Screw speed	-37.6345
Injection pressure* Melting temperature*Viscosity* Screw speed	-5.43563
Flow rate*Injection Speed* Injection pressure* Melting temperature*Viscosity	0.84142
Flow rate*Injection Speed* Injection pressure* Melting temperature*Screw speed	0.105257
Flow rate*Injection Speed* Injection pressure*Viscosity* Screw speed	25.9833
Flow rate*Injection Speed* Melting temperature*Viscosity* Screw speed	14.7653
Flow rate*Injection pressure* Melting temperature*Viscosity* Screw speed	2.15340

Injection Speed*Injection pressure*	0.296556
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	-0.113405
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

## Effects Pareto for Black dots

\* NOTE \* Some factors have more than 2 levels, no alias table was printed.

## Factorial Fit: Bubbles versus Flow rate, Injection Speed, ...

\* NOTE \* This design has some botched runs. It will be analyzed using a regression approach.

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef	SE Coef	T
Constant		676089693	289352422	2.34
Flow rate	820447079	410223540	175454492	2.34
Injection Speed	-16696764	-8348382	3668298	-2.28
Injection pressure	-59558319	-29779160	17443213	-1.71
Melting temperature	-49972005	-24986002	10351772	-2.41
Viscosity	675659242	337829621	131915266	2.56
Screw speed	1429652426	714826213	461355969	1.55
Flow rate*Injection Speed	-10132996	-5066498	2223851	-2.28
Flow rate*Injection pressure	-36136329	-18068164	10577666	-1.71
Flow rate*Melting temperature	-30321316	-15160658	6277305	-2.42
Flow rate*Viscosity	409924232	204962116	79963914	2.56
Flow rate*Screw speed	869901501	434950751	279523131	1.56
Injection Speed*Injection pressure	742234	371117	219845	1.69
Injection Speed*Melting temperature	616778	308389	131051	2.35
Injection Speed*Viscosity	-8320819	-4160409	1670938	-2.49
Injection Speed*Screw speed	-18561847	-9280923	5648837	-1.64
Injection pressure*	2209167	1104583	626021	1.76
Melting temperature				
Injection pressure*Viscosity	-29928977	-14964489	8146637	-1.84
Injection pressure*Screw speed	29410841	14705421	27613086	0.53
Melting temperature*Viscosity	-24955148	-12477574	4749073	-2.63
Melting temperature*Screw speed	-56474167	-28237083	16366293	-1.73
Viscosity*Screw speed	744345049	372172525	187771385	1.98
Flow rate*Injection Speed*	450449	225224	133269	1.69
Injection pressure				
Flow rate*Injection Speed*	374316	187158	79452	2.36
Melting temperature				
Flow rate*Injection pressure*	1340396	670198	379658	1.77
Melting temperature				
Flow rate*Injection Speed*Viscosity	-5049173	-2524586	1012676	-2.49
Flow rate*Injection pressure*	-18156712	-9078356	4940199	-1.84
Viscosity				
Flow rate*Melting temperature*	-15140482	-7570241	2878899	-2.63
Viscosity				
Flow rate*Injection Speed*	-11295556	-5647778	3421446	-1.65
Screw speed				
Flow rate*Injection pressure*	17809250	8904625	16757310	0.53



Screw speed				
Flow rate*Melting temperature*	-34358022	-17179011	9919188	-1.73
Screw speed				
Flow rate*Viscosity*Screw speed	452712825	226356412	113737359	1.99
Injection Speed*Injection pressure*	-27529	-13765	7879	-1.75
Melting temperature				
Injection Speed*Injection pressure*	371150	185575	102187	1.82
Viscosity				
Injection Speed*Melting temperature*	307230	153615	60039	2.56
Viscosity				
Injection Speed*Injection pressure*	-206095	-103047	335853	-0.31
Screw speed				
Injection Speed*Melting temperature*	727162	363581	200264	1.82
Screw speed				
Injection Speed*Viscosity*	-9593946	-4796973	2337690	-2.05
Screw speed				
Injection pressure*	1109045	554523	295070	1.88
Melting temperature*Viscosity				
Injection pressure*	-800656	-400328	964896	-0.41
Melting temperature*Screw speed				
Injection pressure*Viscosity*	9811125	4905563	11910879	0.41
Screw speed				
Melting temperature*Viscosity*	-29121127	-14560563	6686824	-2.18
Screw speed				
Flow rate*Injection Speed*	-16707	-8353	4777	-1.75
Injection pressure*				
Melting temperature				
Flow rate*Injection Speed*	225206	112603	61949	1.82
Injection pressure*Viscosity				
Flow rate*Injection Speed*	186432	93216	36389	2.56
Melting temperature*Viscosity				
Flow rate*Injection pressure*	672815	336407	178949	1.88
Melting temperature*Viscosity				
Flow rate*Injection Speed*	-124354	-62177	203839	-0.31
Injection pressure*Screw speed				
Flow rate*Injection Speed*	442445	221222	121340	1.82
Melting temperature*Screw speed				
Flow rate*Injection pressure*	-484310	-242155	585821	-0.41
Melting temperature*Screw speed				
Flow rate*Injection Speed*Viscosity*	-5835617	-2917809	1415484	-2.06
Screw speed				
Flow rate*Injection pressure*	5945009	2972504	7236644	0.41
Viscosity*Screw speed				
Flow rate*Melting temperature*	-17709944	-8854972	4052094	-2.19
Viscosity*Screw speed				
Injection Speed*Injection pressure*	-13756	-6878	3695	-1.86
Melting temperature*Viscosity				
Injection Speed*Injection pressure*	4332	2166	11785	0.18
Melting temperature*Screw speed				
Injection Speed*Injection pressure*	-49104	-24552	147934	-0.17
Viscosity*Screw speed				
Injection Speed*Melting temperature*	372822	186411	83221	2.24
Viscosity*Screw speed				
Injection pressure*	-235229	-117614	420297	-0.28
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	-8347	-4173	2240	-1.86
Injection pressure*				
Melting temperature*Viscosity				
Flow rate*Injection Speed*	2601	1301	7157	0.18
Injection pressure*				
Melting temperature*Screw speed				
Flow rate*Injection Speed*	-29589	-14795	89902	-0.16

Injection pressure*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	226753	113376	50413	2.25
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection pressure*	-142348	-71174	255500	-0.28
Melting temperature*Viscosity*				
Screw speed				
Injection Speed*Injection pressure*	349	175	5254	0.03
Melting temperature*Viscosity*				
Screw speed				
Flow rate*Injection Speed*	203	102	3195	0.03
Injection pressure*				
Melting temperature*Viscosity*				
Screw speed				

Term	P
Constant	0.044
Flow rate	0.044
Injection Speed	0.049
Injection pressure	0.122
Melting temperature	0.039
Viscosity	0.031
Screw speed	0.156
Flow rate*Injection Speed	0.049
Flow rate*Injection pressure	0.122
Flow rate*Melting temperature	0.039
Flow rate*Viscosity	0.031
Flow rate*Screw speed	0.154
Injection Speed*Injection pressure	0.126
Injection Speed*Melting temperature	0.043
Injection Speed*Viscosity	0.034
Injection Speed*Screw speed	0.135
Injection pressure*	0.111
Melting temperature	
Injection pressure*Viscosity	0.099
Injection pressure*Screw speed	0.607
Melting temperature*Viscosity	0.027
Melting temperature*Screw speed	0.119
Viscosity*Screw speed	0.079
Flow rate*Injection Speed*	0.125
Injection pressure	
Flow rate*Injection Speed*	0.043
Melting temperature	
Flow rate*Injection pressure*	0.111
Melting temperature	
Flow rate*Injection Speed*Viscosity	0.034
Flow rate*Injection pressure*	0.099
Viscosity	
Flow rate*Melting temperature*	0.027
Viscosity	
Flow rate*Injection Speed*	0.133
Screw speed	
Flow rate*Injection pressure*	0.608
Screw speed	
Flow rate*Melting temperature*	0.117
Screw speed	
Flow rate*Viscosity*Screw speed	0.078
Injection Speed*Injection pressure*	0.115
Melting temperature	
Injection Speed*Injection pressure*	0.103
Viscosity	
Injection Speed*Melting temperature*	0.031

Viscosity	
Injection Speed*Injection pressure*	0.766
Screw speed	
Injection Speed*Melting temperature*	0.103
Screw speed	
Injection Speed*Viscosity*	0.070
Screw speed	
Injection pressure*	0.093
Melting temperature*Viscosity	
Injection pressure*	0.688
Melting temperature*Screw speed	
Injection pressure*Viscosity*	0.690
Screw speed	
Melting temperature*Viscosity*	0.057
Screw speed	
Flow rate*Injection Speed*	0.114
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	0.102
Injection pressure*Viscosity	
Flow rate*Injection Speed*	0.031
Melting temperature*Viscosity	
Flow rate*Injection pressure*	0.093
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.767
Injection pressure*Screw speed	
Flow rate*Injection Speed*	0.102
Melting temperature*Screw speed	
Flow rate*Injection pressure*	0.689
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	0.069
Screw speed	
Flow rate*Injection pressure*	0.691
Viscosity*Screw speed	
Flow rate*Melting temperature*	0.057
Viscosity*Screw speed	
Injection Speed*Injection pressure*	0.096
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	0.858
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	0.872
Viscosity*Screw speed	
Injection Speed*Melting temperature*	0.052
Viscosity*Screw speed	
Injection pressure*	0.786
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.095
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.860
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	0.873
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.051
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	0.787
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	0.974

Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.975
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

S = 5.36548      PRESS = 3048194  
 R-Sq = 89.30%    R-Sq(pred) = 0.00%    R-Sq(adj) = 14.40%

Analysis of Variance for Bubbles (coded units)

Source	
DF	
Main Effects	
6	
Flow rate	
1	
Injection Speed	
1	
Injection pressure	
1	
Melting temperature	
1	
Viscosity	
1	
Screw speed	
1	
2-Way Interactions	
15	
Flow rate*Injection Speed	
1	
Flow rate*Injection pressure	
1	
Flow rate*Melting temperature	
1	
Flow rate*Viscosity	
1	
Flow rate*Screw speed	
1	
Injection Speed*Injection pressure	
1	
Injection Speed*Melting temperature	
1	
Injection Speed*Viscosity	
1	
Injection Speed*Screw speed	
1	
Injection pressure*Melting temperature	
1	
Injection pressure*Viscosity	
1	
Injection pressure*Screw speed	
1	
Melting temperature*Viscosity	
1	
Melting temperature*Screw speed	
1	
Viscosity*Screw speed	
1	

### 3-Way Interactions

20

1 Flow rate\*Injection Speed\*Injection pressure  
1 Flow rate\*Injection Speed\*Melting temperature  
1 Flow rate\*Injection pressure\*Melting temperature  
1 Flow rate\*Injection Speed\*Viscosity  
1 Flow rate\*Injection pressure\*Viscosity  
1 Flow rate\*Melting temperature\*Viscosity  
1 Flow rate\*Injection Speed\*Screw speed  
1 Flow rate\*Injection pressure\*Screw speed  
1 Flow rate\*Melting temperature\*Screw speed  
1 Flow rate\*Viscosity\*Screw speed  
1 Injection Speed\*Injection pressure\*Melting temperature  
1 Injection Speed\*Injection pressure\*Viscosity  
1 Injection Speed\*Melting temperature\*Viscosity  
1 Injection Speed\*Injection pressure\*Screw speed  
1 Injection Speed\*Melting temperature\*Screw speed  
1 Injection Speed\*Viscosity\*Screw speed  
1 Injection pressure\*Melting temperature\*Viscosity  
1 Injection pressure\*Melting temperature\*Screw speed  
1 Injection pressure\*Viscosity\*Screw speed  
1 Melting temperature\*Viscosity\*Screw speed

### 4-Way Interactions

15

1 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
1 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
1 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
1 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
1 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
1 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
1 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
1 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
1 Flow rate\*Injection pressure\*Viscosity\*Screw speed

1

```

Flow rate*Melting temperature*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Injection Speed*Injection pressure*Viscosity*Screw speed
1
Injection Speed*Melting temperature*Viscosity*Screw speed
1
Injection pressure*Melting temperature*Viscosity*Screw speed
1
5-Way Interactions
6
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity
1
Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed
1
Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed
1
Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed
1
Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed
1
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed
1
6-Way Interactions
1
Flow rate*Injection Speed*Injection pressure*Melting
temperature*Viscosity*Screw speed 1
Residual Error
9
Total
72

```

```

Source
Seq SS
Main Effects
432.96
Flow rate
57.68
Injection Speed
126.48
Injection pressure
23.83
Melting temperature
72.99
Viscosity
1.81
Screw speed
150.18
2-Way Interactions
374.88
Flow rate*Injection Speed
12.42
Flow rate*Injection pressure
65.46
Flow rate*Melting temperature
3.34
Flow rate*Viscosity
0.65
Flow rate*Screw speed
2.13

```

Injection Speed\*Injection pressure  
 41.04  
 Injection Speed\*Melting temperature  
 3.55  
 Injection Speed\*Viscosity  
 46.88  
 Injection Speed\*Screw speed  
 97.23  
 Injection pressure\*Melting temperature  
 18.75  
 Injection pressure\*Viscosity  
 61.54  
 Injection pressure\*Screw speed  
 0.00  
 Melting temperature\*Viscosity  
 7.31  
 Melting temperature\*Screw speed  
 13.35  
 Viscosity\*Screw speed  
 1.23  
 3-Way Interactions  
 695.00  
 Flow rate\*Injection Speed\*Injection pressure  
 49.56  
 Flow rate\*Injection Speed\*Melting temperature  
 9.32  
 Flow rate\*Injection pressure\*Melting temperature  
 23.89  
 Flow rate\*Injection Speed\*Viscosity  
 31.50  
 Flow rate\*Injection pressure\*Viscosity  
 0.04  
 Flow rate\*Melting temperature\*Viscosity  
 3.27  
 Flow rate\*Injection Speed\*Screw speed  
 32.74  
 Flow rate\*Injection pressure\*Screw speed  
 29.57  
 Flow rate\*Melting temperature\*Screw speed  
 1.24  
 Flow rate\*Viscosity\*Screw speed  
 10.13  
 Injection Speed\*Injection pressure\*Melting temperature  
 2.06  
 Injection Speed\*Injection pressure\*Viscosity  
 1.22  
 Injection Speed\*Melting temperature\*Viscosity  
 109.98  
 Injection Speed\*Injection pressure\*Screw speed  
 151.73  
 Injection Speed\*Melting temperature\*Screw speed  
 28.32  
 Injection Speed\*Viscosity\*Screw speed  
 47.45  
 Injection pressure\*Melting temperature\*Viscosity  
 41.02  
 Injection pressure\*Melting temperature\*Screw speed  
 1.78  
 Injection pressure\*Viscosity\*Screw speed  
 119.98  
 Melting temperature\*Viscosity\*Screw speed  
 0.19

#### 4-Way Interactions

362.07  
Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
6.90  
Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
1.64  
Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
26.42  
Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
11.05  
Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
14.25  
Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
38.67  
Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
0.08  
Flow rate\*Injection Speed\*Viscosity\*Screw speed  
16.56  
Flow rate\*Injection pressure\*Viscosity\*Screw speed  
1.60  
Flow rate\*Melting temperature\*Viscosity\*Screw speed  
33.41  
Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
15.88  
Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
42.76  
Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
70.29  
Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
24.32  
Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
58.26

#### 5-Way Interactions

297.47  
Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
0.00  
Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
0.06  
Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
77.20  
Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
127.49  
Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
92.28  
Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
0.44

#### 6-Way Interactions

0.03  
Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed 0.03

Residual Error

259.10

Total

2421.51

Source

Adj SS

Main Effects

363.084

Flow rate

157.373

Injection Speed

149.105



Injection pressure  
83.905  
Melting temperature  
167.719  
Viscosity  
188.809  
Screw speed  
69.111  
2-Way Interactions  
487.207  
Flow rate\*Injection Speed  
149.425  
Flow rate\*Injection pressure  
83.997  
Flow rate\*Melting temperature  
167.922  
Flow rate\*Viscosity  
189.137  
Flow rate\*Screw speed  
69.705  
Injection Speed\*Injection pressure  
82.036  
Injection Speed\*Melting temperature  
159.416  
Injection Speed\*Viscosity  
178.471  
Injection Speed\*Screw speed  
77.711  
Injection pressure\*Melting temperature  
89.626  
Injection pressure\*Viscosity  
97.137  
Injection pressure\*Screw speed  
8.165  
Melting temperature\*Viscosity  
198.728  
Melting temperature\*Screw speed  
85.695  
Viscosity\*Screw speed  
113.096  
3-Way Interactions  
589.527  
Flow rate\*Injection Speed\*Injection pressure  
82.222  
Flow rate\*Injection Speed\*Melting temperature  
159.742  
Flow rate\*Injection pressure\*Melting temperature  
89.710  
Flow rate\*Injection Speed\*Viscosity  
178.919  
Flow rate\*Injection pressure\*Viscosity  
97.217  
Flow rate\*Melting temperature\*Viscosity  
199.060  
Flow rate\*Injection Speed\*Screw speed  
78.443  
Flow rate\*Injection pressure\*Screw speed  
8.129  
Flow rate\*Melting temperature\*Screw speed  
86.350  
Flow rate\*Viscosity\*Screw speed  
114.024

Injection Speed\*Injection pressure\*Melting temperature  
 87.867  
 Injection Speed\*Injection pressure\*Viscosity  
 94.944  
 Injection Speed\*Melting temperature\*Viscosity  
 188.460  
 Injection Speed\*Injection pressure\*Screw speed  
 2.710  
 Injection Speed\*Melting temperature\*Screw speed  
 94.889  
 Injection Speed\*Viscosity\*Screw speed  
 121.221  
 Injection pressure\*Melting temperature\*Viscosity  
 101.673  
 Injection pressure\*Melting temperature\*Screw speed  
 4.956  
 Injection pressure\*Viscosity\*Screw speed  
 4.883  
 Melting temperature\*Viscosity\*Screw speed  
 136.500  
 4-Way Interactions  
 478.964  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 88.047  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 95.116  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 188.915  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 101.739  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 2.679  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 95.690  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 4.919  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 122.327  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 4.857  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 137.478  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 99.755  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.972  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.793  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 144.444  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 2.254  
 5-Way Interactions  
 294.998  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 99.913  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.951  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.780  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 145.605

Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
2.234	
Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.032	
6-Way Interactions	
0.029	
Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	0.029
Residual Error	
259.096	
Total	
Source	
Adj MS	
Main Effects	
60.514	
Flow rate	
157.373	
Injection Speed	
149.105	
Injection pressure	
83.905	
Melting temperature	
167.719	
Viscosity	
188.809	
Screw speed	
69.111	
2-Way Interactions	
32.480	
Flow rate*Injection Speed	
149.425	
Flow rate*Injection pressure	
83.997	
Flow rate*Melting temperature	
167.922	
Flow rate*Viscosity	
189.137	
Flow rate*Screw speed	
69.705	
Injection Speed*Injection pressure	
82.036	
Injection Speed*Melting temperature	
159.416	
Injection Speed*Viscosity	
178.471	
Injection Speed*Screw speed	
77.711	
Injection pressure*Melting temperature	
89.626	
Injection pressure*Viscosity	
97.137	
Injection pressure*Screw speed	
8.165	
Melting temperature*Viscosity	
198.728	
Melting temperature*Screw speed	
85.695	
Viscosity*Screw speed	
113.096	
3-Way Interactions	
29.476	

Flow rate\*Injection Speed\*Injection pressure  
 82.222  
 Flow rate\*Injection Speed\*Melting temperature  
 159.742  
 Flow rate\*Injection pressure\*Melting temperature  
 89.710  
 Flow rate\*Injection Speed\*Viscosity  
 178.919  
 Flow rate\*Injection pressure\*Viscosity  
 97.217  
 Flow rate\*Melting temperature\*Viscosity  
 199.060  
 Flow rate\*Injection Speed\*Screw speed  
 78.443  
 Flow rate\*Injection pressure\*Screw speed  
 8.129  
 Flow rate\*Melting temperature\*Screw speed  
 86.350  
 Flow rate\*Viscosity\*Screw speed  
 114.024  
 Injection Speed\*Injection pressure\*Melting temperature  
 87.867  
 Injection Speed\*Injection pressure\*Viscosity  
 94.944  
 Injection Speed\*Melting temperature\*Viscosity  
 188.460  
 Injection Speed\*Injection pressure\*Screw speed  
 2.710  
 Injection Speed\*Melting temperature\*Screw speed  
 94.889  
 Injection Speed\*Viscosity\*Screw speed  
 121.221  
 Injection pressure\*Melting temperature\*Viscosity  
 101.673  
 Injection pressure\*Melting temperature\*Screw speed  
 4.956  
 Injection pressure\*Viscosity\*Screw speed  
 4.883  
 Melting temperature\*Viscosity\*Screw speed  
 136.500  
 4-Way Interactions  
 31.931  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 88.047  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 95.116  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 188.915  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 101.739  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 2.679  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 95.690  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 4.919  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 122.327  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 4.857  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 137.478

Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 99.755  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.972  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.793  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 144.444  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 2.254  
 5-Way Interactions  
 49.166  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 99.913  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.951  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.780  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 145.605  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 2.234  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.032  
 6-Way Interactions  
 0.029  
 Flow rate\*Injection Speed\*Injection pressure\*Melting  
 temperature\*Viscosity\*Screw speed 0.029  
 Residual Error  
 28.788  
 Total

#### Source

F

#### Main Effects

2.10

Flow rate

5.47

Injection Speed

5.18

Injection pressure

2.91

Melting temperature

5.83

Viscosity

6.56

Screw speed

2.40

#### 2-Way Interactions

1.13

Flow rate\*Injection Speed

5.19

Flow rate\*Injection pressure

2.92

Flow rate\*Melting temperature

5.83

Flow rate\*Viscosity

6.57

Flow rate\*Screw speed

2.42

Injection Speed\*Injection pressure

2.85

Injection Speed\*Melting temperature  
 5.54  
 Injection Speed\*Viscosity  
 6.20  
 Injection Speed\*Screw speed  
 2.70  
 Injection pressure\*Melting temperature  
 3.11  
 Injection pressure\*Viscosity  
 3.37  
 Injection pressure\*Screw speed  
 0.28  
 Melting temperature\*Viscosity  
 6.90  
 Melting temperature\*Screw speed  
 2.98  
 Viscosity\*Screw speed  
 3.93  
 3-Way Interactions  
 1.02  
 Flow rate\*Injection Speed\*Injection pressure  
 2.86  
 Flow rate\*Injection Speed\*Melting temperature  
 5.55  
 Flow rate\*Injection pressure\*Melting temperature  
 3.12  
 Flow rate\*Injection Speed\*Viscosity  
 6.21  
 Flow rate\*Injection pressure\*Viscosity  
 3.38  
 Flow rate\*Melting temperature\*Viscosity  
 6.91  
 Flow rate\*Injection Speed\*Screw speed  
 2.72  
 Flow rate\*Injection pressure\*Screw speed  
 0.28  
 Flow rate\*Melting temperature\*Screw speed  
 3.00  
 Flow rate\*Viscosity\*Screw speed  
 3.96  
 Injection Speed\*Injection pressure\*Melting temperature  
 3.05  
 Injection Speed\*Injection pressure\*Viscosity  
 3.30  
 Injection Speed\*Melting temperature\*Viscosity  
 6.55  
 Injection Speed\*Injection pressure\*Screw speed  
 0.09  
 Injection Speed\*Melting temperature\*Screw speed  
 3.30  
 Injection Speed\*Viscosity\*Screw speed  
 4.21  
 Injection pressure\*Melting temperature\*Viscosity  
 3.53  
 Injection pressure\*Melting temperature\*Screw speed  
 0.17  
 Injection pressure\*Viscosity\*Screw speed  
 0.17  
 Melting temperature\*Viscosity\*Screw speed  
 4.74  
 4-Way Interactions  
 1.11

	Flow rate*Injection Speed*Injection pressure*Melting temperature	
3.06		
	Flow rate*Injection Speed*Injection pressure*Viscosity	
3.30		
	Flow rate*Injection Speed*Melting temperature*Viscosity	
6.56		
	Flow rate*Injection pressure*Melting temperature*Viscosity	
3.53		
	Flow rate*Injection Speed*Injection pressure*Screw speed	
0.09		
	Flow rate*Injection Speed*Melting temperature*Screw speed	
3.32		
	Flow rate*Injection pressure*Melting temperature*Screw speed	
0.17		
	Flow rate*Injection Speed*Viscosity*Screw speed	
4.25		
	Flow rate*Injection pressure*Viscosity*Screw speed	
0.17		
	Flow rate*Melting temperature*Viscosity*Screw speed	
4.78		
	Injection Speed*Injection pressure*Melting temperature*Viscosity	
3.47		
	Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.03		
	Injection Speed*Injection pressure*Viscosity*Screw speed	
0.03		
	Injection Speed*Melting temperature*Viscosity*Screw speed	
5.02		
	Injection pressure*Melting temperature*Viscosity*Screw speed	
0.08		
	5-Way Interactions	
1.71		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity	
3.47		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Screw speed	
0.03		
	Flow rate*Injection Speed*Injection pressure*Viscosity*Screw speed	
0.03		
	Flow rate*Injection Speed*Melting temperature*Viscosity*Screw speed	
5.06		
	Flow rate*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.08		
	Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	
0.00		
	6-Way Interactions	
0.00		
	Flow rate*Injection Speed*Injection pressure*Melting temperature*Viscosity*Screw speed	0.00
	Residual Error	
	Total	
	Source	
	P	
	Main Effects	
0.152		
	Flow rate	
0.044		
	Injection Speed	
0.049		
	Injection pressure	
0.122		
	Melting temperature	
0.039		

Viscosity  
0.031  
Screw speed  
0.156  
2-Way Interactions  
0.442  
Flow rate\*Injection Speed  
0.049  
Flow rate\*Injection pressure  
0.122  
Flow rate\*Melting temperature  
0.039  
Flow rate\*Viscosity  
0.031  
Flow rate\*Screw speed  
0.154  
Injection Speed\*Injection pressure  
0.126  
Injection Speed\*Melting temperature  
0.043  
Injection Speed\*Viscosity  
0.034  
Injection Speed\*Screw speed  
0.135  
Injection pressure\*Melting temperature  
0.111  
Injection pressure\*Viscosity  
0.099  
Injection pressure\*Screw speed  
0.607  
Melting temperature\*Viscosity  
0.027  
Melting temperature\*Screw speed  
0.119  
Viscosity\*Screw speed  
0.079  
3-Way Interactions  
0.513  
Flow rate\*Injection Speed\*Injection pressure  
0.125  
Flow rate\*Injection Speed\*Melting temperature  
0.043  
Flow rate\*Injection pressure\*Melting temperature  
0.111  
Flow rate\*Injection Speed\*Viscosity  
0.034  
Flow rate\*Injection pressure\*Viscosity  
0.099  
Flow rate\*Melting temperature\*Viscosity  
0.027  
Flow rate\*Injection Speed\*Screw speed  
0.133  
Flow rate\*Injection pressure\*Screw speed  
0.608  
Flow rate\*Melting temperature\*Screw speed  
0.117  
Flow rate\*Viscosity\*Screw speed  
0.078  
Injection Speed\*Injection pressure\*Melting temperature  
0.115  
Injection Speed\*Injection pressure\*Viscosity  
0.103



Injection Speed\*Melting temperature\*Viscosity  
 0.031  
 Injection Speed\*Injection pressure\*Screw speed  
 0.766  
 Injection Speed\*Melting temperature\*Screw speed  
 0.103  
 Injection Speed\*Viscosity\*Screw speed  
 0.070  
 Injection pressure\*Melting temperature\*Viscosity  
 0.093  
 Injection pressure\*Melting temperature\*Screw speed  
 0.688  
 Injection pressure\*Viscosity\*Screw speed  
 0.690  
 Melting temperature\*Viscosity\*Screw speed  
 0.057  
 4-Way Interactions  
 0.453  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature  
 0.114  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity  
 0.102  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity  
 0.031  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity  
 0.093  
 Flow rate\*Injection Speed\*Injection pressure\*Screw speed  
 0.767  
 Flow rate\*Injection Speed\*Melting temperature\*Screw speed  
 0.102  
 Flow rate\*Injection pressure\*Melting temperature\*Screw speed  
 0.689  
 Flow rate\*Injection Speed\*Viscosity\*Screw speed  
 0.069  
 Flow rate\*Injection pressure\*Viscosity\*Screw speed  
 0.691  
 Flow rate\*Melting temperature\*Viscosity\*Screw speed  
 0.057  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.096  
 Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.858  
 Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.872  
 Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 0.052  
 Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.786  
 5-Way Interactions  
 0.226  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Viscosity  
 0.095  
 Flow rate\*Injection Speed\*Injection pressure\*Melting temperature\*Screw speed  
 0.860  
 Flow rate\*Injection Speed\*Injection pressure\*Viscosity\*Screw speed  
 0.873  
 Flow rate\*Injection Speed\*Melting temperature\*Viscosity\*Screw speed  
 0.051  
 Flow rate\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.787  
 Injection Speed\*Injection pressure\*Melting temperature\*Viscosity\*Screw speed  
 0.974

# 6-Way Interactions

0.975

Flow rate\*Injection Speed\*Injection pressure\*Melting

temperature\*Viscosity\*Screw speed 0.975

Residual Error

Total

## Unusual Observations for Bubbles

Obs	StdOrder	Bubbles	Fit	SE Fit	Residual	St Resid
1	1	16.0000	16.0845	5.3653	-0.0845	-2.18RX
2	2	15.0000	14.8886	5.3391	0.1114	0.21 X
4	4	19.0000	18.7430	5.3588	0.2570	0.96 X
5	5	22.0000	22.3113	5.3623	-0.3113	-1.69 X
7	7	8.0000	7.7749	5.3541	0.2251	0.64 X
8	8	13.0000	14.7095	5.3063	-1.7095	-2.15R
17	17	12.0000	13.5435	5.3103	-1.5435	-2.01R
19	19	8.0000	7.6176	5.3557	0.3824	1.18 X
38	38	14.0000	13.9225	5.3577	0.0775	0.27 X
43	43	11.0000	12.8690	5.2900	-1.8690	-2.08R
44	44	17.0000	14.1696	5.1766	2.8304	2.01R
45	45	7.0000	12.1805	4.7792	-5.1805	-2.12R
56	56	23.0000	22.7839	5.3556	0.2161	0.66 X
57	57	18.0000	18.2628	5.3539	-0.2628	-0.75 X
58	58	12.0000	11.9945	5.3620	0.0055	0.03 X
59	59	10.0000	10.8072	5.3403	-0.8072	-1.55 X
60	60	5.0000	5.0424	5.3650	-0.0424	-0.62 X
61	61	12.0000	12.0074	5.3640	-0.0074	-0.06 X
62	62	13.0000	13.4985	5.3464	-0.4985	-1.10 X
63	63	12.0000	11.7664	5.3635	0.2336	1.59 X
64	64	30.0000	22.8827	4.4204	7.1173	2.34R
65	65	8.0000	12.3766	4.9740	-4.3766	-2.18R
68	68	22.0000	21.5236	5.3570	0.4764	1.58 X
69	69	23.0000	23.1495	5.3602	-0.1495	-0.63 X
70	70	13.0000	12.9725	5.3633	0.0275	0.18 X
71	71	19.0000	18.8872	5.3617	0.1128	0.56 X
72	72	13.0000	13.0875	5.3514	-0.0875	-0.23 X
73	73	18.0000	18.0204	5.3653	-0.0204	-0.44 X

R denotes an observation with a large standardized residual.

X denotes an observation whose X value gives it large leverage.

## Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	-2048417
Flow rate	590591
Injection Speed	102326
Injection pressure	-30422.3
Melting temperature	9654.62
Viscosity	1047958
Screw speed	289067
Flow rate*Injection Speed	-31035.3
Flow rate*Injection pressure	13577.8
Flow rate*Melting temperature	-2892.25
Flow rate*Viscosity	-189540
Flow rate*Screw speed	-121079
Injection Speed*Injection pressure	1122.31
Injection Speed*Melting temperature	-476.377
Injection Speed*Viscosity	-54724.5
Injection Speed*Screw speed	-13691.9

Injection pressure*	119.150
Melting temperature	
Injection pressure*Viscosity	23310.1
Injection pressure*Screw speed	-46.40
Melting temperature*Viscosity	-5153.25
Melting temperature*Screw speed	-1288.94
Viscosity*Screw speed	-161646
Flow rate*Injection Speed*	-506.951
Injection pressure	
Flow rate*Injection Speed*	148.611
Melting temperature	
Flow rate*Injection pressure*	-53.7409
Melting temperature	
Flow rate*Injection Speed*Viscosity	11487.2
Flow rate*Injection pressure*	-11771.2
Viscosity	
Flow rate*Melting temperature*	1097.75
Viscosity	
Flow rate*Injection Speed*	5714.43
Screw speed	
Flow rate*Injection pressure*	109.043
Screw speed	
Flow rate*Melting temperature*	540.006
Screw speed	
Flow rate*Viscosity*Screw speed	61566.2
Injection Speed*Injection pressure*	-4.31904
Melting temperature	
Injection Speed*Injection pressure*	-873.173
Viscosity	
Injection Speed*Melting temperature*	262.995
Viscosity	
Injection Speed*Injection pressure*	16.034
Screw speed	
Injection Speed*Melting temperature*	60.8614
Screw speed	
Injection Speed*Viscosity*	7821.21
Screw speed	
Injection pressure*	-91.3063
Melting temperature*Viscosity	
Injection pressure*	0.8269
Melting temperature*Screw speed	
Injection pressure*Viscosity*	-256.02
Screw speed	
Melting temperature*Viscosity*	730.672
Screw speed	
Flow rate*Injection Speed*	1.97837
Injection pressure*	
Melting temperature	
Flow rate*Injection Speed*	459.567
Injection pressure*Viscosity	
Flow rate*Injection Speed*	-61.5089
Melting temperature*Viscosity	
Flow rate*Injection pressure*	46.8316
Melting temperature*Viscosity	
Flow rate*Injection Speed*	-10.6129
Injection pressure*Screw speed	
Flow rate*Injection Speed*	-25.4087
Melting temperature*Screw speed	
Flow rate*Injection pressure*	-0.72464
Melting temperature*Screw speed	
Flow rate*Injection Speed*Viscosity*	-2958.76
Screw speed	
Flow rate*Injection pressure*	149.368

Viscosity*Screw speed	
Flow rate*Melting temperature*	-280.245
Viscosity*Screw speed	
Injection Speed*Injection pressure*	3.36993
Melting temperature*Viscosity	
Injection Speed*Injection pressure*	-0.096594
Melting temperature*Screw speed	
Injection Speed*Injection pressure*	0.8146
Viscosity*Screw speed	
Injection Speed*Melting temperature*	-35.1546
Viscosity*Screw speed	
Injection pressure*	0.61390
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	-1.81302
Injection pressure*	
Melting temperature*Viscosity	
Flow rate*Injection Speed*	0.056873
Injection pressure*	
Melting temperature*Screw speed	
Flow rate*Injection Speed*	-2.6844
Injection pressure*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	13.3880
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection pressure*	-0.43444
Melting temperature*Viscosity*	
Screw speed	
Injection Speed*Injection pressure*	0.017615
Melting temperature*Viscosity*	
Screw speed	
Flow rate*Injection Speed*	0.0025316
Injection pressure*	
Melting temperature*Viscosity*	
Screw speed	

## Effects Pareto for Bubbles

\* NOTE \* Some factors have more than 2 levels, no alias table was printed.

## Results for: Worksheet 2

### Full Factorial Design

Factors:	6	Base Design:	6, 64
Runs:	64	Replicates:	1
Blocks:	1	Center pts (total):	0

All terms are free from aliasing.

## Factorial Fit: Blocks versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Blocks (coded units)

Term	Effect	Coef
Constant		1.00000
Flow_Rate	0.00000	0.00000
Inj_Speed	0.00000	0.00000
Inj_Press	0.00000	0.00000
Melt_Temp	0.00000	0.00000
Viscosity	0.00000	0.00000
Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Speed	0.00000	0.00000
Flow_Rate*Inj_Press	0.00000	0.00000
Flow_Rate*Melt_Temp	0.00000	0.00000
Flow_Rate*Viscosity	0.00000	0.00000
Flow_Rate*Screw_Speed	0.00000	0.00000
Inj_Speed*Inj_Press	0.00000	0.00000
Inj_Speed*Melt_Temp	0.00000	0.00000
Inj_Speed*Viscosity	0.00000	0.00000
Inj_Speed*Screw_Speed	0.00000	0.00000
Inj_Press*Melt_Temp	0.00000	0.00000
Inj_Press*Viscosity	0.00000	0.00000
Inj_Press*Screw_Speed	0.00000	0.00000
Melt_Temp*Viscosity	0.00000	0.00000
Melt_Temp*Screw_Speed	0.00000	0.00000
Viscosity*Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Speed*Inj_Press	0.00000	0.00000
Flow_Rate*Inj_Speed*Melt_Temp	0.00000	0.00000
Flow_Rate*Inj_Press*Melt_Temp	0.00000	0.00000
Flow_Rate*Inj_Speed*Viscosity	0.00000	0.00000
Flow_Rate*Inj_Press*Viscosity	0.00000	0.00000
Flow_Rate*Melt_Temp*Viscosity	0.00000	0.00000
Flow_Rate*Inj_Speed*Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Press*Screw_Speed	0.00000	0.00000
Flow_Rate*Melt_Temp*Screw_Speed	0.00000	0.00000
Flow_Rate*Viscosity*Screw_Speed	0.00000	0.00000
Inj_Speed*Inj_Press*Melt_Temp	0.00000	0.00000
Inj_Speed*Inj_Press*Viscosity	0.00000	0.00000
Inj_Speed*Melt_Temp*Viscosity	0.00000	0.00000
Inj_Speed*Inj_Press*Screw_Speed	0.00000	0.00000
Inj_Speed*Melt_Temp*Screw_Speed	0.00000	0.00000
Inj_Speed*Viscosity*Screw_Speed	0.00000	0.00000
Inj_Press*Melt_Temp*Viscosity	0.00000	0.00000
Inj_Press*Melt_Temp*Screw_Speed	0.00000	0.00000
Inj_Press*Viscosity*Screw_Speed	0.00000	0.00000
Melt_Temp*Viscosity*Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp	0.00000	0.00000
Flow_Rate*Inj_Speed*Inj_Press* Viscosity	0.00000	0.00000
Flow_Rate*Inj_Speed*Melt_Temp* Viscosity	0.00000	0.00000
Flow_Rate*Inj_Press*Melt_Temp* Viscosity	0.00000	0.00000
Flow_Rate*Inj_Speed*Inj_Press* Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Speed*Melt_Temp* Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Press*Melt_Temp* Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Speed*Viscosity* Screw_Speed	0.00000	0.00000
Flow_Rate*Inj_Press*Viscosity* Screw_Speed	0.00000	0.00000

Flow_Rate*Melt_Temp*Viscosity*	0.00000	0.00000
Screw_Speed		
Inj_Speed*Inj_Press*Melt_Temp*	0.00000	0.00000
Viscosity		
Inj_Speed*Inj_Press*Melt_Temp*	0.00000	0.00000
Screw_Speed		
Inj_Speed*Inj_Press*Viscosity*	0.00000	0.00000
Screw_Speed		
Inj_Speed*Melt_Temp*Viscosity*	0.00000	0.00000
Screw_Speed		
Inj_Press*Melt_Temp*Viscosity*	0.00000	0.00000
Screw_Speed		
Flow_Rate*Inj_Speed*Inj_Press*	0.00000	0.00000
Melt_Temp*Viscosity		
Flow_Rate*Inj_Speed*Inj_Press*	0.00000	0.00000
Melt_Temp*Screw_Speed		
Flow_Rate*Inj_Speed*Inj_Press*	0.00000	0.00000
Viscosity*Screw_Speed		
Flow_Rate*Inj_Speed*Melt_Temp*	0.00000	0.00000
Viscosity*Screw_Speed		
Flow_Rate*Inj_Press*Melt_Temp*	0.00000	0.00000
Viscosity*Screw_Speed		
Inj_Speed*Inj_Press*Melt_Temp*	0.00000	0.00000
Viscosity*Screw_Speed		
Flow_Rate*Inj_Speed*Inj_Press*	0.00000	0.00000
Melt_Temp*Viscosity*Screw_Speed		

S = \* PRESS = \*

Analysis of Variance for Blocks (coded units)

Source	DF	Seq SS	Adj SS
Main Effects	6	0	0
Flow_Rate	1	0	0
Inj_Speed	1	0	0
Inj_Press	1	0	0
Melt_Temp	1	0	0
Viscosity	1	0	0
Screw_Speed	1	0	0
2-Way Interactions	15	0	0
Flow_Rate*Inj_Speed	1	0	0
Flow_Rate*Inj_Press	1	0	0
Flow_Rate*Melt_Temp	1	0	0
Flow_Rate*Viscosity	1	0	0
Flow_Rate*Screw_Speed	1	0	0
Inj_Speed*Inj_Press	1	0	0
Inj_Speed*Melt_Temp	1	0	0
Inj_Speed*Viscosity	1	0	0
Inj_Speed*Screw_Speed	1	0	0
Inj_Press*Melt_Temp	1	0	0
Inj_Press*Viscosity	1	0	0
Inj_Press*Screw_Speed	1	0	0
Melt_Temp*Viscosity	1	0	0
Melt_Temp*Screw_Speed	1	0	0
Viscosity*Screw_Speed	1	0	0
3-Way Interactions	20	0	0
Flow_Rate*Inj_Speed*Inj_Press	1	0	0
Flow_Rate*Inj_Speed*Melt_Temp	1	0	0
Flow_Rate*Inj_Press*Melt_Temp	1	0	0
Flow_Rate*Inj_Speed*Viscosity	1	0	0

Flow_Rate*Inj_Press*Viscosity	1	0	0
Flow_Rate*Melt_Temp*Viscosity	1	0	0
Flow_Rate*Inj_Speed*Screw_Speed	1	0	0
Flow_Rate*Inj_Press*Screw_Speed	1	0	0
Flow_Rate*Melt_Temp*Screw_Speed	1	0	0
Flow_Rate*Viscosity*Screw_Speed	1	0	0
Inj_Speed*Inj_Press*Melt_Temp	1	0	0
Inj_Speed*Inj_Press*Viscosity	1	0	0
Inj_Speed*Melt_Temp*Viscosity	1	0	0
Inj_Speed*Inj_Press*Screw_Speed	1	0	0
Inj_Speed*Melt_Temp*Screw_Speed	1	0	0
Inj_Speed*Viscosity*Screw_Speed	1	0	0
Inj_Press*Melt_Temp*Viscosity	1	0	0
Inj_Press*Melt_Temp*Screw_Speed	1	0	0
Inj_Press*Viscosity*Screw_Speed	1	0	0
Melt_Temp*Viscosity*Screw_Speed	1	0	0
4-Way Interactions	15	0	0
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp	1	0	0
Flow_Rate*Inj_Speed*Inj_Press*Viscosity	1	0	0
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity	1	0	0
Flow_Rate*Inj_Press*Melt_Temp*Viscosity	1	0	0
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed	1	0	0
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed	1	0	0
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed	1	0	0
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed	1	0	0
Flow_Rate*Inj_Press*Viscosity*Screw_Speed	1	0	0
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed	1	0	0
Inj_Speed*Inj_Press*Melt_Temp*Viscosity	1	0	0
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	1	0	0
Inj_Speed*Inj_Press*Viscosity*Screw_Speed	1	0	0
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	1	0	0
Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	0	0
5-Way Interactions	6	0	0
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity	1	0	0
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	1	0	0
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed	1	0	0
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	1	0	0
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	0	0
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	0	0
6-Way Interactions	1	0	0
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	0	0
Residual Error	0	*	*
Total	63	0	

Adj			
Source	MS	F	P
Main Effects	0	*	*
Flow_Rate	0	*	*
Inj_Speed	0	*	*
Inj_Press	0	*	*
Melt_Temp	0	*	*
Viscosity	0	*	*
Screw_Speed	0	*	*
2-Way Interactions	0	*	*
Flow_Rate*Inj_Speed	0	*	*
Flow_Rate*Inj_Press	0	*	*
Flow_Rate*Melt_Temp	0	*	*
Flow_Rate*Viscosity	0	*	*
Flow_Rate*Screw_Speed	0	*	*
Inj_Speed*Inj_Press	0	*	*
Inj_Speed*Melt_Temp	0	*	*
Inj_Speed*Viscosity	0	*	*
Inj_Speed*Screw_Speed	0	*	*

Inj_Press*Melt_Temp	0	*	*
Inj_Press*Viscosity	0	*	*
Inj_Press*Screw_Speed	0	*	*
Melt_Temp*Viscosity	0	*	*
Melt_Temp*Screw_Speed	0	*	*
Viscosity*Screw_Speed	0	*	*
3-Way Interactions	0	*	*
Flow_Rate*Inj_Speed*Inj_Press	0	*	*
Flow_Rate*Inj_Speed*Melt_Temp	0	*	*
Flow_Rate*Inj_Press*Melt_Temp	0	*	*
Flow_Rate*Inj_Speed*Viscosity	0	*	*
Flow_Rate*Inj_Press*Viscosity	0	*	*
Flow_Rate*Melt_Temp*Viscosity	0	*	*
Flow_Rate*Inj_Speed*Screw_Speed	0	*	*
Flow_Rate*Inj_Press*Screw_Speed	0	*	*
Flow_Rate*Melt_Temp*Screw_Speed	0	*	*
Flow_Rate*Viscosity*Screw_Speed	0	*	*
Inj_Speed*Inj_Press*Melt_Temp	0	*	*
Inj_Speed*Inj_Press*Viscosity	0	*	*
Inj_Speed*Melt_Temp*Viscosity	0	*	*
Inj_Speed*Inj_Press*Screw_Speed	0	*	*
Inj_Speed*Melt_Temp*Screw_Speed	0	*	*
Inj_Speed*Viscosity*Screw_Speed	0	*	*
Inj_Press*Melt_Temp*Viscosity	0	*	*
Inj_Press*Melt_Temp*Screw_Speed	0	*	*
Inj_Press*Viscosity*Screw_Speed	0	*	*
Melt_Temp*Viscosity*Screw_Speed	0	*	*
4-Way Interactions	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Viscosity	0	*	*
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity	0	*	*
Flow_Rate*Inj_Press*Melt_Temp*Viscosity	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed	0	*	*
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed	0	*	*
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed	0	*	*
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed	0	*	*
Flow_Rate*Inj_Press*Viscosity*Screw_Speed	0	*	*
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed	0	*	*
Inj_Speed*Inj_Press*Melt_Temp*Viscosity	0	*	*
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	0	*	*
Inj_Speed*Inj_Press*Viscosity*Screw_Speed	0	*	*
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	0	*	*
Inj_Press*Melt_Temp*Viscosity*Screw_Speed	0	*	*
5-Way Interactions	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed	0	*	*
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	0	*	*
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	0	*	*
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	0	*	*
6-Way Interactions	0	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	0	*	*
Residual Error	*		
Total			

Estimated Coefficients for Blocks using data in uncoded units

Term	Coef
Constant	1.00000
Flow_Rate	0.000000000
Inj_Speed	0.000000000
Inj_Press	0.000000000



Melt_Temp	0.000000000
Viscosity	0.000000000
Screw_Speed	0.000000000
Flow_Rate*Inj_Speed	0.000000000
Flow_Rate*Inj_Press	0.000000000
Flow_Rate*Melt_Temp	0.000000000
Flow_Rate*Viscosity	0.000000000
Flow_Rate*Screw_Speed	0.000000000
Inj_Speed*Inj_Press	0.000000000
Inj_Speed*Melt_Temp	0.000000000
Inj_Speed*Viscosity	0.000000000
Inj_Speed*Screw_Speed	0.000000000
Inj_Press*Melt_Temp	0.000000000
Inj_Press*Viscosity	0.000000000
Inj_Press*Screw_Speed	0.000000000
Melt_Temp*Viscosity	0.000000000
Melt_Temp*Screw_Speed	0.000000000
Viscosity*Screw_Speed	0.000000000
Flow_Rate*Inj_Speed*Inj_Press	0.000000000
Flow_Rate*Inj_Speed*Melt_Temp	0.000000000
Flow_Rate*Inj_Press*Melt_Temp	0.000000000
Flow_Rate*Inj_Speed*Viscosity	0.000000000
Flow_Rate*Inj_Press*Viscosity	0.000000000
Flow_Rate*Melt_Temp*Viscosity	0.000000000
Flow_Rate*Inj_Speed*Screw_Speed	0.000000000
Flow_Rate*Inj_Press*Screw_Speed	0.000000000
Flow_Rate*Melt_Temp*Screw_Speed	0.000000000
Flow_Rate*Viscosity*Screw_Speed	0.000000000
Inj_Speed*Inj_Press*Melt_Temp	0.000000000
Inj_Speed*Inj_Press*Viscosity	0.000000000
Inj_Speed*Melt_Temp*Viscosity	0.000000000
Inj_Speed*Inj_Press*Screw_Speed	0.000000000
Inj_Speed*Melt_Temp*Screw_Speed	0.000000000
Inj_Speed*Viscosity*Screw_Speed	0.000000000
Inj_Press*Melt_Temp*Viscosity	0.000000000
Inj_Press*Melt_Temp*Screw_Speed	0.000000000
Inj_Press*Viscosity*Screw_Speed	0.000000000
Melt_Temp*Viscosity*Screw_Speed	0.000000000
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Melt_Temp	
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Viscosity	
Flow_Rate*Inj_Speed*Melt_Temp*	0.000000000
Viscosity	
Flow_Rate*Inj_Press*Melt_Temp*	0.000000000
Viscosity	
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Screw_Speed	
Flow_Rate*Inj_Speed*Melt_Temp*	0.000000000
Screw_Speed	
Flow_Rate*Inj_Press*Melt_Temp*	0.000000000
Screw_Speed	
Flow_Rate*Inj_Speed*Viscosity*	0.000000000
Screw_Speed	
Flow_Rate*Inj_Press*Viscosity*	0.000000000
Screw_Speed	
Flow_Rate*Melt_Temp*Viscosity*	0.000000000
Screw_Speed	
Inj_Speed*Inj_Press*Melt_Temp*	0.000000000
Viscosity	
Inj_Speed*Inj_Press*Melt_Temp*	0.000000000
Screw_Speed	
Inj_Speed*Inj_Press*Viscosity*	0.000000000

Screw_Speed	
Inj_Speed*Melt_Temp*Viscosity*	0.000000000
Screw_Speed	
Inj_Press*Melt_Temp*Viscosity*	0.000000000
Screw_Speed	
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Melt_Temp*Viscosity	
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Melt_Temp*Screw_Speed	
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Viscosity*Screw_Speed	
Flow_Rate*Inj_Speed*Melt_Temp*	0.000000000
Viscosity*Screw_Speed	
Flow_Rate*Inj_Press*Melt_Temp*	0.000000000
Viscosity*Screw_Speed	
Inj_Speed*Inj_Press*Melt_Temp*	0.000000000
Viscosity*Screw_Speed	
Flow_Rate*Inj_Speed*Inj_Press*	0.000000000
Melt_Temp*Viscosity*Screw_Speed	

## Effects Pareto for Blocks

Alias Structure

I

Flow\_Rate  
Inj\_Speed  
Inj\_Press  
Melt\_Temp  
Viscosity  
Screw\_Speed  
Flow\_Rate\*Inj\_Speed  
Flow\_Rate\*Inj\_Press  
Flow\_Rate\*Melt\_Temp  
Flow\_Rate\*Viscosity  
Flow\_Rate\*Screw\_Speed  
Inj\_Speed\*Inj\_Press  
Inj\_Speed\*Melt\_Temp  
Inj\_Speed\*Viscosity  
Inj\_Speed\*Screw\_Speed  
Inj\_Press\*Melt\_Temp  
Inj\_Press\*Viscosity  
Inj\_Press\*Screw\_Speed  
Melt\_Temp\*Viscosity  
Melt\_Temp\*Screw\_Speed  
Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed\*Inj\_Press  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp  
Flow\_Rate\*Inj\_Press\*Melt\_Temp  
Flow\_Rate\*Inj\_Speed\*Viscosity  
Flow\_Rate\*Inj\_Press\*Viscosity  
Flow\_Rate\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Inj\_Speed\*Screw\_Speed  
Flow\_Rate\*Inj\_Press\*Screw\_Speed  
Flow\_Rate\*Melt\_Temp\*Screw\_Speed  
Flow\_Rate\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Inj\_Press\*Melt\_Temp  
Inj\_Speed\*Inj\_Press\*Viscosity  
Inj\_Speed\*Melt\_Temp\*Viscosity  
Inj\_Speed\*Inj\_Press\*Screw\_Speed  
Inj\_Speed\*Melt\_Temp\*Screw\_Speed

Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Press\*Melt\_Temp\*Viscosity  
 Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Press\*Viscosity\*Screw\_Speed  
 Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.688
Flow_Rate	-2.750	-1.375
Inj_Speed	-1.688	-0.844
Inj_Press	0.562	0.281
Melt_Temp	-3.313	-1.656
Viscosity	-0.813	-0.406
Screw_Speed	0.438	0.219
Flow_Rate*Inj_Speed	1.437	0.719
Flow_Rate*Inj_Press	-2.563	-1.281
Flow_Rate*Melt_Temp	1.437	0.719
Flow_Rate*Viscosity	0.687	0.344
Flow_Rate*Screw_Speed	0.812	0.406
Inj_Speed*Inj_Press	0.250	0.125
Inj_Speed*Melt_Temp	0.875	0.437
Inj_Speed*Viscosity	0.875	0.438
Inj_Speed*Screw_Speed	0.000	0.000
Inj_Press*Melt_Temp	-2.000	-1.000
Inj_Press*Viscosity	1.000	0.500
Inj_Press*Screw_Speed	-1.000	-0.500
Melt_Temp*Viscosity	4.500	2.250
Melt_Temp*Screw_Speed	1.500	0.750
Viscosity*Screw_Speed	1.000	0.500
Flow_Rate*Inj_Speed*Inj_Press	0.875	0.438
Flow_Rate*Inj_Speed*Melt_Temp	-0.875	-0.438
Flow_Rate*Inj_Press*Melt_Temp	0.000	0.000
Flow_Rate*Inj_Speed*Viscosity	0.375	0.187
Flow_Rate*Inj_Press*Viscosity	-0.000	-0.000

Flow_Rate*Melt_Temp*Viscosity	0.625	0.313
Flow_Rate*Inj_Speed*Screw_Speed	1.125	0.563
Flow_Rate*Inj_Press*Screw_Speed	-0.375	-0.187
Flow_Rate*Melt_Temp*Screw_Speed	-1.000	-0.500
Flow_Rate*Viscosity*Screw_Speed	1.500	0.750
Inj_Speed*Inj_Press*Melt_Temp	0.688	0.344
Inj_Speed*Inj_Press*Viscosity	0.188	0.094
Inj_Speed*Melt_Temp*Viscosity	-1.063	-0.531
Inj_Speed*Inj_Press*Screw_Speed	-0.938	-0.469
Inj_Speed*Melt_Temp*Screw_Speed	0.562	0.281
Inj_Speed*Viscosity*Screw_Speed	0.563	0.281
Inj_Press*Melt_Temp*Viscosity	-0.062	-0.031
Inj_Press*Melt_Temp*Screw_Speed	0.437	0.219
Inj_Press*Viscosity*Screw_Speed	0.187	0.094
Melt_Temp*Viscosity*Screw_Speed	0.312	0.156
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp	-0.312	-0.156
Flow_Rate*Inj_Speed*Inj_Press* Viscosity	1.687	0.844
Flow_Rate*Inj_Speed*Melt_Temp* Viscosity	1.313	0.656
Flow_Rate*Inj_Press*Melt_Temp* Viscosity	-3.188	-1.594
Flow_Rate*Inj_Speed*Inj_Press* Screw_Speed	0.437	0.219
Flow_Rate*Inj_Speed*Melt_Temp* Screw_Speed	-2.438	-1.219
Flow_Rate*Inj_Press*Melt_Temp* Screw_Speed	-1.563	-0.781
Flow_Rate*Inj_Speed*Viscosity* Screw_Speed	-0.437	-0.219
Flow_Rate*Inj_Press*Viscosity* Screw_Speed	-0.062	-0.031
Flow_Rate*Melt_Temp*Viscosity* Screw_Speed	1.688	0.844
Inj_Speed*Inj_Press*Melt_Temp* Viscosity	-2.875	-1.438
Inj_Speed*Inj_Press*Melt_Temp* Screw_Speed	1.750	0.875
Inj_Speed*Inj_Press*Viscosity* Screw_Speed	1.500	0.750
Inj_Speed*Melt_Temp*Viscosity* Screw_Speed	0.375	0.187
Inj_Press*Melt_Temp*Viscosity* Screw_Speed	-0.625	-0.313
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp*Viscosity	1.750	0.875
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp*Screw_Speed	0.250	0.125
Flow_Rate*Inj_Speed*Inj_Press* Viscosity*Screw_Speed	1.750	0.875
Flow_Rate*Inj_Speed*Melt_Temp* Viscosity*Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Press*Melt_Temp* Viscosity*Screw_Speed	2.250	1.125
Inj_Speed*Inj_Press*Melt_Temp* Viscosity*Screw_Speed	-2.563	-1.281
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp*Viscosity*Screw_Speed	0.563	0.281

S = \*      PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS
Main Effects	6	360.81
Flow_Rate	1	121.00
Inj_Speed	1	45.56
Inj_Press	1	5.06
Melt_Temp	1	175.56
Viscosity	1	10.56
Screw_Speed	1	3.06
2-Way Interactions	15	686.81
Flow_Rate*Inj_Speed	1	33.06
Flow_Rate*Inj_Press	1	105.06
Flow_Rate*Melt_Temp	1	33.06
Flow_Rate*Viscosity	1	7.56
Flow_Rate*Screw_Speed	1	10.56
Inj_Speed*Inj_Press	1	1.00
Inj_Speed*Melt_Temp	1	12.25
Inj_Speed*Viscosity	1	12.25
Inj_Speed*Screw_Speed	1	0.00
Inj_Press*Melt_Temp	1	64.00
Inj_Press*Viscosity	1	16.00
Inj_Press*Screw_Speed	1	16.00
Melt_Temp*Viscosity	1	324.00
Melt_Temp*Screw_Speed	1	36.00
Viscosity*Screw_Speed	1	16.00
3-Way Interactions	20	163.13
Flow_Rate*Inj_Speed*Inj_Press	1	12.25
Flow_Rate*Inj_Speed*Melt_Temp	1	12.25
Flow_Rate*Inj_Press*Melt_Temp	1	0.00
Flow_Rate*Inj_Speed*Viscosity	1	2.25
Flow_Rate*Inj_Press*Viscosity	1	0.00
Flow_Rate*Melt_Temp*Viscosity	1	6.25
Flow_Rate*Inj_Speed*Screw_Speed	1	20.25
Flow_Rate*Inj_Press*Screw_Speed	1	2.25
Flow_Rate*Melt_Temp*Screw_Speed	1	16.00
Flow_Rate*Viscosity*Screw_Speed	1	36.00
Inj_Speed*Inj_Press*Melt_Temp	1	7.56
Inj_Speed*Inj_Press*Viscosity	1	0.56
Inj_Speed*Melt_Temp*Viscosity	1	18.06
Inj_Speed*Inj_Press*Screw_Speed	1	14.06
Inj_Speed*Melt_Temp*Screw_Speed	1	5.06
Inj_Speed*Viscosity*Screw_Speed	1	5.06
Inj_Press*Melt_Temp*Viscosity	1	0.06
Inj_Press*Melt_Temp*Screw_Speed	1	3.06
Inj_Press*Viscosity*Screw_Speed	1	0.56
Melt_Temp*Viscosity*Screw_Speed	1	1.56
4-Way Interactions	15	648.88
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp	1	1.56
Flow_Rate*Inj_Speed*Inj_Press*Viscosity	1	45.56
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity	1	27.56
Flow_Rate*Inj_Press*Melt_Temp*Viscosity	1	162.56
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed	1	3.06
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed	1	95.06
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed	1	39.06
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed	1	3.06
Flow_Rate*Inj_Press*Viscosity*Screw_Speed	1	0.06
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed	1	45.56
Inj_Speed*Inj_Press*Melt_Temp*Viscosity	1	132.25
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	1	49.00
Inj_Speed*Inj_Press*Viscosity*Screw_Speed	1	36.00
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	1	2.25

Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	6.25
5-Way Interactions	6	301.06
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity	1	49.00
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	1	1.00
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed	1	49.00
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	1	16.00
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	81.00
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	105.06
6-Way Interactions	1	5.06
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	1	5.06
Residual Error	0	*
Total	63	2165.75

Source	Adj SS
Main Effects	360.813
Flow_Rate	121.000
Inj_Speed	45.563
Inj_Press	5.063
Melt_Temp	175.563
Viscosity	10.562
Screw_Speed	3.063
2-Way Interactions	686.813
Flow_Rate*Inj_Speed	33.063
Flow_Rate*Inj_Press	105.063
Flow_Rate*Melt_Temp	33.062
Flow_Rate*Viscosity	7.562
Flow_Rate*Screw_Speed	10.562
Inj_Speed*Inj_Press	1.000
Inj_Speed*Melt_Temp	12.250
Inj_Speed*Viscosity	12.250
Inj_Speed*Screw_Speed	0.000
Inj_Press*Melt_Temp	64.000
Inj_Press*Viscosity	16.000
Inj_Press*Screw_Speed	16.000
Melt_Temp*Viscosity	324.000
Melt_Temp*Screw_Speed	36.000
Viscosity*Screw_Speed	16.000
3-Way Interactions	163.125
Flow_Rate*Inj_Speed*Inj_Press	12.250
Flow_Rate*Inj_Speed*Melt_Temp	12.250
Flow_Rate*Inj_Press*Melt_Temp	0.000
Flow_Rate*Inj_Speed*Viscosity	2.250
Flow_Rate*Inj_Press*Viscosity	0.000
Flow_Rate*Melt_Temp*Viscosity	6.250
Flow_Rate*Inj_Speed*Screw_Speed	20.250
Flow_Rate*Inj_Press*Screw_Speed	2.250
Flow_Rate*Melt_Temp*Screw_Speed	16.000
Flow_Rate*Viscosity*Screw_Speed	36.000
Inj_Speed*Inj_Press*Melt_Temp	7.563
Inj_Speed*Inj_Press*Viscosity	0.563
Inj_Speed*Melt_Temp*Viscosity	18.063
Inj_Speed*Inj_Press*Screw_Speed	14.063
Inj_Speed*Melt_Temp*Screw_Speed	5.062
Inj_Speed*Viscosity*Screw_Speed	5.063
Inj_Press*Melt_Temp*Viscosity	0.062
Inj_Press*Melt_Temp*Screw_Speed	3.062
Inj_Press*Viscosity*Screw_Speed	0.562
Melt_Temp*Viscosity*Screw_Speed	1.562
4-Way Interactions	648.875
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp	1.562
Flow_Rate*Inj_Speed*Inj_Press*Viscosity	45.562
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity	27.563
Flow_Rate*Inj_Press*Melt_Temp*Viscosity	162.563

Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed	3.062
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed	95.063
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed	39.063
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed	3.062
Flow_Rate*Inj_Press*Viscosity*Screw_Speed	0.062
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed	45.563
Inj_Speed*Inj_Press*Melt_Temp*Viscosity	132.250
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	49.000
Inj_Speed*Inj_Press*Viscosity*Screw_Speed	36.000
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	2.250
Inj_Press*Melt_Temp*Viscosity*Screw_Speed	6.250
5-Way Interactions	301.063
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity	49.000
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	1.000
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed	49.000
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	16.000
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	81.000
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	105.063
6-Way Interactions	5.063
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	5.063
Residual Error	*
Total	

Source	Adj MS	F	P
Main Effects	60.135	*	*
Flow_Rate	121.000	*	*
Inj_Speed	45.563	*	*
Inj_Press	5.063	*	*
Melt_Temp	175.563	*	*
Viscosity	10.562	*	*
Screw_Speed	3.063	*	*
2-Way Interactions	45.788	*	*
Flow_Rate*Inj_Speed	33.063	*	*
Flow_Rate*Inj_Press	105.063	*	*
Flow_Rate*Melt_Temp	33.062	*	*
Flow_Rate*Viscosity	7.562	*	*
Flow_Rate*Screw_Speed	10.562	*	*
Inj_Speed*Inj_Press	1.000	*	*
Inj_Speed*Melt_Temp	12.250	*	*
Inj_Speed*Viscosity	12.250	*	*
Inj_Speed*Screw_Speed	0.000	*	*
Inj_Press*Melt_Temp	64.000	*	*
Inj_Press*Viscosity	16.000	*	*
Inj_Press*Screw_Speed	16.000	*	*
Melt_Temp*Viscosity	324.000	*	*
Melt_Temp*Screw_Speed	36.000	*	*
Viscosity*Screw_Speed	16.000	*	*
3-Way Interactions	8.156	*	*
Flow_Rate*Inj_Speed*Inj_Press	12.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	12.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	0.000	*	*
Flow_Rate*Inj_Speed*Viscosity	2.250	*	*
Flow_Rate*Inj_Press*Viscosity	0.000	*	*
Flow_Rate*Melt_Temp*Viscosity	6.250	*	*
Flow_Rate*Inj_Speed*Screw_Speed	20.250	*	*
Flow_Rate*Inj_Press*Screw_Speed	2.250	*	*
Flow_Rate*Melt_Temp*Screw_Speed	16.000	*	*
Flow_Rate*Viscosity*Screw_Speed	36.000	*	*
Inj_Speed*Inj_Press*Melt_Temp	7.563	*	*
Inj_Speed*Inj_Press*Viscosity	0.563	*	*
Inj_Speed*Melt_Temp*Viscosity	18.063	*	*
Inj_Speed*Inj_Press*Screw_Speed	14.063	*	*
Inj_Speed*Melt_Temp*Screw_Speed	5.062	*	*

Inj_Speed*Viscosity*Screw_Speed	5.063	*	*
Inj_Press*Melt_Temp*Viscosity	0.062	*	*
Inj_Press*Melt_Temp*Screw_Speed	3.062	*	*
Inj_Press*Viscosity*Screw_Speed	0.562	*	*
Melt_Temp*Viscosity*Screw_Speed	1.562	*	*
4-Way Interactions	43.258	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp	1.562	*	*
Flow_Rate*Inj_Speed*Inj_Press*Viscosity	45.562	*	*
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity	27.563	*	*
Flow_Rate*Inj_Press*Melt_Temp*Viscosity	162.563	*	*
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed	3.062	*	*
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed	95.063	*	*
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed	39.063	*	*
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed	3.062	*	*
Flow_Rate*Inj_Press*Viscosity*Screw_Speed	0.062	*	*
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed	45.563	*	*
Inj_Speed*Inj_Press*Melt_Temp*Viscosity	132.250	*	*
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	49.000	*	*
Inj_Speed*Inj_Press*Viscosity*Screw_Speed	36.000	*	*
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	2.250	*	*
Inj_Press*Melt_Temp*Viscosity*Screw_Speed	6.250	*	*
5-Way Interactions	50.177	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity	49.000	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed	1.000	*	*
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed	49.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed	16.000	*	*
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	81.000	*	*
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	105.063	*	*
6-Way Interactions	5.063	*	*
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed	5.063	*	*
Residual Error		*	
Total			

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	970663
Flow_Rate	-208186
Inj_Speed	-87882.9
Inj_Press	-6397.55
Melt_Temp	-5357.82
Viscosity	-609707
Screw_Speed	-82841.6
Flow_Rate*Inj_Speed	23931.6
Flow_Rate*Inj_Press	879.624
Flow_Rate*Melt_Temp	1294.51
Flow_Rate*Viscosity	150901
Flow_Rate*Screw_Speed	20360.6
Inj_Speed*Inj_Press	820.337
Inj_Speed*Melt_Temp	432.010
Inj_Speed*Viscosity	47364.7
Inj_Speed*Screw_Speed	6110.55
Inj_Press*Melt_Temp	39.8121
Inj_Press*Viscosity	4007.94
Inj_Press*Screw_Speed	684.824
Melt_Temp*Viscosity	3219.78
Melt_Temp*Screw_Speed	430.804
Viscosity*Screw_Speed	48221.8
Flow_Rate*Inj_Speed*Inj_Press	-215.014
Flow_Rate*Inj_Speed*Melt_Temp	-121.146
Flow_Rate*Inj_Press*Melt_Temp	-7.94131
Flow_Rate*Inj_Speed*Viscosity	-13355.9



Flow_Rate*Inj_Press*Viscosity	-770.892
Flow_Rate*Melt_Temp*Viscosity	-850.235
Flow_Rate*Inj_Speed*Screw_Speed	-1700.75
Flow_Rate*Inj_Press*Screw_Speed	-149.014
Flow_Rate*Melt_Temp*Screw_Speed	-112.653
Flow_Rate*Viscosity*Screw_Speed	-12774.6
Inj_Speed*Inj_Press*Melt_Temp	-4.09818
Inj_Speed*Inj_Press*Viscosity	-420.687
Inj_Speed*Melt_Temp*Viscosity	-230.840
Inj_Speed*Inj_Press*Screw_Speed	-59.7259
Inj_Speed*Melt_Temp*Screw_Speed	-29.6701
Inj_Speed*Viscosity*Screw_Speed	-3236.19
Inj_Press*Melt_Temp*Viscosity	-23.4804
Inj_Press*Melt_Temp*Screw_Speed	-3.72449
Inj_Press*Viscosity*Screw_Speed	-382.925
Melt_Temp*Viscosity*Screw_Speed	-245.068
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp	1.11737
Flow_Rate*Inj_Speed*Inj_Press* Viscosity	113.897
Flow_Rate*Inj_Speed*Melt_Temp* Viscosity	66.5728
Flow_Rate*Inj_Press*Melt_Temp* Viscosity	5.42254
Flow_Rate*Inj_Speed*Inj_Press* Screw_Speed	16.2300
Flow_Rate*Inj_Speed*Melt_Temp* Screw_Speed	8.45540
Flow_Rate*Inj_Press*Melt_Temp* Screw_Speed	0.903756
Flow_Rate*Inj_Speed*Viscosity* Screw_Speed	925.822
Flow_Rate*Inj_Press*Viscosity* Screw_Speed	91.7840
Flow_Rate*Melt_Temp*Viscosity* Screw_Speed	67.6056
Inj_Speed*Inj_Press*Melt_Temp* Viscosity	2.09692
Inj_Speed*Inj_Press*Melt_Temp* Screw_Speed	0.292815
Inj_Speed*Inj_Press*Viscosity* Screw_Speed	30.2017
Inj_Speed*Melt_Temp*Viscosity* Screw_Speed	15.6212
Inj_Press*Melt_Temp*Viscosity* Screw_Speed	2.04303
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp*Viscosity	-0.586854
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp*Screw_Speed	-0.0819249
Flow_Rate*Inj_Speed*Inj_Press* Viscosity*Screw_Speed	-8.40376
Flow_Rate*Inj_Speed*Melt_Temp* Viscosity*Screw_Speed	-4.55399
Flow_Rate*Inj_Press*Melt_Temp* Viscosity*Screw_Speed	-0.528169
Inj_Speed*Inj_Press*Melt_Temp* Viscosity*Screw_Speed	-0.148042
Flow_Rate*Inj_Speed*Inj_Press* Melt_Temp*Viscosity*Screw_Speed	0.0422535

## Effects Pareto for Bubbles

Alias Structure

I

Flow\_Rate

Inj\_Speed

Inj\_Press

Melt\_Temp

Viscosity

Screw\_Speed

Flow\_Rate\*Inj\_Speed

Flow\_Rate\*Inj\_Press

Flow\_Rate\*Melt\_Temp

Flow\_Rate\*Viscosity

Flow\_Rate\*Screw\_Speed

Inj\_Speed\*Inj\_Press

Inj\_Speed\*Melt\_Temp

Inj\_Speed\*Viscosity

Inj\_Speed\*Screw\_Speed

Inj\_Press\*Melt\_Temp

Inj\_Press\*Viscosity

Inj\_Press\*Screw\_Speed

Melt\_Temp\*Viscosity

Melt\_Temp\*Screw\_Speed

Viscosity\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Inj\_Press

Flow\_Rate\*Inj\_Speed\*Melt\_Temp

Flow\_Rate\*Inj\_Press\*Melt\_Temp

Flow\_Rate\*Inj\_Speed\*Viscosity

Flow\_Rate\*Inj\_Press\*Viscosity

Flow\_Rate\*Melt\_Temp\*Viscosity

Flow\_Rate\*Inj\_Speed\*Screw\_Speed

Flow\_Rate\*Inj\_Press\*Screw\_Speed

Flow\_Rate\*Melt\_Temp\*Screw\_Speed

Flow\_Rate\*Viscosity\*Screw\_Speed

Inj\_Speed\*Inj\_Press\*Melt\_Temp

Inj\_Speed\*Inj\_Press\*Viscosity

Inj\_Speed\*Melt\_Temp\*Viscosity

Inj\_Speed\*Inj\_Press\*Screw\_Speed

Inj\_Speed\*Melt\_Temp\*Screw\_Speed

Inj\_Speed\*Viscosity\*Screw\_Speed

Inj\_Press\*Melt\_Temp\*Viscosity

Inj\_Press\*Melt\_Temp\*Screw\_Speed

Inj\_Press\*Viscosity\*Screw\_Speed

Melt\_Temp\*Viscosity\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp

Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity

Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity

Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity

Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed

Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed

Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed

Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed

Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity

Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed

Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed

Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed

Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity

Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed

Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed

## Results for: Worksheet 3

### Fractional Factorial Design

Factors:	6	Base Design:	6, 16	Resolution:	IV
Runs:	16	Replicates:	1	Fraction:	1/4
Blocks:	1	Center pts (total):	0		

Design Generators: E = ABC, F = BCD

Alias Structure

I + ABCE + ADEF + BCDF

A + BCE + DEF + ABCDF  
 B + ACE + CDF + ABDEF  
 C + ABE + BDF + ACDEF  
 D + AEF + BCF + ABCDE  
 E + ABC + ADF + BCDEF  
 F + ADE + BCD + ABCEF  
 AB + CE + ACDF + BDEF  
 AC + BE + ABDF + CDEF  
 AD + EF + ABCF + BCDE  
 AE + BC + DF + ABCDEF  
 AF + DE + ABCD + BCEF  
 BD + CF + ABEF + ACDE  
 BF + CD + ABDE + ACEF  
 ABD + ACF + BEF + CDE  
 ABF + ACD + BDE + CEF

Alias Information for Terms in the Model.  
 Totally confounded terms were removed from the analysis.

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
     Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
     Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
     Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
     Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
     Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
     Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
     Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +

```

      Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
      Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
      Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
      Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
      Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
      Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
      Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.500
Flow_Rate	-2.000	-1.000
Inj_Speed	-0.750	-0.375
Inj_Press	-2.500	-1.250
Melt_Temp	-2.000	-1.000
Viscosity	1.250	0.625
Screw_Speed	-1.250	-0.625
Flow_Rate*Inj_Speed	0.250	0.125
Flow_Rate*Inj_Press	-1.000	-0.500
Flow_Rate*Melt_Temp	1.000	0.500
Flow_Rate*Viscosity	-2.250	-1.125
Flow_Rate*Screw_Speed	-1.750	-0.875
Inj_Speed*Melt_Temp	-0.250	-0.125
Inj_Speed*Screw_Speed	-2.000	-1.000
Flow_Rate*Inj_Speed*Melt_Temp	-2.250	-1.125
Flow_Rate*Inj_Press*Melt_Temp	4.500	2.250

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	71.750	71.750	11.9583	*	*
Flow_Rate	1	16.000	16.000	16.0000	*	*
Inj_Speed	1	2.250	2.250	2.2500	*	*
Inj_Press	1	25.000	25.000	25.0000	*	*
Melt_Temp	1	16.000	16.000	16.0000	*	*
Viscosity	1	6.250	6.250	6.2500	*	*
Screw_Speed	1	6.250	6.250	6.2500	*	*
2-Way Interactions	7	57.000	57.000	8.1429	*	*
Flow_Rate*Inj_Speed	1	0.250	0.250	0.2500	*	*
Flow_Rate*Inj_Press	1	4.000	4.000	4.0000	*	*
Flow_Rate*Melt_Temp	1	4.000	4.000	4.0000	*	*
Flow_Rate*Viscosity	1	20.250	20.250	20.2500	*	*
Flow_Rate*Screw_Speed	1	12.250	12.250	12.2500	*	*

Inj_Speed*Melt_Temp	1	0.250	0.250	0.2500	*	*
Inj_Speed*Screw_Speed	1	16.000	16.000	16.0000	*	*
3-Way Interactions	2	101.250	101.250	50.6250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	20.250	20.250	20.2500	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	81.000	81.000	81.0000	*	*
Residual Error	0	*	*	*		
Total	15	230.000				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	-3703.35
Flow_Rate	2327.23
Inj_Speed	146.679
Inj_Press	1.29214
Melt_Temp	-30.1016
Viscosity	130.042
Screw_Speed	607.115
Flow_Rate*Inj_Speed	97.6526
Flow_Rate*Inj_Press	-49.0610
Flow_Rate*Melt_Temp	-9.03756
Flow_Rate*Viscosity	-42.2535
Flow_Rate*Screw_Speed	-8.21596
Inj_Speed*Melt_Temp	1.27042
Inj_Speed*Screw_Speed	-25.9085
Flow_Rate*Inj_Speed*Melt_Temp	-0.422535
Flow_Rate*Inj_Press*Melt_Temp	0.211268

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +

```

```

    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.000

Flow_Rate	-3.000	-1.500
Inj_Speed	-1.750	-0.875
Inj_Press	-1.500	-0.750
Melt_Temp	-1.000	-0.500
Viscosity	2.250	1.125
Screw_Speed	-2.250	-1.125
Flow_Rate*Inj_Speed	-0.750	-0.375
Flow_Rate*Inj_Press	-0.000	-0.000
Flow_Rate*Melt_Temp	2.000	1.000
Flow_Rate*Viscosity	-1.250	-0.625
Flow_Rate*Screw_Speed	-2.750	-1.375
Inj_Speed*Melt_Temp	0.750	0.375
Inj_Speed*Screw_Speed	-3.000	-1.500
Flow_Rate*Inj_Speed*Melt_Temp	-1.250	-0.625
Flow_Rate*Inj_Press*Melt_Temp	3.500	1.750

S = \*      PRESS = \*

#### Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	101.750	101.750	16.9583	*	*
Flow_Rate	1	36.000	36.000	36.0000	*	*
Inj_Speed	1	12.250	12.250	12.2500	*	*
Inj_Press	1	9.000	9.000	9.0000	*	*
Melt_Temp	1	4.000	4.000	4.0000	*	*
Viscosity	1	20.250	20.250	20.2500	*	*
Screw_Speed	1	20.250	20.250	20.2500	*	*
2-Way Interactions	7	93.000	93.000	13.2857	*	*
Flow_Rate*Inj_Speed	1	2.250	2.250	2.2500	*	*
Flow_Rate*Inj_Press	1	0.000	0.000	0.0000	*	*
Flow_Rate*Melt_Temp	1	16.000	16.000	16.0000	*	*
Flow_Rate*Viscosity	1	6.250	6.250	6.2500	*	*
Flow_Rate*Screw_Speed	1	30.250	30.250	30.2500	*	*
Inj_Speed*Melt_Temp	1	2.250	2.250	2.2500	*	*
Inj_Speed*Screw_Speed	1	36.000	36.000	36.0000	*	*
3-Way Interactions	2	55.250	55.250	27.6250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	6.250	6.250	6.2500	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	49.000	49.000	49.0000	*	*
Residual Error	0	*	*	*		
Total	15	250.000				

#### Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	-4233.80
Flow_Rate	2255.87
Inj_Speed	184.959
Inj_Press	-0.0750000
Melt_Temp	-19.1646
Viscosity	75.3568
Screw_Speed	497.744
Flow_Rate*Inj_Speed	52.5822
Flow_Rate*Inj_Press	-37.7934
Flow_Rate*Melt_Temp	-8.56808
Flow_Rate*Viscosity	-23.4742
Flow_Rate*Screw_Speed	-12.9108
Inj_Speed*Melt_Temp	0.723568
Inj_Speed*Screw_Speed	-20.4399
Flow_Rate*Inj_Speed*Melt_Temp	-0.234742

Flow\_Rate\*Inj\_Press\*Melt\_Temp 0.164319

## Effects Pareto for Bubbles

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
```



Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.250
Flow_Rate	-0.500	-0.250
Inj_Speed	0.750	0.375
Inj_Press	-4.000	-2.000
Melt_Temp	-3.500	-1.750
Viscosity	-0.250	-0.125
Screw_Speed	0.250	0.125
Flow_Rate*Inj_Speed	1.750	0.875
Flow_Rate*Inj_Press	-2.500	-1.250
Flow_Rate*Melt_Temp	-0.500	-0.250
Flow_Rate*Viscosity	-3.750	-1.875
Flow_Rate*Screw_Speed	-0.250	-0.125
Inj_Speed*Melt_Temp	-1.750	-0.875
Inj_Speed*Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed*Melt_Temp	-3.750	-1.875
Flow_Rate*Inj_Press*Melt_Temp	6.000	3.000

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	116.750	116.750	19.458	*	*
Flow_Rate	1	1.000	1.000	1.000	*	*
Inj_Speed	1	2.250	2.250	2.250	*	*
Inj_Press	1	64.000	64.000	64.000	*	*

Melt_Temp	1	49.000	49.000	49.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	0.250	0.250	0.250	*	*
2-Way Interactions	7	108.000	108.000	15.429	*	*
Flow_Rate*Inj_Speed	1	12.250	12.250	12.250	*	*
Flow_Rate*Inj_Press	1	25.000	25.000	25.000	*	*
Flow_Rate*Melt_Temp	1	1.000	1.000	1.000	*	*
Flow_Rate*Viscosity	1	56.250	56.250	56.250	*	*
Flow_Rate*Screw_Speed	1	0.250	0.250	0.250	*	*
Inj_Speed*Melt_Temp	1	12.250	12.250	12.250	*	*
Inj_Speed*Screw_Speed	1	1.000	1.000	1.000	*	*
3-Way Interactions	2	200.250	200.250	100.125	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	56.250	56.250	56.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	144.000	144.000	144.000	*	*
Residual Error	0	*	*	*		
Total	15	425.000				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	-2907.68
Flow_Rate	2434.27
Inj_Speed	89.2596
Inj_Press	3.34284
Melt_Temp	-46.5073
Viscosity	212.070
Screw_Speed	771.171
Flow_Rate*Inj_Speed	165.258
Flow_Rate*Inj_Press	-65.9624
Flow_Rate*Melt_Temp	-9.74178
Flow_Rate*Viscosity	-70.4225
Flow_Rate*Screw_Speed	-1.17371
Inj_Speed*Melt_Temp	2.09070
Inj_Speed*Screw_Speed	-34.1113
Flow_Rate*Inj_Speed*Melt_Temp	-0.704225
Flow_Rate*Inj_Press*Melt_Temp	0.281690

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +

```

```

Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +

```

Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.875
Flow_Rate	0.250	0.125
Inj_Speed	1.500	0.750
Inj_Press	-3.250	-1.625
Melt_Temp	-4.250	-2.125
Viscosity	0.500	0.250
Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed	1.000	0.500
Flow_Rate*Inj_Press	-3.250	-1.625
Flow_Rate*Melt_Temp	0.250	0.125
Flow_Rate*Viscosity	-4.500	-2.250
Flow_Rate*Screw_Speed	0.500	0.250
Inj_Speed*Melt_Temp	-1.000	-0.500
Inj_Speed*Screw_Speed	0.250	0.125
Flow_Rate*Inj_Speed*Melt_Temp	-4.500	-2.250
Flow_Rate*Inj_Press*Melt_Temp	5.250	2.625

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	125.750	125.750	20.958	*	*
Flow_Rate	1	0.250	0.250	0.250	*	*
Inj_Speed	1	9.000	9.000	9.000	*	*
Inj_Press	1	42.250	42.250	42.250	*	*
Melt_Temp	1	72.250	72.250	72.250	*	*
Viscosity	1	1.000	1.000	1.000	*	*
Screw_Speed	1	1.000	1.000	1.000	*	*
2-Way Interactions	7	132.750	132.750	18.964	*	*
Flow_Rate*Inj_Speed	1	4.000	4.000	4.000	*	*
Flow_Rate*Inj_Press	1	42.250	42.250	42.250	*	*
Flow_Rate*Melt_Temp	1	0.250	0.250	0.250	*	*
Flow_Rate*Viscosity	1	81.000	81.000	81.000	*	*
Flow_Rate*Screw_Speed	1	1.000	1.000	1.000	*	*
Inj_Speed*Melt_Temp	1	4.000	4.000	4.000	*	*
Inj_Speed*Screw_Speed	1	0.250	0.250	0.250	*	*
3-Way Interactions	2	191.250	191.250	95.625	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	81.000	81.000	81.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	110.250	110.250	110.250	*	*
Residual Error	0	*	*	*		
Total	15	449.750				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	1194.43
Flow_Rate	931.455
Inj_Speed	-82.3953
Inj_Press	4.44319
Melt_Temp	-57.5108
Viscosity	256.085

Screw_Speed	661.136
Flow_Rate*Inj_Speed	196.244
Flow_Rate*Inj_Press	-58.2160
Flow_Rate*Melt_Temp	-3.05164
Flow_Rate*Viscosity	-84.5070
Flow_Rate*Screw_Speed	2.34742
Inj_Speed*Melt_Temp	2.53085
Inj_Speed*Screw_Speed	-29.7099
Flow_Rate*Inj_Speed*Melt_Temp	-0.845070
Flow_Rate*Inj_Press*Melt_Temp	0.246479

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +

```

Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.000
Flow_Rate	0.000	0.000
Inj_Speed	1.250	0.625
Inj_Press	-3.500	-1.750
Melt_Temp	-4.000	-2.000
Viscosity	0.250	0.125
Screw_Speed	-0.250	-0.125
Flow_Rate*Inj_Speed	1.250	0.625
Flow_Rate*Inj_Press	-3.000	-1.500
Flow_Rate*Melt_Temp	0.000	0.000
Flow_Rate*Viscosity	-4.250	-2.125
Flow_Rate*Screw_Speed	0.250	0.125
Inj_Speed*Melt_Temp	-1.250	-0.625
Inj_Speed*Screw_Speed	-0.000	-0.000
Flow_Rate*Inj_Speed*Melt_Temp	-4.250	-2.125
Flow_Rate*Inj_Press*Melt_Temp	5.500	2.750

S = \* PRESS = \*

# Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	119.750	119.750	19.958	*	*
Flow_Rate	1	0.000	0.000	0.000	*	*
Inj_Speed	1	6.250	6.250	6.250	*	*
Inj_Press	1	49.000	49.000	49.000	*	*
Melt_Temp	1	64.000	64.000	64.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	0.250	0.250	0.250	*	*
2-Way Interactions	7	121.000	121.000	17.286	*	*
Flow_Rate*Inj_Speed	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press	1	36.000	36.000	36.000	*	*
Flow_Rate*Melt_Temp	1	0.000	0.000	0.000	*	*
Flow_Rate*Viscosity	1	72.250	72.250	72.250	*	*
Flow_Rate*Screw_Speed	1	0.250	0.250	0.250	*	*
Inj_Speed*Melt_Temp	1	6.250	6.250	6.250	*	*
Inj_Speed*Screw_Speed	1	0.000	0.000	0.000	*	*
3-Way Interactions	2	193.250	193.250	96.625	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	72.250	72.250	72.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	121.000	121.000	121.000	*	*
Residual Error	0	*	*	*		
Total	15	434.000				

## Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	-172.938
Flow_Rate	1432.39
Inj_Speed	-25.1770
Inj_Press	4.07641
Melt_Temp	-53.8430
Viscosity	241.413
Screw_Speed	697.815
Flow_Rate*Inj_Speed	185.915
Flow_Rate*Inj_Press	-60.7981
Flow_Rate*Melt_Temp	-5.28169
Flow_Rate*Viscosity	-79.8122
Flow_Rate*Screw_Speed	1.17371
Inj_Speed*Melt_Temp	2.38413
Inj_Speed*Screw_Speed	-31.1770
Flow_Rate*Inj_Speed*Melt_Temp	-0.798122
Flow_Rate*Inj_Press*Melt_Temp	0.258216

## Effects Pareto for Bubbles

### Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +

```





$\text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.938
Flow_Rate	0.125	0.063
Inj_Speed	1.375	0.687
Inj_Press	-3.375	-1.688
Melt_Temp	-4.125	-2.063
Viscosity	0.375	0.188
Screw_Speed	-0.375	-0.187
Flow_Rate*Inj_Speed	1.125	0.563
Flow_Rate*Inj_Press	-3.125	-1.562
Flow_Rate*Melt_Temp	0.125	0.062
Flow_Rate*Viscosity	-4.375	-2.188
Flow_Rate*Screw_Speed	0.375	0.187
Inj_Speed*Melt_Temp	-1.125	-0.563
Inj_Speed*Screw_Speed	0.125	0.062
Flow_Rate*Inj_Speed*Melt_Temp	-4.375	-2.188
Flow_Rate*Inj_Press*Melt_Temp	5.375	2.688

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	122.375	122.375	20.396	*	*
Flow_Rate	1	0.062	0.063	0.063	*	*
Inj_Speed	1	7.562	7.562	7.562	*	*
Inj_Press	1	45.562	45.562	45.562	*	*
Melt_Temp	1	68.062	68.063	68.063	*	*
Viscosity	1	0.562	0.563	0.563	*	*
Screw_Speed	1	0.562	0.562	0.562	*	*
2-Way Interactions	7	126.438	126.438	18.063	*	*
Flow_Rate*Inj_Speed	1	5.062	5.062	5.062	*	*
Flow_Rate*Inj_Press	1	39.063	39.062	39.062	*	*
Flow_Rate*Melt_Temp	1	0.062	0.062	0.062	*	*
Flow_Rate*Viscosity	1	76.563	76.563	76.563	*	*
Flow_Rate*Screw_Speed	1	0.563	0.562	0.562	*	*
Inj_Speed*Melt_Temp	1	5.063	5.063	5.063	*	*
Inj_Speed*Screw_Speed	1	0.062	0.062	0.062	*	*
3-Way Interactions	2	192.125	192.125	96.063	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	76.563	76.563	76.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	115.563	115.563	115.563	*	*
Residual Error	0	*	*	*		
Total	15	440.938				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	510.747
Flow_Rate	1181.92
Inj_Speed	-53.7862
Inj_Press	4.25980
Melt_Temp	-55.6769
Viscosity	248.749
Screw_Speed	679.475
Flow_Rate*Inj_Speed	191.080
Flow_Rate*Inj_Press	-59.5070
Flow_Rate*Melt_Temp	-4.16667
Flow_Rate*Viscosity	-82.1596
Flow_Rate*Screw_Speed	1.76056
Inj_Speed*Melt_Temp	2.45749
Inj_Speed*Screw_Speed	-30.4434
Flow_Rate*Inj_Speed*Melt_Temp	-0.821596
Flow_Rate*Inj_Press*Melt_Temp	0.252347

## Effects Pareto for Bubbles

Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity  
Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity

Flow\_Rate\*Inj\_Speed\*Screw\_Speed + Flow\_Rate\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

Alias Information for Terms in the Model.  
 Totally confounded terms were removed from the analysis.

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
 Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.063
Flow_Rate	0.375	0.188
Inj_Speed	1.125	0.562
Inj_Press	-3.125	-1.563
Melt_Temp	-3.875	-1.937
Viscosity	0.125	0.063
Screw_Speed	-0.625	-0.312
Flow_Rate*Inj_Speed	0.875	0.437
Flow_Rate*Inj_Press	-2.875	-1.437
Flow_Rate*Melt_Temp	0.375	0.187

Flow_Rate*Viscosity	-4.625	-2.313
Flow_Rate*Screw_Speed	0.125	0.062
Inj_Speed*Melt_Temp	-1.375	-0.688
Inj_Speed*Screw_Speed	0.375	0.187
Flow_Rate*Inj_Speed*Melt_Temp	-4.625	-2.313
Flow_Rate*Inj_Press*Melt_Temp	5.625	2.813

S = \* PRESS = \*

#### Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	106.375	106.375	17.729	*	*
Flow_Rate	1	0.562	0.563	0.563	*	*
Inj_Speed	1	5.062	5.062	5.062	*	*
Inj_Press	1	39.063	39.063	39.063	*	*
Melt_Temp	1	60.062	60.063	60.063	*	*
Viscosity	1	0.062	0.063	0.063	*	*
Screw_Speed	1	1.562	1.562	1.562	*	*
2-Way Interactions	7	130.438	130.438	18.634	*	*
Flow_Rate*Inj_Speed	1	3.062	3.062	3.062	*	*
Flow_Rate*Inj_Press	1	33.063	33.062	33.062	*	*
Flow_Rate*Melt_Temp	1	0.562	0.562	0.562	*	*
Flow_Rate*Viscosity	1	85.563	85.563	85.563	*	*
Flow_Rate*Screw_Speed	1	0.062	0.062	0.062	*	*
Inj_Speed*Melt_Temp	1	7.563	7.563	7.563	*	*
Inj_Speed*Screw_Speed	1	0.562	0.562	0.562	*	*
3-Way Interactions	2	212.125	212.125	106.063	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	85.563	85.563	85.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	126.563	126.563	126.563	*	*
Residual Error	0	*	*	*		
Total	15	448.938				

#### Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	684.374
Flow_Rate	1185.68
Inj_Speed	-60.6218
Inj_Press	3.91802
Melt_Temp	-59.0947
Viscosity	262.420
Screw_Speed	713.654
Flow_Rate*Inj_Speed	201.408
Flow_Rate*Inj_Press	-62.0892
Flow_Rate*Melt_Temp	-4.04930
Flow_Rate*Viscosity	-86.8545
Flow_Rate*Screw_Speed	0.586854
Inj_Speed*Melt_Temp	2.59420
Inj_Speed*Screw_Speed	-31.8106
Flow_Rate*Inj_Speed*Melt_Temp	-0.868545
Flow_Rate*Inj_Press*Melt_Temp	0.264085

### Effects Pareto for Bubbles

Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +

```

Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +

```

```

      Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
      Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
      Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
      Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
      Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
      Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
      Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.250
Flow_Rate	0.750	0.375
Inj_Speed	0.750	0.375
Inj_Press	-2.750	-1.375
Melt_Temp	-3.500	-1.750
Viscosity	-0.250	-0.125
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	0.500	0.250
Flow_Rate*Inj_Press	-2.500	-1.250
Flow_Rate*Melt_Temp	0.750	0.375
Flow_Rate*Viscosity	-5.000	-2.500
Flow_Rate*Screw_Speed	-0.250	-0.125
Inj_Speed*Melt_Temp	-1.750	-0.875
Inj_Speed*Screw_Speed	0.750	0.375
Flow_Rate*Inj_Speed*Melt_Temp	-5.000	-2.500
Flow_Rate*Inj_Press*Melt_Temp	6.000	3.000

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	88.000	88.000	14.667	*	*
Flow_Rate	1	2.250	2.250	2.250	*	*
Inj_Speed	1	2.250	2.250	2.250	*	*
Inj_Press	1	30.250	30.250	30.250	*	*
Melt_Temp	1	49.000	49.000	49.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	143.000	143.000	20.429	*	*
Flow_Rate*Inj_Speed	1	1.000	1.000	1.000	*	*
Flow_Rate*Inj_Press	1	25.000	25.000	25.000	*	*
Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	100.000	100.000	100.000	*	*
Flow_Rate*Screw_Speed	1	0.250	0.250	0.250	*	*

Inj_Speed*Melt_Temp	1	12.250	12.250	12.250	*	*
Inj_Speed*Screw_Speed	1	2.250	2.250	2.250	*	*
3-Way Interactions	2	244.000	244.000	122.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	100.000	100.000	100.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	144.000	144.000	144.000	*	*
Residual Error	0	*	*	*		
Total	15	475.000				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	944.813
Flow_Rate	1191.31
Inj_Speed	-70.8754
Inj_Press	3.40534
Melt_Temp	-64.2215
Viscosity	282.927
Screw_Speed	764.921
Flow_Rate*Inj_Speed	216.901
Flow_Rate*Inj_Press	-65.9624
Flow_Rate*Melt_Temp	-3.87324
Flow_Rate*Viscosity	-93.8967
Flow_Rate*Screw_Speed	-1.17371
Inj_Speed*Melt_Temp	2.79927
Inj_Speed*Screw_Speed	-33.8613
Flow_Rate*Inj_Speed*Melt_Temp	-0.938967
Flow_Rate*Inj_Press*Melt_Temp	0.281690

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +

```

```

    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.875



Flow_Rate	1.500	0.750
Inj_Speed	0.000	0.000
Inj_Press	-2.000	-1.000
Melt_Temp	-4.250	-2.125
Viscosity	-1.000	-0.500
Screw_Speed	-0.250	-0.125
Flow_Rate*Inj_Speed	1.250	0.625
Flow_Rate*Inj_Press	-3.250	-1.625
Flow_Rate*Melt_Temp	1.500	0.750
Flow_Rate*Viscosity	-4.250	-2.125
Flow_Rate*Screw_Speed	-1.000	-0.500
Inj_Speed*Melt_Temp	-2.500	-1.250
Inj_Speed*Screw_Speed	1.500	0.750
Flow_Rate*Inj_Speed*Melt_Temp	-4.250	-2.125
Flow_Rate*Inj_Press*Melt_Temp	5.250	2.625

S = \*      PRESS = \*

#### Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	101.500	101.500	16.917	*	*
Flow_Rate	1	9.000	9.000	9.000	*	*
Inj_Speed	1	0.000	0.000	0.000	*	*
Inj_Press	1	16.000	16.000	16.000	*	*
Melt_Temp	1	72.250	72.250	72.250	*	*
Viscosity	1	4.000	4.000	4.000	*	*
Screw_Speed	1	0.250	0.250	0.250	*	*
2-Way Interactions	7	167.750	167.750	23.964	*	*
Flow_Rate*Inj_Speed	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press	1	42.250	42.250	42.250	*	*
Flow_Rate*Melt_Temp	1	9.000	9.000	9.000	*	*
Flow_Rate*Viscosity	1	72.250	72.250	72.250	*	*
Flow_Rate*Screw_Speed	1	4.000	4.000	4.000	*	*
Inj_Speed*Melt_Temp	1	25.000	25.000	25.000	*	*
Inj_Speed*Screw_Speed	1	9.000	9.000	9.000	*	*
3-Way Interactions	2	182.500	182.500	91.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	72.250	72.250	72.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	110.250	110.250	110.250	*	*
Residual Error	0	*	*	*		
Total	15	451.750				

#### Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	495.869
Flow_Rate	1144.84
Inj_Speed	-48.8683
Inj_Press	4.50569
Melt_Temp	-55.4187
Viscosity	238.913
Screw_Speed	676.893
Flow_Rate*Inj_Speed	185.915
Flow_Rate*Inj_Press	-58.2160
Flow_Rate*Melt_Temp	-3.52113
Flow_Rate*Viscosity	-79.8122
Flow_Rate*Screw_Speed	-4.69484
Inj_Speed*Melt_Temp	2.35913
Inj_Speed*Screw_Speed	-29.4599
Flow_Rate*Inj_Speed*Melt_Temp	-0.798122

Flow\_Rate\*Inj\_Press\*Melt\_Temp 0.246479

## Effects Pareto for Bubbles

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
```

Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.188
Flow_Rate	0.875	0.438
Inj_Speed	0.625	0.313
Inj_Press	-2.625	-1.313
Melt_Temp	-3.625	-1.812
Viscosity	-0.375	-0.188
Screw_Speed	-0.875	-0.438
Flow_Rate*Inj_Speed	0.625	0.312
Flow_Rate*Inj_Press	-2.625	-1.313
Flow_Rate*Melt_Temp	0.875	0.437
Flow_Rate*Viscosity	-4.875	-2.438
Flow_Rate*Screw_Speed	-0.375	-0.188
Inj_Speed*Melt_Temp	-1.875	-0.938
Inj_Speed*Screw_Speed	0.875	0.438
Flow_Rate*Inj_Speed*Melt_Temp	-4.875	-2.438
Flow_Rate*Inj_Press*Melt_Temp	5.875	2.938

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	88.375	88.375	14.729	*	*
Flow_Rate	1	3.063	3.063	3.063	*	*
Inj_Speed	1	1.563	1.563	1.563	*	*
Inj_Press	1	27.563	27.562	27.562	*	*

Melt_Temp	1	52.562	52.562	52.562	*	*
Viscosity	1	0.563	0.563	0.563	*	*
Screw_Speed	1	3.062	3.063	3.063	*	*
2-Way Interactions	7	144.938	144.938	20.705	*	*
Flow_Rate*Inj_Speed	1	1.562	1.562	1.562	*	*
Flow_Rate*Inj_Press	1	27.563	27.563	27.563	*	*
Flow_Rate*Melt_Temp	1	3.062	3.062	3.062	*	*
Flow_Rate*Viscosity	1	95.063	95.063	95.063	*	*
Flow_Rate*Screw_Speed	1	0.563	0.563	0.563	*	*
Inj_Speed*Melt_Temp	1	14.063	14.063	14.063	*	*
Inj_Speed*Screw_Speed	1	3.063	3.063	3.063	*	*
3-Way Interactions	2	233.125	233.125	116.563	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	95.063	95.063	95.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	138.063	138.063	138.063	*	*
Residual Error	0	*	*	*		
Total	15	466.438				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	869.989
Flow_Rate	1183.57
Inj_Speed	-67.2075
Inj_Press	3.58873
Melt_Temp	-62.7543
Viscosity	275.592
Screw_Speed	750.250
Flow_Rate*Inj_Speed	211.737
Flow_Rate*Inj_Press	-64.6714
Flow_Rate*Melt_Temp	-3.81455
Flow_Rate*Viscosity	-91.5493
Flow_Rate*Screw_Speed	-1.76056
Inj_Speed*Melt_Temp	2.72592
Inj_Speed*Screw_Speed	-33.1277
Flow_Rate*Inj_Speed*Melt_Temp	-0.915493
Flow_Rate*Inj_Press*Melt_Temp	0.275822

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +

```

```

Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +

```

Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.250
Flow_Rate	0.750	0.375
Inj_Speed	0.750	0.375
Inj_Press	-2.750	-1.375
Melt_Temp	-3.500	-1.750
Viscosity	-0.250	-0.125
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	0.500	0.250
Flow_Rate*Inj_Press	-2.500	-1.250
Flow_Rate*Melt_Temp	0.750	0.375
Flow_Rate*Viscosity	-5.000	-2.500
Flow_Rate*Screw_Speed	-0.250	-0.125
Inj_Speed*Melt_Temp	-1.750	-0.875
Inj_Speed*Screw_Speed	0.750	0.375
Flow_Rate*Inj_Speed*Melt_Temp	-5.000	-2.500
Flow_Rate*Inj_Press*Melt_Temp	6.000	3.000

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	88.000	88.000	14.667	*	*
Flow_Rate	1	2.250	2.250	2.250	*	*
Inj_Speed	1	2.250	2.250	2.250	*	*
Inj_Press	1	30.250	30.250	30.250	*	*
Melt_Temp	1	49.000	49.000	49.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	143.000	143.000	20.429	*	*
Flow_Rate*Inj_Speed	1	1.000	1.000	1.000	*	*
Flow_Rate*Inj_Press	1	25.000	25.000	25.000	*	*
Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	100.000	100.000	100.000	*	*
Flow_Rate*Screw_Speed	1	0.250	0.250	0.250	*	*
Inj_Speed*Melt_Temp	1	12.250	12.250	12.250	*	*
Inj_Speed*Screw_Speed	1	2.250	2.250	2.250	*	*
3-Way Interactions	2	244.000	244.000	122.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	100.000	100.000	100.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	144.000	144.000	144.000	*	*
Residual Error	0	*	*	*		
Total	15	475.000				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	944.813
Flow_Rate	1191.31
Inj_Speed	-70.8754
Inj_Press	3.40534
Melt_Temp	-64.2215
Viscosity	282.927

Screw_Speed	764.921
Flow_Rate*Inj_Speed	216.901
Flow_Rate*Inj_Press	-65.9624
Flow_Rate*Melt_Temp	-3.87324
Flow_Rate*Viscosity	-93.8967
Flow_Rate*Screw_Speed	-1.17371
Inj_Speed*Melt_Temp	2.79927
Inj_Speed*Screw_Speed	-33.8613
Flow_Rate*Inj_Speed*Melt_Temp	-0.938967
Flow_Rate*Inj_Press*Melt_Temp	0.281690

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +

```

Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.438
Flow_Rate	0.375	0.188
Inj_Speed	0.375	0.188
Inj_Press	-2.375	-1.187
Melt_Temp	-3.875	-1.937
Viscosity	0.125	0.062
Screw_Speed	-0.625	-0.313
Flow_Rate*Inj_Speed	0.875	0.437
Flow_Rate*Inj_Press	-2.875	-1.438
Flow_Rate*Melt_Temp	1.125	0.563
Flow_Rate*Viscosity	-5.375	-2.688
Flow_Rate*Screw_Speed	-0.625	-0.313
Inj_Speed*Melt_Temp	-1.375	-0.688
Inj_Speed*Screw_Speed	0.375	0.188
Flow_Rate*Inj_Speed*Melt_Temp	-5.375	-2.688
Flow_Rate*Inj_Press*Melt_Temp	6.375	3.187

S = \* PRESS = \*



# Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	85.375	85.375	14.229	*	*
Flow_Rate	1	0.562	0.563	0.563	*	*
Inj_Speed	1	0.562	0.563	0.563	*	*
Inj_Press	1	22.563	22.562	22.562	*	*
Melt_Temp	1	60.062	60.062	60.062	*	*
Viscosity	1	0.062	0.062	0.062	*	*
Screw_Speed	1	1.562	1.563	1.563	*	*
2-Way Interactions	7	166.438	166.437	23.777	*	*
Flow_Rate*Inj_Speed	1	3.062	3.062	3.062	*	*
Flow_Rate*Inj_Press	1	33.063	33.063	33.063	*	*
Flow_Rate*Melt_Temp	1	5.062	5.063	5.063	*	*
Flow_Rate*Viscosity	1	115.563	115.562	115.562	*	*
Flow_Rate*Screw_Speed	1	1.563	1.563	1.563	*	*
Inj_Speed*Melt_Temp	1	7.563	7.563	7.563	*	*
Inj_Speed*Screw_Speed	1	0.562	0.563	0.563	*	*
3-Way Interactions	2	278.125	278.125	139.063	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	115.563	115.563	115.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	162.562	162.562	162.562	*	*
Residual Error	0	*	*	*		
Total	15	529.938				

## Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	1235.31
Flow_Rate	1193.43
Inj_Speed	-86.2803
Inj_Press	3.95552
Melt_Temp	-69.7232
Viscosity	304.934
Screw_Speed	819.939
Flow_Rate*Inj_Speed	233.803
Flow_Rate*Inj_Press	-70.1878
Flow_Rate*Melt_Temp	-3.69718
Flow_Rate*Viscosity	-100.939
Flow_Rate*Screw_Speed	-2.93427
Inj_Speed*Melt_Temp	3.01934
Inj_Speed*Screw_Speed	-36.0620
Flow_Rate*Inj_Speed*Melt_Temp	-1.00939
Flow_Rate*Inj_Press*Melt_Temp	0.299296

## Effects Pareto for Bubbles

### Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
     Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
     Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
     Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +



```

Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
  Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
  Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
  Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
  Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
  Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
  Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.813
Flow_Rate	-0.375	-0.187
Inj_Speed	1.125	0.562
Inj_Press	-3.125	-1.563
Melt_Temp	-4.625	-2.312
Viscosity	0.875	0.437
Screw_Speed	0.125	0.062
Flow_Rate*Inj_Speed	0.125	0.062
Flow_Rate*Inj_Press	-2.125	-1.063
Flow_Rate*Melt_Temp	1.875	0.938
Flow_Rate*Viscosity	-6.125	-3.063
Flow_Rate*Screw_Speed	-1.375	-0.688
Inj_Speed*Melt_Temp	-2.125	-1.063
Inj_Speed*Screw_Speed	1.125	0.563
Flow_Rate*Inj_Speed*Melt_Temp	-4.625	-2.313
Flow_Rate*Inj_Press*Melt_Temp	5.625	2.813

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	133.375	133.375	22.229	*	*
Flow_Rate	1	0.562	0.562	0.562	*	*
Inj_Speed	1	5.062	5.062	5.062	*	*
Inj_Press	1	39.063	39.063	39.063	*	*
Melt_Temp	1	85.562	85.562	85.562	*	*
Viscosity	1	3.062	3.062	3.062	*	*
Screw_Speed	1	0.063	0.062	0.062	*	*
2-Way Interactions	7	212.938	212.938	30.420	*	*
Flow_Rate*Inj_Speed	1	0.062	0.062	0.062	*	*
Flow_Rate*Inj_Press	1	18.063	18.063	18.063	*	*
Flow_Rate*Melt_Temp	1	14.063	14.063	14.063	*	*
Flow_Rate*Viscosity	1	150.063	150.063	150.063	*	*
Flow_Rate*Screw_Speed	1	7.563	7.563	7.563	*	*
Inj_Speed*Melt_Temp	1	18.063	18.063	18.063	*	*
Inj_Speed*Screw_Speed	1	5.063	5.063	5.063	*	*
3-Way Interactions	2	212.125	212.125	106.063	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	85.563	85.563	85.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	126.563	126.563	126.563	*	*
Residual Error	0	*	*	*		
Total	15	558.438				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	627.912
Flow_Rate	1197.65
Inj_Speed	-55.4704
Inj_Press	2.85516
Melt_Temp	-60.9204
Viscosity	348.948
Screw_Speed	731.911
Flow_Rate*Inj_Speed	200.000
Flow_Rate*Inj_Press	-61.7371
Flow_Rate*Melt_Temp	-3.34507
Flow_Rate*Viscosity	-115.023
Flow_Rate*Screw_Speed	-6.45540
Inj_Speed*Melt_Temp	2.57920
Inj_Speed*Screw_Speed	-31.6606
Flow_Rate*Inj_Speed*Melt_Temp	-0.868545
Flow_Rate*Inj_Press*Melt_Temp	0.264085

## Effects Pareto for Bubbles

Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity  
Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity

Flow\_Rate\*Inj\_Speed\*Screw\_Speed + Flow\_Rate\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

Alias Information for Terms in the Model.  
 Totally confounded terms were removed from the analysis.

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
 Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.250
Flow_Rate	0.750	0.375
Inj_Speed	0.000	0.000
Inj_Press	-2.000	-1.000
Melt_Temp	-3.500	-1.750
Viscosity	-0.250	-0.125
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	1.250	0.625
Flow_Rate*Inj_Press	-3.250	-1.625
Flow_Rate*Melt_Temp	0.750	0.375

Flow_Rate*Viscosity	-5.000	-2.500
Flow_Rate*Screw_Speed	-0.250	-0.125
Inj_Speed*Melt_Temp	-1.000	-0.500
Inj_Speed*Screw_Speed	-0.000	-0.000
Flow_Rate*Inj_Speed*Melt_Temp	-5.750	-2.875
Flow_Rate*Inj_Press*Melt_Temp	6.750	3.375

S = \* PRESS = \*

#### Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	71.500	71.500	11.917	*	*
Flow_Rate	1	2.250	2.250	2.250	*	*
Inj_Speed	1	0.000	0.000	0.000	*	*
Inj_Press	1	16.000	16.000	16.000	*	*
Melt_Temp	1	49.000	49.000	49.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	155.000	155.000	22.143	*	*
Flow_Rate*Inj_Speed	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press	1	42.250	42.250	42.250	*	*
Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	100.000	100.000	100.000	*	*
Flow_Rate*Screw_Speed	1	0.250	0.250	0.250	*	*
Inj_Speed*Melt_Temp	1	4.000	4.000	4.000	*	*
Inj_Speed*Screw_Speed	1	0.000	0.000	0.000	*	*
3-Way Interactions	2	314.500	314.500	157.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	132.250	132.250	132.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	182.250	182.250	182.250	*	*
Residual Error	0	*	*	*		
Total	15	541.000				

#### Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	1539.00
Flow_Rate	1191.31
Inj_Speed	-101.685
Inj_Press	4.50569
Melt_Temp	-74.1246
Viscosity	282.927
Screw_Speed	863.953
Flow_Rate*Inj_Speed	250.704
Flow_Rate*Inj_Press	-74.4131
Flow_Rate*Melt_Temp	-3.87324
Flow_Rate*Viscosity	-93.8967
Flow_Rate*Screw_Speed	-1.17371
Inj_Speed*Melt_Temp	3.23941
Inj_Speed*Screw_Speed	-38.2627
Flow_Rate*Inj_Speed*Melt_Temp	-1.07981
Flow_Rate*Inj_Press*Melt_Temp	0.316901

### Effects Pareto for Bubbles

Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +

```

Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +

```

```

      Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
      Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
      Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
      Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
      Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
      Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
      Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		14.125
Flow_Rate	1.000	0.500
Inj_Speed	-0.250	-0.125
Inj_Press	-1.750	-0.875
Melt_Temp	-3.250	-1.625
Viscosity	-0.500	-0.250
Screw_Speed	-1.250	-0.625
Flow_Rate*Inj_Speed	1.500	0.750
Flow_Rate*Inj_Press	-3.500	-1.750
Flow_Rate*Melt_Temp	0.500	0.250
Flow_Rate*Viscosity	-4.750	-2.375
Flow_Rate*Screw_Speed	-0.000	-0.000
Inj_Speed*Melt_Temp	-0.750	-0.375
Inj_Speed*Screw_Speed	-0.250	-0.125
Flow_Rate*Inj_Speed*Melt_Temp	-6.000	-3.000
Flow_Rate*Inj_Press*Melt_Temp	7.000	3.500

S = \* PRESS = \*

Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	66.000	66.000	11.000	*	*
Flow_Rate	1	4.000	4.000	4.000	*	*
Inj_Speed	1	0.250	0.250	0.250	*	*
Inj_Press	1	12.250	12.250	12.250	*	*
Melt_Temp	1	42.250	42.250	42.250	*	*
Viscosity	1	1.000	1.000	1.000	*	*
Screw_Speed	1	6.250	6.250	6.250	*	*
2-Way Interactions	7	151.750	151.750	21.679	*	*
Flow_Rate*Inj_Speed	1	9.000	9.000	9.000	*	*
Flow_Rate*Inj_Press	1	49.000	49.000	49.000	*	*
Flow_Rate*Melt_Temp	1	1.000	1.000	1.000	*	*
Flow_Rate*Viscosity	1	90.250	90.250	90.250	*	*
Flow_Rate*Screw_Speed	1	0.000	0.000	0.000	*	*



Inj_Speed*Melt_Temp	1	2.250	2.250	2.250	*	*
Inj_Speed*Screw_Speed	1	0.250	0.250	0.250	*	*
3-Way Interactions	2	340.000	340.000	170.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	144.000	144.000	144.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	196.000	196.000	196.000	*	*
Residual Error	0	*	*	*		
Total	15	557.750				

Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	1741.47
Flow_Rate	1189.91
Inj_Speed	-111.955
Inj_Press	4.87248
Melt_Temp	-77.0589
Viscosity	268.256
Screw_Speed	893.296
Flow_Rate*Inj_Speed	261.972
Flow_Rate*Inj_Press	-77.2300
Flow_Rate*Melt_Temp	-3.99061
Flow_Rate*Viscosity	-89.2019
Flow_Rate*Screw_Speed	6.82859E-13
Inj_Speed*Melt_Temp	3.38613
Inj_Speed*Screw_Speed	-39.7298
Flow_Rate*Inj_Speed*Melt_Temp	-1.12676
Flow_Rate*Inj_Press*Melt_Temp	0.328638

## Effects Pareto for Bubbles

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +

```

```

    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Bubbles versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Bubbles (coded units)

Term	Effect	Coef
Constant		13.875

Flow_Rate	0.500	0.250
Inj_Speed	0.250	0.125
Inj_Press	-1.250	-0.625
Melt_Temp	-3.750	-1.875
Viscosity	-1.000	-0.500
Screw_Speed	-1.750	-0.875
Flow_Rate*Inj_Speed	2.000	1.000
Flow_Rate*Inj_Press	-3.000	-1.500
Flow_Rate*Melt_Temp	-0.000	-0.000
Flow_Rate*Viscosity	-5.250	-2.625
Flow_Rate*Screw_Speed	-0.500	-0.250
Inj_Speed*Melt_Temp	-0.250	-0.125
Inj_Speed*Screw_Speed	0.250	0.125
Flow_Rate*Inj_Speed*Melt_Temp	-5.500	-2.750
Flow_Rate*Inj_Press*Melt_Temp	7.500	3.750

S = \*      PRESS = \*

#### Analysis of Variance for Bubbles (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	80.000	80.000	13.333	*	*
Flow_Rate	1	1.000	1.000	1.000	*	*
Inj_Speed	1	0.250	0.250	0.250	*	*
Inj_Press	1	6.250	6.250	6.250	*	*
Melt_Temp	1	56.250	56.250	56.250	*	*
Viscosity	1	4.000	4.000	4.000	*	*
Screw_Speed	1	12.250	12.250	12.250	*	*
2-Way Interactions	7	163.750	163.750	23.393	*	*
Flow_Rate*Inj_Speed	1	16.000	16.000	16.000	*	*
Flow_Rate*Inj_Press	1	36.000	36.000	36.000	*	*
Flow_Rate*Melt_Temp	1	0.000	0.000	0.000	*	*
Flow_Rate*Viscosity	1	110.250	110.250	110.250	*	*
Flow_Rate*Screw_Speed	1	1.000	1.000	1.000	*	*
Inj_Speed*Melt_Temp	1	0.250	0.250	0.250	*	*
Inj_Speed*Screw_Speed	1	0.250	0.250	0.250	*	*
3-Way Interactions	2	346.000	346.000	173.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	121.000	121.000	121.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	225.000	225.000	225.000	*	*
Residual Error	0	*	*	*		
Total	15	589.750				

#### Estimated Coefficients for Bubbles using data in uncoded units

Term	Coef
Constant	-918.979
Flow_Rate	2230.28
Inj_Speed	-5.31854
Inj_Press	4.18891
Melt_Temp	-70.2232
Viscosity	295.599
Screw_Speed	961.653
Flow_Rate*Inj_Speed	241.315
Flow_Rate*Inj_Press	-82.3944
Flow_Rate*Melt_Temp	-8.45070
Flow_Rate*Viscosity	-98.5915
Flow_Rate*Screw_Speed	-2.34742
Inj_Speed*Melt_Temp	3.11270
Inj_Speed*Screw_Speed	-42.4641
Flow_Rate*Inj_Speed*Melt_Temp	-1.03286

Flow\_Rate\*Inj\_Press\*Melt\_Temp 0.352113

## Effects Pareto for Bubbles

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

## Response Optimization

Parameters

	Goal	Lower	Target	Upper	Weight	Import
Bubbles	Target	0	1	2	1	1

Global Solution

Flow_Rate	=	2.912
Inj_Speed	=	24.9574
Inj_Press	=	80.2292
Melt_Temp	=	220.331

Viscosity = 1.8  
Screw\_Speed = 18

Predicted Responses

Bubbles = 1 , desirability = 1.000000

Composite Desirability = 1.000000

## Optimization Plot

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Inj\_Press\*Melt\_Temp + Flow\_Rate\*Inj\_Speed\*Screw\_Speed +  
Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.875
Flow_Rate	-2.500	-1.250
Inj_Speed	-2.750	-1.375
Inj_Press	-1.250	-0.625
Melt_Temp	-0.750	-0.375
Viscosity	-1.000	-0.500
Screw_Speed	-1.750	-0.875
Flow_Rate*Inj_Speed	2.000	1.000
Flow_Rate*Inj_Press	-0.000	-0.000
Flow_Rate*Melt_Temp	-0.000	-0.000
Flow_Rate*Viscosity	-2.250	-1.125
Flow_Rate*Screw_Speed	-3.500	-1.750
Inj_Speed*Melt_Temp	-0.250	-0.125
Inj_Speed*Screw_Speed	-2.750	-1.375
Flow_Rate*Inj_Speed*Melt_Temp	-2.500	-1.250
Flow_Rate*Inj_Press*Melt_Temp	7.500	3.750

S = \*      PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	80.000	80.000	13.333	*	*
Flow_Rate	1	25.000	25.000	25.000	*	*
Inj_Speed	1	30.250	30.250	30.250	*	*
Inj_Press	1	6.250	6.250	6.250	*	*
Melt_Temp	1	2.250	2.250	2.250	*	*
Viscosity	1	4.000	4.000	4.000	*	*
Screw_Speed	1	12.250	12.250	12.250	*	*
2-Way Interactions	7	115.750	115.750	16.536	*	*
Flow_Rate*Inj_Speed	1	16.000	16.000	16.000	*	*
Flow_Rate*Inj_Press	1	0.000	0.000	0.000	*	*
Flow_Rate*Melt_Temp	1	0.000	0.000	0.000	*	*
Flow_Rate*Viscosity	1	20.250	20.250	20.250	*	*
Flow_Rate*Screw_Speed	1	49.000	49.000	49.000	*	*
Inj_Speed*Melt_Temp	1	0.250	0.250	0.250	*	*
Inj_Speed*Screw_Speed	1	30.250	30.250	30.250	*	*
3-Way Interactions	2	250.000	250.000	125.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	25.000	25.000	25.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	225.000	225.000	225.000	*	*
Residual Error	0	*	*	*		
Total	15	445.750				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-9918.88
Flow_Rate	5128.87
Inj_Speed	395.411
Inj_Press	-0.0625000
Melt_Temp	-31.8106
Viscosity	125.542
Screw_Speed	1017.67
Flow_Rate*Inj_Speed	111.737
Flow_Rate*Inj_Press	-80.9859
Flow_Rate*Melt_Temp	-21.1268
Flow_Rate*Viscosity	-42.2535
Flow_Rate*Screw_Speed	-16.4319

Inj_Speed*Melt_Temp	1.41214
Inj_Speed*Screw_Speed	-43.0641
Flow_Rate*Inj_Speed*Melt_Temp	-0.469484
Flow_Rate*Inj_Press*Melt_Temp	0.352113

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +

```

```

Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.000
Flow_Rate	-4.250	-2.125
Inj_Speed	-1.000	-0.500
Inj_Press	-3.000	-1.500
Melt_Temp	-2.500	-1.250
Viscosity	0.750	0.375
Screw_Speed	-0.000	-0.000
Flow_Rate*Inj_Speed	3.750	1.875
Flow_Rate*Inj_Press	-1.750	-0.875
Flow_Rate*Melt_Temp	-1.750	-0.875
Flow_Rate*Viscosity	-0.500	-0.250
Flow_Rate*Screw_Speed	-1.750	-0.875
Inj_Speed*Melt_Temp	1.500	0.750
Inj_Speed*Screw_Speed	-4.500	-2.250
Flow_Rate*Inj_Speed*Melt_Temp	-0.750	-0.375
Flow_Rate*Inj_Press*Melt_Temp	5.750	2.875

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	139.500	139.500	23.250	*	*



Flow_Rate	1	72.250	72.250	72.250	*	*
Inj_Speed	1	4.000	4.000	4.000	*	*
Inj_Press	1	36.000	36.000	36.000	*	*
Melt_Temp	1	25.000	25.000	25.000	*	*
Viscosity	1	2.250	2.250	2.250	*	*
Screw_Speed	1	0.000	0.000	0.000	*	*
2-Way Interactions	7	184.000	184.000	26.286	*	*
Flow_Rate*Inj_Speed	1	56.250	56.250	56.250	*	*
Flow_Rate*Inj_Press	1	12.250	12.250	12.250	*	*
Flow_Rate*Melt_Temp	1	12.250	12.250	12.250	*	*
Flow_Rate*Viscosity	1	1.000	1.000	1.000	*	*
Flow_Rate*Screw_Speed	1	12.250	12.250	12.250	*	*
Inj_Speed*Melt_Temp	1	9.000	9.000	9.000	*	*
Inj_Speed*Screw_Speed	1	81.000	81.000	81.000	*	*
3-Way Interactions	2	134.500	134.500	67.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	132.250	132.250	132.250	*	*
Residual Error	0	*	*	*		
Total	15	458.000				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-11134.3
Flow_Rate	5102.58
Inj_Speed	443.261
Inj_Press	2.32999
Melt_Temp	-7.88568
Viscosity	29.8427
Screw_Speed	778.418
Flow_Rate*Inj_Speed	39.4366
Flow_Rate*Inj_Press	-62.9108
Flow_Rate*Melt_Temp	-21.9484
Flow_Rate*Viscosity	-9.38967
Flow_Rate*Screw_Speed	-8.21596
Inj_Speed*Melt_Temp	0.455141
Inj_Speed*Screw_Speed	-33.4941
Flow_Rate*Inj_Speed*Melt_Temp	-0.140845
Flow_Rate*Inj_Press*Melt_Temp	0.269953

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +

```

```

Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed

```

$\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.750
Flow_Rate	-2.750	-1.375
Inj_Speed	-2.500	-1.250
Inj_Press	-1.500	-0.750
Melt_Temp	-1.000	-0.500
Viscosity	-0.750	-0.375
Screw_Speed	-1.500	-0.750
Flow_Rate*Inj_Speed	2.250	1.125
Flow_Rate*Inj_Press	-0.250	-0.125
Flow_Rate*Melt_Temp	-0.250	-0.125
Flow_Rate*Viscosity	-2.000	-1.000
Flow_Rate*Screw_Speed	-3.250	-1.625
Inj_Speed*Melt_Temp	-0.000	-0.000
Inj_Speed*Screw_Speed	-3.000	-1.500
Flow_Rate*Inj_Speed*Melt_Temp	-2.250	-1.125
Flow_Rate*Inj_Press*Melt_Temp	7.250	3.625

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	79.500	79.500	13.250	*	*
Flow_Rate	1	30.250	30.250	30.250	*	*
Inj_Speed	1	25.000	25.000	25.000	*	*
Inj_Press	1	9.000	9.000	9.000	*	*
Melt_Temp	1	4.000	4.000	4.000	*	*
Viscosity	1	2.250	2.250	2.250	*	*
Screw_Speed	1	9.000	9.000	9.000	*	*
2-Way Interactions	7	115.000	115.000	16.429	*	*
Flow_Rate*Inj_Speed	1	20.250	20.250	20.250	*	*
Flow_Rate*Inj_Press	1	0.250	0.250	0.250	*	*
Flow_Rate*Melt_Temp	1	0.250	0.250	0.250	*	*
Flow_Rate*Viscosity	1	16.000	16.000	16.000	*	*
Flow_Rate*Screw_Speed	1	42.250	42.250	42.250	*	*
Inj_Speed*Melt_Temp	1	0.000	0.000	0.000	*	*
Inj_Speed*Screw_Speed	1	36.000	36.000	36.000	*	*
3-Way Interactions	2	230.500	230.500	115.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	20.250	20.250	20.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	210.250	210.250	210.250	*	*
Residual Error	0	*	*	*		
Total	15	425.000				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10092.5
Flow_Rate	5125.12
Inj_Speed	402.247

Inj_Press	0.279284
Melt_Temp	-28.3927
Viscosity	111.871
Screw_Speed	983.488
Flow_Rate*Inj_Speed	101.408
Flow_Rate*Inj_Press	-78.4038
Flow_Rate*Melt_Temp	-21.2441
Flow_Rate*Viscosity	-37.5587
Flow_Rate*Screw_Speed	-15.2582
Inj_Speed*Melt_Temp	1.27542
Inj_Speed*Screw_Speed	-41.6969
Flow_Rate*Inj_Speed*Melt_Temp	-0.422535
Flow_Rate*Inj_Press*Melt_Temp	0.340376

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

$$\begin{aligned}
& I + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Press} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} + \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Viscosity} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} + \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Press} + \text{Inj\_Speed} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Melt\_Temp} + \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} + \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Screw\_Speed} + \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}
\end{aligned}$$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.250
Flow_Rate	-1.250	-0.625
Inj_Speed	-4.000	-2.000
Inj_Press	-0.000	-0.000
Melt_Temp	-2.000	-1.000
Viscosity	-2.250	-1.125
Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed	3.250	1.625
Flow_Rate*Inj_Press	-1.250	-0.625
Flow_Rate*Melt_Temp	1.250	0.625
Flow_Rate*Viscosity	-1.000	-0.500
Flow_Rate*Screw_Speed	-4.750	-2.375
Inj_Speed*Melt_Temp	-1.500	-0.750
Inj_Speed*Screw_Speed	-1.500	-0.750
Flow_Rate*Inj_Speed*Melt_Temp	-1.250	-0.625
Flow_Rate*Inj_Press*Melt_Temp	6.250	3.125

S = \* PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	107.500	107.500	17.917	*	*
Flow_Rate	1	6.250	6.250	6.250	*	*
Inj_Speed	1	64.000	64.000	64.000	*	*
Inj_Press	1	0.000	0.000	0.000	*	*
Melt_Temp	1	16.000	16.000	16.000	*	*
Viscosity	1	20.250	20.250	20.250	*	*
Screw_Speed	1	1.000	1.000	1.000	*	*
2-Way Interactions	7	167.000	167.000	23.857	*	*
Flow_Rate*Inj_Speed	1	42.250	42.250	42.250	*	*
Flow_Rate*Inj_Press	1	6.250	6.250	6.250	*	*
Flow_Rate*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Viscosity	1	4.000	4.000	4.000	*	*
Flow_Rate*Screw_Speed	1	90.250	90.250	90.250	*	*
Inj_Speed*Melt_Temp	1	9.000	9.000	9.000	*	*
Inj_Speed*Screw_Speed	1	9.000	9.000	9.000	*	*
3-Way Interactions	2	162.500	162.500	81.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	156.250	156.250	156.250	*	*
Residual Error	0	*	*	*		
Total	15	437.000				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10667.1
Flow_Rate	5051.41
Inj_Speed	432.089
Inj_Press	1.77142
Melt_Temp	-17.1392
Viscosity	52.1854
Screw_Speed	870.953
Flow_Rate*Inj_Speed	60.0939
Flow_Rate*Inj_Press	-68.0751
Flow_Rate*Melt_Temp	-20.5399
Flow_Rate*Viscosity	-18.7793
Flow_Rate*Screw_Speed	-22.3005
Inj_Speed*Melt_Temp	0.678568
Inj_Speed*Screw_Speed	-35.7284
Flow_Rate*Inj_Speed*Melt_Temp	-0.234742
Flow_Rate*Inj_Press*Melt_Temp	0.293427

### Effects Pareto for Shrinkage

#### Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed

```



$\text{Flow\_Rate} \times \text{Screw\_Speed} + \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Inj\_Speed} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		12.438
Flow_Rate	0.375	0.188
Inj_Speed	-2.375	-1.187
Inj_Press	-1.625	-0.813
Melt_Temp	-0.375	-0.188
Viscosity	-3.875	-1.938
Screw_Speed	-2.125	-1.062
Flow_Rate*Inj_Speed	1.625	0.813
Flow_Rate*Inj_Press	0.375	0.187
Flow_Rate*Melt_Temp	-0.375	-0.188
Flow_Rate*Viscosity	0.625	0.312
Flow_Rate*Screw_Speed	-3.125	-1.563
Inj_Speed*Melt_Temp	-3.125	-1.562
Inj_Speed*Screw_Speed	0.125	0.063
Flow_Rate*Inj_Speed*Melt_Temp	0.375	0.188
Flow_Rate*Inj_Press*Melt_Temp	4.625	2.313

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	112.375	112.375	18.7292	*	*
Flow_Rate	1	0.563	0.563	0.5625	*	*
Inj_Speed	1	22.562	22.562	22.5625	*	*
Inj_Press	1	10.563	10.563	10.5625	*	*
Melt_Temp	1	0.563	0.563	0.5625	*	*
Viscosity	1	60.063	60.063	60.0625	*	*
Screw_Speed	1	18.062	18.062	18.0625	*	*
2-Way Interactions	7	91.437	91.437	13.0625	*	*
Flow_Rate*Inj_Speed	1	10.562	10.563	10.5625	*	*
Flow_Rate*Inj_Press	1	0.562	0.562	0.5625	*	*
Flow_Rate*Melt_Temp	1	0.563	0.563	0.5625	*	*
Flow_Rate*Viscosity	1	1.562	1.562	1.5625	*	*
Flow_Rate*Screw_Speed	1	39.062	39.063	39.0625	*	*
Inj_Speed*Melt_Temp	1	39.062	39.062	39.0625	*	*
Inj_Speed*Screw_Speed	1	0.063	0.063	0.0625	*	*
3-Way Interactions	2	86.125	86.125	43.0625	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	0.563	0.563	0.5625	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	85.563	85.563	85.5625	*	*
Residual Error	0	*	*	*		



Total 15 289.937

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-11925.9
Flow_Rate	5042.25
Inj_Speed	498.844
Inj_Press	-0.612676
Melt_Temp	6.70176
Viscosity	-43.1784
Screw_Speed	632.543
Flow_Rate*Inj_Speed	-13.1455
Flow_Rate*Inj_Press	-49.7653
Flow_Rate*Melt_Temp	-21.3028
Flow_Rate*Viscosity	11.7371
Flow_Rate*Screw_Speed	-14.6714
Inj_Speed*Melt_Temp	-0.275070
Inj_Speed*Screw_Speed	-26.1920
Flow_Rate*Inj_Speed*Melt_Temp	0.0704225
Flow_Rate*Inj_Press*Melt_Temp	0.217136

## Effects Pareto for Shrinkage

Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity  
Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +

```

Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.563
Flow_Rate	-1.875	-0.937
Inj_Speed	-4.625	-2.312
Inj_Press	0.625	0.313
Melt_Temp	-2.625	-1.312
Viscosity	-1.625	-0.813
Screw_Speed	0.125	0.063

Flow_Rate*Inj_Speed	3.875	1.938
Flow_Rate*Inj_Press	-1.875	-0.938
Flow_Rate*Melt_Temp	1.875	0.938
Flow_Rate*Viscosity	-1.625	-0.812
Flow_Rate*Screw_Speed	-5.375	-2.688
Inj_Speed*Melt_Temp	-0.875	-0.438
Inj_Speed*Screw_Speed	-2.125	-1.063
Flow_Rate*Inj_Speed*Melt_Temp	-1.875	-0.938
Flow_Rate*Inj_Press*Melt_Temp	6.875	3.438

S = \*      PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	139.375	139.375	23.229	*	*
Flow_Rate	1	14.062	14.062	14.062	*	*
Inj_Speed	1	85.563	85.563	85.563	*	*
Inj_Press	1	1.562	1.562	1.562	*	*
Melt_Temp	1	27.562	27.563	27.563	*	*
Viscosity	1	10.563	10.563	10.563	*	*
Screw_Speed	1	0.063	0.063	0.063	*	*
2-Way Interactions	7	235.438	235.438	33.634	*	*
Flow_Rate*Inj_Speed	1	60.063	60.063	60.063	*	*
Flow_Rate*Inj_Press	1	14.063	14.063	14.063	*	*
Flow_Rate*Melt_Temp	1	14.062	14.063	14.063	*	*
Flow_Rate*Viscosity	1	10.563	10.562	10.562	*	*
Flow_Rate*Screw_Speed	1	115.563	115.563	115.563	*	*
Inj_Speed*Melt_Temp	1	3.063	3.063	3.063	*	*
Inj_Speed*Screw_Speed	1	18.063	18.063	18.063	*	*
3-Way Interactions	2	203.125	203.125	101.563	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	14.063	14.063	14.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	189.063	189.063	189.063	*	*
Residual Error	0	*	*	*		
Total	15	577.938				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10183.0
Flow_Rate	5054.93
Inj_Speed	406.415
Inj_Press	2.68838
Melt_Temp	-26.3088
Viscosity	88.8638
Screw_Speed	962.649
Flow_Rate*Inj_Speed	88.2629
Flow_Rate*Inj_Press	-75.1174
Flow_Rate*Melt_Temp	-20.2465
Flow_Rate*Viscosity	-30.5164
Flow_Rate*Screw_Speed	-25.2347
Inj_Speed*Melt_Temp	1.04535
Inj_Speed*Screw_Speed	-39.3962
Flow_Rate*Inj_Speed*Melt_Temp	-0.352113
Flow_Rate*Inj_Press*Melt_Temp	0.322770

#### Effects Pareto for Shrinkage

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
```

```

      Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
      Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
      Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
      Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
      Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
      Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
      Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
      Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
      Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.250
Flow_Rate	-1.250	-0.625
Inj_Speed	-4.000	-2.000
Inj_Press	-0.000	-0.000
Melt_Temp	-2.000	-1.000
Viscosity	-2.250	-1.125
Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed	3.250	1.625
Flow_Rate*Inj_Press	-1.250	-0.625
Flow_Rate*Melt_Temp	1.250	0.625
Flow_Rate*Viscosity	-1.000	-0.500
Flow_Rate*Screw_Speed	-4.750	-2.375
Inj_Speed*Melt_Temp	-1.500	-0.750
Inj_Speed*Screw_Speed	-1.500	-0.750
Flow_Rate*Inj_Speed*Melt_Temp	-1.250	-0.625
Flow_Rate*Inj_Press*Melt_Temp	6.250	3.125

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	107.500	107.500	17.917	*	*
Flow_Rate	1	6.250	6.250	6.250	*	*
Inj_Speed	1	64.000	64.000	64.000	*	*
Inj_Press	1	0.000	0.000	0.000	*	*
Melt_Temp	1	16.000	16.000	16.000	*	*
Viscosity	1	20.250	20.250	20.250	*	*
Screw_Speed	1	1.000	1.000	1.000	*	*
2-Way Interactions	7	167.000	167.000	23.857	*	*
Flow_Rate*Inj_Speed	1	42.250	42.250	42.250	*	*
Flow_Rate*Inj_Press	1	6.250	6.250	6.250	*	*

Flow_Rate*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Viscosity	1	4.000	4.000	4.000	*	*
Flow_Rate*Screw_Speed	1	90.250	90.250	90.250	*	*
Inj_Speed*Melt_Temp	1	9.000	9.000	9.000	*	*
Inj_Speed*Screw_Speed	1	9.000	9.000	9.000	*	*
3-Way Interactions	2	162.500	162.500	81.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	156.250	156.250	156.250	*	*
Residual Error	0	*	*	*		
Total	15	437.000				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10667.1
Flow_Rate	5051.41
Inj_Speed	432.089
Inj_Press	1.77142
Melt_Temp	-17.1392
Viscosity	52.1854
Screw_Speed	870.953
Flow_Rate*Inj_Speed	60.0939
Flow_Rate*Inj_Press	-68.0751
Flow_Rate*Melt_Temp	-20.5399
Flow_Rate*Viscosity	-18.7793
Flow_Rate*Screw_Speed	-22.3005
Inj_Speed*Melt_Temp	0.678568
Inj_Speed*Screw_Speed	-35.7284
Flow_Rate*Inj_Speed*Melt_Temp	-0.234742
Flow_Rate*Inj_Press*Melt_Temp	0.293427

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +

```

```

Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.063
Flow_Rate	-0.875	-0.437
Inj_Speed	-4.375	-2.187
Inj_Press	0.375	0.187
Melt_Temp	-1.625	-0.813
Viscosity	-2.625	-1.313
Screw_Speed	-0.875	-0.437
Flow_Rate*Inj_Speed	3.625	1.813
Flow_Rate*Inj_Press	-1.625	-0.813
Flow_Rate*Melt_Temp	0.875	0.437
Flow_Rate*Viscosity	-0.625	-0.312
Flow_Rate*Screw_Speed	-4.375	-2.187
Inj_Speed*Melt_Temp	-1.125	-0.563
Inj_Speed*Screw_Speed	-1.875	-0.938
Flow_Rate*Inj_Speed*Melt_Temp	-1.625	-0.813
Flow_Rate*Inj_Press*Melt_Temp	6.625	3.312

S = \*      PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	121.375	121.375	20.229	*	*
Flow_Rate	1	3.062	3.062	3.062	*	*
Inj_Speed	1	76.562	76.562	76.562	*	*
Inj_Press	1	0.562	0.562	0.562	*	*
Melt_Temp	1	10.563	10.563	10.563	*	*
Viscosity	1	27.563	27.563	27.563	*	*
Screw_Speed	1	3.062	3.062	3.062	*	*
2-Way Interactions	7	163.437	163.437	23.348	*	*
Flow_Rate*Inj_Speed	1	52.563	52.563	52.563	*	*
Flow_Rate*Inj_Press	1	10.563	10.563	10.563	*	*
Flow_Rate*Melt_Temp	1	3.062	3.062	3.062	*	*
Flow_Rate*Viscosity	1	1.563	1.562	1.562	*	*
Flow_Rate*Screw_Speed	1	76.562	76.562	76.562	*	*
Inj_Speed*Melt_Temp	1	5.063	5.063	5.063	*	*
Inj_Speed*Screw_Speed	1	14.062	14.063	14.063	*	*
3-Way Interactions	2	186.125	186.125	93.062	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	10.563	10.563	10.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	175.562	175.562	175.562	*	*
Residual Error	0	*	*	*		
Total	15	470.937				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10363.4
Flow_Rate	5049.30
Inj_Speed	416.685
Inj_Press	2.32160
Melt_Temp	-21.5406
Viscosity	30.1784
Screw_Speed	914.967
Flow_Rate*Inj_Speed	76.9953
Flow_Rate*Inj_Press	-72.3005
Flow_Rate*Melt_Temp	-20.7160
Flow_Rate*Viscosity	-11.7371
Flow_Rate*Screw_Speed	-20.5399



Inj_Speed*Melt_Temp	0.898638
Inj_Speed*Screw_Speed	-37.9291
Flow_Rate*Inj_Speed*Melt_Temp	-0.305164
Flow_Rate*Inj_Press*Melt_Temp	0.311033

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +

```

```

Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.313
Flow_Rate	-1.375	-0.687
Inj_Speed	-3.875	-1.937
Inj_Press	-0.125	-0.063
Melt_Temp	-2.125	-1.063
Viscosity	-2.125	-1.063
Screw_Speed	-0.375	-0.187
Flow_Rate*Inj_Speed	3.125	1.562
Flow_Rate*Inj_Press	-1.125	-0.563
Flow_Rate*Melt_Temp	1.375	0.687
Flow_Rate*Viscosity	-1.125	-0.562
Flow_Rate*Screw_Speed	-4.875	-2.438
Inj_Speed*Melt_Temp	-1.625	-0.812
Inj_Speed*Screw_Speed	-1.375	-0.687
Flow_Rate*Inj_Speed*Melt_Temp	-1.125	-0.563
Flow_Rate*Inj_Press*Melt_Temp	6.125	3.063

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	104.375	104.375	17.396	*	*

Flow_Rate	1	7.563	7.562	7.562	*	*
Inj_Speed	1	60.062	60.062	60.062	*	*
Inj_Press	1	0.063	0.063	0.063	*	*
Melt_Temp	1	18.063	18.063	18.063	*	*
Viscosity	1	18.063	18.063	18.063	*	*
Screw_Speed	1	0.562	0.562	0.562	*	*
2-Way Interactions	7	169.937	169.938	24.277	*	*
Flow_Rate*Inj_Speed	1	39.062	39.062	39.062	*	*
Flow_Rate*Inj_Press	1	5.063	5.063	5.063	*	*
Flow_Rate*Melt_Temp	1	7.562	7.562	7.562	*	*
Flow_Rate*Viscosity	1	5.063	5.062	5.062	*	*
Flow_Rate*Screw_Speed	1	95.063	95.063	95.063	*	*
Inj_Speed*Melt_Temp	1	10.562	10.562	10.562	*	*
Inj_Speed*Screw_Speed	1	7.562	7.562	7.562	*	*
3-Way Interactions	2	155.125	155.125	77.563	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	5.063	5.063	5.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	150.063	150.063	150.063	*	*
Residual Error	0	*	*	*		
Total	15	429.437				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10768.3
Flow_Rate	5052.11
Inj_Speed	437.224
Inj_Press	1.58803
Melt_Temp	-15.6721
Viscosity	59.5211
Screw_Speed	856.282
Flow_Rate*Inj_Speed	54.4601
Flow_Rate*Inj_Press	-66.6667
Flow_Rate*Melt_Temp	-20.4812
Flow_Rate*Viscosity	-21.1268
Flow_Rate*Screw_Speed	-22.8873
Inj_Speed*Melt_Temp	0.605211
Inj_Speed*Screw_Speed	-34.9948
Flow_Rate*Inj_Speed*Melt_Temp	-0.211268
Flow_Rate*Inj_Press*Melt_Temp	0.287559

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +

```



$\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.000
Flow_Rate	-0.750	-0.375
Inj_Speed	-4.500	-2.250
Inj_Press	-0.750	-0.375
Melt_Temp	-2.750	-1.375
Viscosity	-1.500	-0.750
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	3.750	1.875
Flow_Rate*Inj_Press	-0.500	-0.250
Flow_Rate*Melt_Temp	2.000	1.000
Flow_Rate*Viscosity	-1.750	-0.875
Flow_Rate*Screw_Speed	-4.250	-2.125
Inj_Speed*Melt_Temp	-2.250	-1.125
Inj_Speed*Screw_Speed	-2.000	-1.000
Flow_Rate*Inj_Speed*Melt_Temp	-0.500	-0.250
Flow_Rate*Inj_Press*Melt_Temp	6.750	3.375

S = \*      PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	128.750	128.750	21.458	*	*
Flow_Rate	1	2.250	2.250	2.250	*	*
Inj_Speed	1	81.000	81.000	81.000	*	*
Inj_Press	1	2.250	2.250	2.250	*	*
Melt_Temp	1	30.250	30.250	30.250	*	*
Viscosity	1	9.000	9.000	9.000	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	194.000	194.000	27.714	*	*
Flow_Rate*Inj_Speed	1	56.250	56.250	56.250	*	*
Flow_Rate*Inj_Press	1	1.000	1.000	1.000	*	*
Flow_Rate*Melt_Temp	1	16.000	16.000	16.000	*	*
Flow_Rate*Viscosity	1	12.250	12.250	12.250	*	*
Flow_Rate*Screw_Speed	1	72.250	72.250	72.250	*	*
Inj_Speed*Melt_Temp	1	20.250	20.250	20.250	*	*
Inj_Speed*Screw_Speed	1	16.000	16.000	16.000	*	*
3-Way Interactions	2	183.250	183.250	91.625	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	1.000	1.000	1.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	182.250	182.250	182.250	*	*
Residual Error	0	*	*	*		
Total	15	506.000				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-13621.9
Flow_Rate	6123.71
Inj_Speed	580.270

Inj_Press	0.671068
Melt_Temp	-8.33638
Viscosity	96.1995
Screw_Speed	929.638
Flow_Rate*Inj_Speed	28.6385
Flow_Rate*Inj_Press	-73.1221
Flow_Rate*Melt_Temp	-25.4695
Flow_Rate*Viscosity	-32.8638
Flow_Rate*Screw_Speed	-19.9531
Inj_Speed*Melt_Temp	0.238427
Inj_Speed*Screw_Speed	-38.6627
Flow_Rate*Inj_Speed*Melt_Temp	-0.0938967
Flow_Rate*Inj_Press*Melt_Temp	0.316901

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

$$\begin{aligned}
& I + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Press} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} + \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Viscosity} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} + \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Press} + \text{Inj\_Speed} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Melt\_Temp} + \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} + \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Screw\_Speed} + \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}
\end{aligned}$$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.563
Flow_Rate	-1.875	-0.937
Inj_Speed	-4.375	-2.187
Inj_Press	-0.625	-0.313
Melt_Temp	-2.625	-1.313
Viscosity	-2.625	-1.313
Screw_Speed	-0.875	-0.438
Flow_Rate*Inj_Speed	3.625	1.812
Flow_Rate*Inj_Press	-0.625	-0.313
Flow_Rate*Melt_Temp	1.875	0.938
Flow_Rate*Viscosity	-0.625	-0.312
Flow_Rate*Screw_Speed	-4.375	-2.188
Inj_Speed*Melt_Temp	-1.125	-0.563
Inj_Speed*Screw_Speed	-0.875	-0.438
Flow_Rate*Inj_Speed*Melt_Temp	-1.625	-0.813
Flow_Rate*Inj_Press*Melt_Temp	5.625	2.813

S = \* PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	150.375	150.375	25.062	*	*
Flow_Rate	1	14.062	14.062	14.062	*	*
Inj_Speed	1	76.562	76.562	76.562	*	*
Inj_Press	1	1.563	1.563	1.563	*	*
Melt_Temp	1	27.563	27.563	27.563	*	*
Viscosity	1	27.562	27.562	27.562	*	*
Screw_Speed	1	3.063	3.063	3.063	*	*
2-Way Interactions	7	154.437	154.437	22.062	*	*
Flow_Rate*Inj_Speed	1	52.562	52.562	52.562	*	*
Flow_Rate*Inj_Press	1	1.563	1.563	1.563	*	*
Flow_Rate*Melt_Temp	1	14.062	14.062	14.062	*	*
Flow_Rate*Viscosity	1	1.563	1.562	1.562	*	*
Flow_Rate*Screw_Speed	1	76.562	76.563	76.563	*	*
Inj_Speed*Melt_Temp	1	5.063	5.063	5.063	*	*
Inj_Speed*Screw_Speed	1	3.062	3.063	3.063	*	*
3-Way Interactions	2	137.125	137.125	68.563	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	10.563	10.563	10.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	126.563	126.563	126.563	*	*
Residual Error	0	*	*	*		
Total	15	441.937				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-7634.55
Flow_Rate	3922.54
Inj_Speed	316.919
Inj_Press	0.854460
Melt_Temp	-23.0077
Viscosity	30.1784
Screw_Speed	782.925
Flow_Rate*Inj_Speed	76.9953
Flow_Rate*Inj_Press	-61.0329
Flow_Rate*Melt_Temp	-16.0211
Flow_Rate*Viscosity	-11.7371
Flow_Rate*Screw_Speed	-20.5399
Inj_Speed*Melt_Temp	0.898638
Inj_Speed*Screw_Speed	-32.0606
Flow_Rate*Inj_Speed*Melt_Temp	-0.305164
Flow_Rate*Inj_Press*Melt_Temp	0.264085

### Effects Pareto for Shrinkage

#### Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed

```





$\text{Flow\_Rate} \times \text{Screw\_Speed} + \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Inj\_Speed} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.188
Flow_Rate	-1.125	-0.562
Inj_Speed	-3.625	-1.812
Inj_Press	0.125	0.062
Melt_Temp	-1.875	-0.937
Viscosity	-1.875	-0.938
Screw_Speed	-0.125	-0.062
Flow_Rate*Inj_Speed	2.875	1.438
Flow_Rate*Inj_Press	-1.375	-0.688
Flow_Rate*Melt_Temp	1.125	0.562
Flow_Rate*Viscosity	-1.375	-0.688
Flow_Rate*Screw_Speed	-5.125	-2.563
Inj_Speed*Melt_Temp	-1.875	-0.937
Inj_Speed*Screw_Speed	-1.625	-0.813
Flow_Rate*Inj_Speed*Melt_Temp	-0.875	-0.438
Flow_Rate*Inj_Press*Melt_Temp	6.375	3.188

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	85.875	85.875	14.312	*	*
Flow_Rate	1	5.062	5.062	5.062	*	*
Inj_Speed	1	52.562	52.562	52.562	*	*
Inj_Press	1	0.062	0.062	0.062	*	*
Melt_Temp	1	14.062	14.062	14.062	*	*
Viscosity	1	14.062	14.062	14.062	*	*
Screw_Speed	1	0.062	0.062	0.062	*	*
2-Way Interactions	7	182.937	182.938	26.134	*	*
Flow_Rate*Inj_Speed	1	33.062	33.063	33.063	*	*
Flow_Rate*Inj_Press	1	7.563	7.563	7.563	*	*
Flow_Rate*Melt_Temp	1	5.062	5.062	5.062	*	*
Flow_Rate*Viscosity	1	7.563	7.562	7.562	*	*
Flow_Rate*Screw_Speed	1	105.062	105.063	105.063	*	*
Inj_Speed*Melt_Temp	1	14.062	14.062	14.062	*	*
Inj_Speed*Screw_Speed	1	10.563	10.563	10.563	*	*
3-Way Interactions	2	165.625	165.625	82.813	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	3.063	3.063	3.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	162.563	162.563	162.563	*	*
Residual Error	0	*	*	*		

Total 15 434.437

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-12335.3
Flow_Rate	5616.90
Inj_Speed	497.377
Inj_Press	1.95481
Melt_Temp	-12.0042
Viscosity	74.1925
Screw_Speed	892.960
Flow_Rate*Inj_Speed	43.1925
Flow_Rate*Inj_Press	-69.4836
Flow_Rate*Melt_Temp	-22.7113
Flow_Rate*Viscosity	-25.8216
Flow_Rate*Screw_Speed	-24.0610
Inj_Speed*Melt_Temp	0.458498
Inj_Speed*Screw_Speed	-36.4620
Flow_Rate*Inj_Speed*Melt_Temp	-0.164319
Flow_Rate*Inj_Press*Melt_Temp	0.299296

## Effects Pareto for Shrinkage

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
```

```

Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.313
Flow_Rate	-1.375	-0.687
Inj_Speed	-3.875	-1.937
Inj_Press	-0.125	-0.063
Melt_Temp	-2.125	-1.063
Viscosity	-2.125	-1.063
Screw_Speed	-0.375	-0.187

Flow_Rate*Inj_Speed	3.125	1.562
Flow_Rate*Inj_Press	-1.125	-0.563
Flow_Rate*Melt_Temp	1.375	0.687
Flow_Rate*Viscosity	-1.125	-0.562
Flow_Rate*Screw_Speed	-4.875	-2.438
Inj_Speed*Melt_Temp	-1.625	-0.812
Inj_Speed*Screw_Speed	-1.375	-0.687
Flow_Rate*Inj_Speed*Melt_Temp	-1.125	-0.563
Flow_Rate*Inj_Press*Melt_Temp	6.125	3.063

S = \*      PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	104.375	104.375	17.396	*	*
Flow_Rate	1	7.563	7.562	7.562	*	*
Inj_Speed	1	60.062	60.062	60.062	*	*
Inj_Press	1	0.063	0.063	0.063	*	*
Melt_Temp	1	18.063	18.063	18.063	*	*
Viscosity	1	18.063	18.063	18.063	*	*
Screw_Speed	1	0.562	0.562	0.562	*	*
2-Way Interactions	7	169.937	169.938	24.277	*	*
Flow_Rate*Inj_Speed	1	39.062	39.062	39.062	*	*
Flow_Rate*Inj_Press	1	5.063	5.063	5.063	*	*
Flow_Rate*Melt_Temp	1	7.562	7.562	7.562	*	*
Flow_Rate*Viscosity	1	5.063	5.062	5.062	*	*
Flow_Rate*Screw_Speed	1	95.063	95.063	95.063	*	*
Inj_Speed*Melt_Temp	1	10.562	10.562	10.562	*	*
Inj_Speed*Screw_Speed	1	7.562	7.562	7.562	*	*
3-Way Interactions	2	155.125	155.125	77.563	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	5.063	5.063	5.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	150.063	150.063	150.063	*	*
Residual Error	0	*	*	*		
Total	15	429.437				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10768.3
Flow_Rate	5052.11
Inj_Speed	437.224
Inj_Press	1.58803
Melt_Temp	-15.6721
Viscosity	59.5211
Screw_Speed	856.282
Flow_Rate*Inj_Speed	54.4601
Flow_Rate*Inj_Press	-66.6667
Flow_Rate*Melt_Temp	-20.4812
Flow_Rate*Viscosity	-21.1268
Flow_Rate*Screw_Speed	-22.8873
Inj_Speed*Melt_Temp	0.605211
Inj_Speed*Screw_Speed	-34.9948
Flow_Rate*Inj_Speed*Melt_Temp	-0.211268
Flow_Rate*Inj_Press*Melt_Temp	0.287559

#### Effects Pareto for Shrinkage

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
```

```

      Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
      Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
      Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
      Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
      Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
      Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
      Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
      Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
      Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.375
Flow_Rate	-1.250	-0.625
Inj_Speed	-3.750	-1.875
Inj_Press	-0.000	-0.000
Melt_Temp	-2.250	-1.125
Viscosity	-2.000	-1.000
Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed	3.250	1.625
Flow_Rate*Inj_Press	-1.000	-0.500
Flow_Rate*Melt_Temp	1.250	0.625
Flow_Rate*Viscosity	-1.000	-0.500
Flow_Rate*Screw_Speed	-5.000	-2.500
Inj_Speed*Melt_Temp	-1.750	-0.875
Inj_Speed*Screw_Speed	-1.500	-0.750
Flow_Rate*Inj_Speed*Melt_Temp	-1.250	-0.625
Flow_Rate*Inj_Press*Melt_Temp	6.000	3.000

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	99.750	99.750	16.625	*	*
Flow_Rate	1	6.250	6.250	6.250	*	*
Inj_Speed	1	56.250	56.250	56.250	*	*
Inj_Press	1	0.000	0.000	0.000	*	*
Melt_Temp	1	20.250	20.250	20.250	*	*
Viscosity	1	16.000	16.000	16.000	*	*
Screw_Speed	1	1.000	1.000	1.000	*	*
2-Way Interactions	7	177.750	177.750	25.393	*	*
Flow_Rate*Inj_Speed	1	42.250	42.250	42.250	*	*
Flow_Rate*Inj_Press	1	4.000	4.000	4.000	*	*

Flow_Rate*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Viscosity	1	4.000	4.000	4.000	*	*
Flow_Rate*Screw_Speed	1	100.000	100.000	100.000	*	*
Inj_Speed*Melt_Temp	1	12.250	12.250	12.250	*	*
Inj_Speed*Screw_Speed	1	9.000	9.000	9.000	*	*
3-Way Interactions	2	150.250	150.250	75.125	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	144.000	144.000	144.000	*	*
Residual Error	0	*	*	*		
Total	15	427.750				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10178.4
Flow_Rate	4817.84
Inj_Speed	409.198
Inj_Press	1.41714
Melt_Temp	-17.0392
Viscosity	52.6854
Screw_Speed	842.610
Flow_Rate*Inj_Speed	60.0939
Flow_Rate*Inj_Press	-65.2582
Flow_Rate*Melt_Temp	-19.4836
Flow_Rate*Viscosity	-18.7793
Flow_Rate*Screw_Speed	-23.4742
Inj_Speed*Melt_Temp	0.673568
Inj_Speed*Screw_Speed	-34.3113
Flow_Rate*Inj_Speed*Melt_Temp	-0.234742
Flow_Rate*Inj_Press*Melt_Temp	0.281690

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +

```



```

Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
 Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.063
Flow_Rate	-0.625	-0.312
Inj_Speed	-3.125	-1.562
Inj_Press	-0.625	-0.313
Melt_Temp	-2.875	-1.437
Viscosity	-2.625	-1.313
Screw_Speed	0.125	0.063
Flow_Rate*Inj_Speed	2.625	1.312
Flow_Rate*Inj_Press	-0.375	-0.188
Flow_Rate*Melt_Temp	1.875	0.938
Flow_Rate*Viscosity	-0.375	-0.187
Flow_Rate*Screw_Speed	-5.625	-2.813
Inj_Speed*Melt_Temp	-1.125	-0.563
Inj_Speed*Screw_Speed	-2.125	-1.063
Flow_Rate*Inj_Speed*Melt_Temp	-1.875	-0.938
Flow_Rate*Inj_Press*Melt_Temp	6.625	3.312

S = \*      PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	102.875	102.875	17.146	*	*
Flow_Rate	1	1.563	1.562	1.562	*	*
Inj_Speed	1	39.062	39.062	39.062	*	*
Inj_Press	1	1.563	1.563	1.563	*	*
Melt_Temp	1	33.062	33.062	33.062	*	*
Viscosity	1	27.563	27.563	27.563	*	*
Screw_Speed	1	0.063	0.063	0.063	*	*
2-Way Interactions	7	192.437	192.437	27.491	*	*
Flow_Rate*Inj_Speed	1	27.562	27.562	27.562	*	*
Flow_Rate*Inj_Press	1	0.563	0.563	0.563	*	*
Flow_Rate*Melt_Temp	1	14.062	14.063	14.063	*	*
Flow_Rate*Viscosity	1	0.563	0.562	0.562	*	*
Flow_Rate*Screw_Speed	1	126.562	126.563	126.563	*	*
Inj_Speed*Melt_Temp	1	5.063	5.063	5.063	*	*
Inj_Speed*Screw_Speed	1	18.062	18.063	18.063	*	*
3-Way Interactions	2	189.625	189.625	94.812	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	14.063	14.063	14.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	175.562	175.562	175.562	*	*
Residual Error	0	*	*	*		
Total	15	484.937				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-9562.23
Flow_Rate	4779.11
Inj_Speed	390.859
Inj_Press	0.500176
Melt_Temp	-26.2088
Viscosity	16.0070
Screw_Speed	934.306
Flow_Rate*Inj_Speed	85.9155
Flow_Rate*Inj_Press	-71.7136
Flow_Rate*Melt_Temp	-19.1901
Flow_Rate*Viscosity	-7.04225
Flow_Rate*Screw_Speed	-26.4085

Inj_Speed*Melt_Temp	1.04035
Inj_Speed*Screw_Speed	-37.9791
Flow_Rate*Inj_Speed*Melt_Temp	-0.352113
Flow_Rate*Inj_Press*Melt_Temp	0.311033

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +

```

```

Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.313
Flow_Rate	-1.125	-0.562
Inj_Speed	-3.625	-1.812
Inj_Press	-0.125	-0.063
Melt_Temp	-2.375	-1.187
Viscosity	-2.125	-1.063
Screw_Speed	-0.375	-0.187
Flow_Rate*Inj_Speed	3.125	1.562
Flow_Rate*Inj_Press	-0.875	-0.438
Flow_Rate*Melt_Temp	1.375	0.688
Flow_Rate*Viscosity	-0.875	-0.437
Flow_Rate*Screw_Speed	-5.125	-2.563
Inj_Speed*Melt_Temp	-1.625	-0.813
Inj_Speed*Screw_Speed	-1.625	-0.813
Flow_Rate*Inj_Speed*Melt_Temp	-1.375	-0.688
Flow_Rate*Inj_Press*Melt_Temp	6.125	3.063

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	98.875	98.875	16.479	*	*

Flow_Rate	1	5.062	5.062	5.062	*	*
Inj_Speed	1	52.562	52.562	52.562	*	*
Inj_Press	1	0.063	0.062	0.062	*	*
Melt_Temp	1	22.562	22.563	22.563	*	*
Viscosity	1	18.062	18.063	18.063	*	*
Screw_Speed	1	0.562	0.562	0.562	*	*
2-Way Interactions	7	178.937	178.937	25.562	*	*
Flow_Rate*Inj_Speed	1	39.062	39.062	39.062	*	*
Flow_Rate*Inj_Press	1	3.063	3.063	3.063	*	*
Flow_Rate*Melt_Temp	1	7.562	7.562	7.562	*	*
Flow_Rate*Viscosity	1	3.063	3.062	3.062	*	*
Flow_Rate*Screw_Speed	1	105.062	105.063	105.063	*	*
Inj_Speed*Melt_Temp	1	10.563	10.563	10.563	*	*
Inj_Speed*Screw_Speed	1	10.562	10.562	10.562	*	*
3-Way Interactions	2	157.625	157.625	78.813	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	7.563	7.563	7.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	150.063	150.063	150.063	*	*
Residual Error	0	*	*	*		
Total	15	435.437				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10055.2
Flow_Rate	4810.09
Inj_Speed	405.530
Inj_Press	1.23374
Melt_Temp	-18.8731
Viscosity	45.3498
Screw_Speed	860.950
Flow_Rate*Inj_Speed	65.2582
Flow_Rate*Inj_Press	-66.5493
Flow_Rate*Melt_Temp	-19.4249
Flow_Rate*Viscosity	-16.4319
Flow_Rate*Screw_Speed	-24.0610
Inj_Speed*Melt_Temp	0.746925
Inj_Speed*Screw_Speed	-35.0448
Flow_Rate*Inj_Speed*Melt_Temp	-0.258216
Flow_Rate*Inj_Press*Melt_Temp	0.287559

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +

```

Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp + Flow\_Rate\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Viscosity\*Screw\_Speed + Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Inj\_Speed\*Screw\_Speed + Flow\_Rate\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Melt\_Temp\*Viscosity + Inj\_Press\*Viscosity\*Screw\_Speed

Alias Information for Terms in the Model.  
 Totally confounded terms were removed from the analysis.

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
 Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
 Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
 Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
 Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
 Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
 Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
 Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
 Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed  
 Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
 Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +  
 Flow\_Rate\*Inj\_Press\*Viscosity\*Screw\_Speed

$\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.688
Flow_Rate	-1.875	-0.937
Inj_Speed	-4.375	-2.187
Inj_Press	0.625	0.312
Melt_Temp	-1.625	-0.812
Viscosity	-1.375	-0.688
Screw_Speed	-1.125	-0.563
Flow_Rate*Inj_Speed	3.875	1.937
Flow_Rate*Inj_Press	-1.625	-0.813
Flow_Rate*Melt_Temp	0.625	0.312
Flow_Rate*Viscosity	-1.625	-0.812
Flow_Rate*Screw_Speed	-4.375	-2.188
Inj_Speed*Melt_Temp	-2.375	-1.188
Inj_Speed*Screw_Speed	-0.875	-0.438
Flow_Rate*Inj_Speed*Melt_Temp	-0.625	-0.313
Flow_Rate*Inj_Press*Melt_Temp	5.375	2.687

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	115.375	115.375	19.229	*	*
Flow_Rate	1	14.062	14.062	14.062	*	*
Inj_Speed	1	76.562	76.562	76.562	*	*
Inj_Press	1	1.562	1.562	1.562	*	*
Melt_Temp	1	10.562	10.562	10.562	*	*
Viscosity	1	7.562	7.563	7.563	*	*
Screw_Speed	1	5.062	5.063	5.063	*	*
2-Way Interactions	7	184.937	184.937	26.420	*	*
Flow_Rate*Inj_Speed	1	60.062	60.062	60.062	*	*
Flow_Rate*Inj_Press	1	10.563	10.563	10.563	*	*
Flow_Rate*Melt_Temp	1	1.562	1.562	1.562	*	*
Flow_Rate*Viscosity	1	10.563	10.562	10.562	*	*
Flow_Rate*Screw_Speed	1	76.562	76.562	76.562	*	*
Inj_Speed*Melt_Temp	1	22.563	22.563	22.563	*	*
Inj_Speed*Screw_Speed	1	3.062	3.063	3.063	*	*
3-Way Interactions	2	117.125	117.125	58.562	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	1.563	1.563	1.563	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	115.562	115.562	115.562	*	*
Residual Error	0	*	*	*		
Total	15	417.437				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-10794.6
Flow_Rate	4856.57
Inj_Speed	427.537

Inj_Press	2.33410
Melt_Temp	-7.86960
Viscosity	89.3638
Screw_Speed	750.914
Flow_Rate*Inj_Speed	34.2723
Flow_Rate*Inj_Press	-58.8028
Flow_Rate*Melt_Temp	-19.7770
Flow_Rate*Viscosity	-30.5164
Flow_Rate*Screw_Speed	-20.5399
Inj_Speed*Melt_Temp	0.306784
Inj_Speed*Screw_Speed	-30.6434
Flow_Rate*Inj_Speed*Melt_Temp	-0.117371
Flow_Rate*Inj_Press*Melt_Temp	0.252347

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.



$$\begin{aligned}
& I + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Press} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} + \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Viscosity} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} + \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Press} + \text{Inj\_Speed} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Melt\_Temp} + \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} + \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Screw\_Speed} + \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}
\end{aligned}$$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.563
Flow_Rate	-0.875	-0.437
Inj_Speed	-4.125	-2.062
Inj_Press	-0.375	-0.188
Melt_Temp	-2.625	-1.312
Viscosity	-1.625	-0.813
Screw_Speed	-0.875	-0.437
Flow_Rate*Inj_Speed	2.875	1.437
Flow_Rate*Inj_Press	-1.375	-0.688
Flow_Rate*Melt_Temp	0.875	0.437
Flow_Rate*Viscosity	-0.625	-0.312
Flow_Rate*Screw_Speed	-5.375	-2.688
Inj_Speed*Melt_Temp	-1.375	-0.688
Inj_Speed*Screw_Speed	-1.125	-0.563
Flow_Rate*Inj_Speed*Melt_Temp	-0.875	-0.438
Flow_Rate*Inj_Press*Melt_Temp	6.375	3.187

S = \* PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	112.875	112.875	18.812	*	*
Flow_Rate	1	3.062	3.062	3.062	*	*
Inj_Speed	1	68.062	68.062	68.062	*	*
Inj_Press	1	0.563	0.563	0.563	*	*
Melt_Temp	1	27.563	27.563	27.563	*	*
Viscosity	1	10.562	10.563	10.563	*	*
Screw_Speed	1	3.062	3.062	3.062	*	*
2-Way Interactions	7	173.437	173.437	24.777	*	*
Flow_Rate*Inj_Speed	1	33.062	33.062	33.062	*	*
Flow_Rate*Inj_Press	1	7.563	7.563	7.563	*	*
Flow_Rate*Melt_Temp	1	3.062	3.062	3.062	*	*
Flow_Rate*Viscosity	1	1.563	1.562	1.562	*	*
Flow_Rate*Screw_Speed	1	115.562	115.563	115.563	*	*
Inj_Speed*Melt_Temp	1	7.563	7.563	7.563	*	*
Inj_Speed*Screw_Speed	1	5.062	5.063	5.063	*	*
3-Way Interactions	2	165.625	165.625	82.812	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	3.063	3.063	3.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	162.562	162.562	162.562	*	*
Residual Error	0	*	*	*		
Total	15	451.937				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-12284.5
Flow_Rate	5636.15
Inj_Speed	493.277
Inj_Press	1.92981
Melt_Temp	-11.9124
Viscosity	32.1784
Screw_Speed	893.878
Flow_Rate*Inj_Speed	43.1925
Flow_Rate*Inj_Press	-69.4836
Flow_Rate*Melt_Temp	-22.8286
Flow_Rate*Viscosity	-11.7371
Flow_Rate*Screw_Speed	-25.2347
Inj_Speed*Melt_Temp	0.468498
Inj_Speed*Screw_Speed	-36.3620
Flow_Rate*Inj_Speed*Melt_Temp	-0.164319
Flow_Rate*Inj_Press*Melt_Temp	0.299296

### Effects Pareto for Shrinkage

#### Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed

```



$\text{Flow\_Rate} \times \text{Screw\_Speed} + \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Inj\_Speed} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Inj\_Speed} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} +$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$   
 $\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.375
Flow_Rate	-1.250	-0.625
Inj_Speed	-4.500	-2.250
Inj_Press	-0.000	-0.000
Melt_Temp	-3.000	-1.500
Viscosity	-1.250	-0.625
Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed	2.500	1.250
Flow_Rate*Inj_Press	-1.000	-0.500
Flow_Rate*Melt_Temp	0.500	0.250
Flow_Rate*Viscosity	-0.250	-0.125
Flow_Rate*Screw_Speed	-5.000	-2.500
Inj_Speed*Melt_Temp	-1.750	-0.875
Inj_Speed*Screw_Speed	-0.750	-0.375
Flow_Rate*Inj_Speed*Melt_Temp	-1.250	-0.625
Flow_Rate*Inj_Press*Melt_Temp	6.750	3.375

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	130.500	130.500	21.750	*	*
Flow_Rate	1	6.250	6.250	6.250	*	*
Inj_Speed	1	81.000	81.000	81.000	*	*
Inj_Press	1	0.000	0.000	0.000	*	*
Melt_Temp	1	36.000	36.000	36.000	*	*
Viscosity	1	6.250	6.250	6.250	*	*
Screw_Speed	1	1.000	1.000	1.000	*	*
2-Way Interactions	7	144.750	144.750	20.679	*	*
Flow_Rate*Inj_Speed	1	25.000	25.000	25.000	*	*
Flow_Rate*Inj_Press	1	4.000	4.000	4.000	*	*
Flow_Rate*Melt_Temp	1	1.000	1.000	1.000	*	*
Flow_Rate*Viscosity	1	0.250	0.250	0.250	*	*
Flow_Rate*Screw_Speed	1	100.000	100.000	100.000	*	*
Inj_Speed*Melt_Temp	1	12.250	12.250	12.250	*	*
Inj_Speed*Screw_Speed	1	2.250	2.250	2.250	*	*
3-Way Interactions	2	188.500	188.500	94.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	182.250	182.250	182.250	*	*
Residual Error	0	*	*	*		

Total 15 463.750

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-11991.3
Flow_Rate	5630.52
Inj_Speed	483.023
Inj_Press	1.41714
Melt_Temp	-16.0138
Viscosity	11.6714
Screw_Speed	934.892
Flow_Rate*Inj_Speed	58.6854
Flow_Rate*Inj_Press	-73.3568
Flow_Rate*Melt_Temp	-23.0047
Flow_Rate*Viscosity	-4.69484
Flow_Rate*Screw_Speed	-23.4742
Inj_Speed*Melt_Temp	0.673568
Inj_Speed*Screw_Speed	-38.4127
Flow_Rate*Inj_Speed*Melt_Temp	-0.234742
Flow_Rate*Inj_Press*Melt_Temp	0.316901

## Effects Pareto for Shrinkage

Alias Structure

I + Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity +  
Flow\_Rate\*Melt\_Temp\*Viscosity\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Flow\_Rate + Inj\_Speed\*Inj\_Press\*Viscosity + Melt\_Temp\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Screw\_Speed  
Inj\_Speed + Flow\_Rate\*Inj\_Press\*Viscosity + Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Inj\_Press + Flow\_Rate\*Inj\_Speed\*Viscosity + Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Melt\_Temp + Flow\_Rate\*Viscosity\*Screw\_Speed + Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Viscosity + Flow\_Rate\*Inj\_Speed\*Inj\_Press + Flow\_Rate\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Screw\_Speed + Flow\_Rate\*Melt\_Temp\*Viscosity + Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Speed + Inj\_Press\*Viscosity +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Screw\_Speed +  
Inj\_Speed\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Inj\_Press + Inj\_Speed\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Screw\_Speed +  
Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Melt\_Temp + Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Screw\_Speed +  
Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity  
Flow\_Rate\*Viscosity + Inj\_Speed\*Inj\_Press + Melt\_Temp\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp\*Viscosity\*Screw\_Speed  
Flow\_Rate\*Screw\_Speed + Melt\_Temp\*Viscosity +  
Flow\_Rate\*Inj\_Speed\*Inj\_Press\*Melt\_Temp +  
Inj\_Speed\*Inj\_Press\*Viscosity\*Screw\_Speed  
Inj\_Speed\*Melt\_Temp + Inj\_Press\*Screw\_Speed +  
Flow\_Rate\*Inj\_Speed\*Viscosity\*Screw\_Speed +  
Flow\_Rate\*Inj\_Press\*Melt\_Temp\*Viscosity  
Inj\_Speed\*Screw\_Speed + Inj\_Press\*Melt\_Temp +  
Flow\_Rate\*Inj\_Speed\*Melt\_Temp\*Viscosity +

```

Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.125
Flow_Rate	-1.750	-0.875
Inj_Speed	-5.000	-2.500
Inj_Press	-0.500	-0.250
Melt_Temp	-3.500	-1.750
Viscosity	-1.750	-0.875
Screw_Speed	-1.000	-0.500

Flow_Rate*Inj_Speed	2.000	1.000
Flow_Rate*Inj_Press	-1.500	-0.750
Flow_Rate*Melt_Temp	-0.000	-0.000
Flow_Rate*Viscosity	-0.750	-0.375
Flow_Rate*Screw_Speed	-5.500	-2.750
Inj_Speed*Melt_Temp	-2.250	-1.125
Inj_Speed*Screw_Speed	-1.250	-0.625
Flow_Rate*Inj_Speed*Melt_Temp	-1.750	-0.875
Flow_Rate*Inj_Press*Melt_Temp	6.250	3.125

S = \*      PRESS = \*

#### Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	178.500	178.500	29.750	*	*
Flow_Rate	1	12.250	12.250	12.250	*	*
Inj_Speed	1	100.000	100.000	100.000	*	*
Inj_Press	1	1.000	1.000	1.000	*	*
Melt_Temp	1	49.000	49.000	49.000	*	*
Viscosity	1	12.250	12.250	12.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	174.750	174.750	24.964	*	*
Flow_Rate*Inj_Speed	1	16.000	16.000	16.000	*	*
Flow_Rate*Inj_Press	1	9.000	9.000	9.000	*	*
Flow_Rate*Melt_Temp	1	0.000	0.000	0.000	*	*
Flow_Rate*Viscosity	1	2.250	2.250	2.250	*	*
Flow_Rate*Screw_Speed	1	121.000	121.000	121.000	*	*
Inj_Speed*Melt_Temp	1	20.250	20.250	20.250	*	*
Inj_Speed*Screw_Speed	1	6.250	6.250	6.250	*	*
3-Way Interactions	2	168.500	168.500	84.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	12.250	12.250	12.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	156.250	156.250	156.250	*	*
Residual Error	0	*	*	*		
Total	15	521.750				

#### Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-9976.09
Flow_Rate	4811.74
Inj_Speed	376.387
Inj_Press	2.10070
Melt_Temp	-21.4824
Viscosity	39.0141
Screw_Speed	880.207
Flow_Rate*Inj_Speed	79.3427
Flow_Rate*Inj_Press	-68.1925
Flow_Rate*Melt_Temp	-19.0141
Flow_Rate*Viscosity	-14.0845
Flow_Rate*Screw_Speed	-25.8216
Inj_Speed*Melt_Temp	0.946995
Inj_Speed*Screw_Speed	-35.6784
Flow_Rate*Inj_Speed*Melt_Temp	-0.328638
Flow_Rate*Inj_Press*Melt_Temp	0.293427

#### Effects Pareto for Shrinkage

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
```



```

      Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
      Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
      Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
      Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
      Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
      Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
      Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
      Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
      Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
      Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Shrinkage versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Shrinkage (coded units)

Term	Effect	Coef
Constant		13.500
Flow_Rate	-1.000	-0.500
Inj_Speed	-4.250	-2.125
Inj_Press	0.250	0.125
Melt_Temp	-2.750	-1.375
Viscosity	-1.000	-0.500
Screw_Speed	-0.250	-0.125
Flow_Rate*Inj_Speed	2.750	1.375
Flow_Rate*Inj_Press	-0.750	-0.375
Flow_Rate*Melt_Temp	0.750	0.375
Flow_Rate*Viscosity	0.000	0.000
Flow_Rate*Screw_Speed	-4.750	-2.375
Inj_Speed*Melt_Temp	-1.500	-0.750
Inj_Speed*Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed*Melt_Temp	-1.000	-0.500
Flow_Rate*Inj_Press*Melt_Temp	7.000	3.500

S = \* PRESS = \*

Analysis of Variance for Shrinkage (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	111.000	111.000	18.500	*	*
Flow_Rate	1	4.000	4.000	4.000	*	*
Inj_Speed	1	72.250	72.250	72.250	*	*
Inj_Press	1	0.250	0.250	0.250	*	*
Melt_Temp	1	30.250	30.250	30.250	*	*
Viscosity	1	4.000	4.000	4.000	*	*
Screw_Speed	1	0.250	0.250	0.250	*	*
2-Way Interactions	7	135.000	135.000	19.286	*	*
Flow_Rate*Inj_Speed	1	30.250	30.250	30.250	*	*
Flow_Rate*Inj_Press	1	2.250	2.250	2.250	*	*

Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	0.000	0.000	0.000	*	*
Flow_Rate*Screw_Speed	1	90.250	90.250	90.250	*	*
Inj_Speed*Melt_Temp	1	9.000	9.000	9.000	*	*
Inj_Speed*Screw_Speed	1	1.000	1.000	1.000	*	*
3-Way Interactions	2	200.000	200.000	100.000	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	4.000	4.000	4.000	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	196.000	196.000	196.000	*	*
Residual Error	0	*	*	*		
Total	15	446.000				

Estimated Coefficients for Shrinkage using data in uncoded units

Term	Coef
Constant	-12998.8
Flow_Rate	6039.91
Inj_Speed	536.342
Inj_Press	1.07535
Melt_Temp	-13.2796
Viscosity	-2.00000
Screw_Speed	962.235
Flow_Rate*Inj_Speed	48.3568
Flow_Rate*Inj_Press	-75.9390
Flow_Rate*Melt_Temp	-25.0000
Flow_Rate*Viscosity	-1.02879E-11
Flow_Rate*Screw_Speed	-22.3005
Inj_Speed*Melt_Temp	0.536854
Inj_Speed*Screw_Speed	-39.7798
Flow_Rate*Inj_Speed*Melt_Temp	-0.187793
Flow_Rate*Inj_Press*Melt_Temp	0.328638

## Effects Pareto for Shrinkage

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +

```

```

Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
 Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Black\_dots versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Black\_dots (coded units)

Term	Effect	Coef
Constant		14.813
Flow_Rate	2.875	1.438
Inj_Speed	2.625	1.313
Inj_Press	-3.125	-1.562
Melt_Temp	-6.125	-3.062
Viscosity	-2.875	-1.438
Screw_Speed	0.125	0.062
Flow_Rate*Inj_Speed	3.875	1.938
Flow_Rate*Inj_Press	-5.375	-2.687
Flow_Rate*Melt_Temp	-1.875	-0.938
Flow_Rate*Viscosity	-7.625	-3.812
Flow_Rate*Screw_Speed	1.875	0.937
Inj_Speed*Melt_Temp	-2.125	-1.063
Inj_Speed*Screw_Speed	2.625	1.312
Flow_Rate*Inj_Speed*Melt_Temp	-7.875	-3.938
Flow_Rate*Inj_Press*Melt_Temp	9.375	4.687

S = \*      PRESS = \*

#### Analysis of Variance for Black\_dots (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	282.87	282.875	47.146	*	*
Flow_Rate	1	33.06	33.063	33.063	*	*
Inj_Speed	1	27.56	27.563	27.563	*	*
Inj_Press	1	39.06	39.062	39.062	*	*
Melt_Temp	1	150.06	150.063	150.063	*	*
Viscosity	1	33.06	33.063	33.063	*	*
Screw_Speed	1	0.06	0.062	0.062	*	*
2-Way Interactions	7	481.94	481.937	68.848	*	*
Flow_Rate*Inj_Speed	1	60.06	60.063	60.063	*	*
Flow_Rate*Inj_Press	1	115.56	115.562	115.562	*	*
Flow_Rate*Melt_Temp	1	14.06	14.063	14.063	*	*
Flow_Rate*Viscosity	1	232.56	232.562	232.562	*	*
Flow_Rate*Screw_Speed	1	14.06	14.062	14.062	*	*
Inj_Speed*Melt_Temp	1	18.06	18.063	18.063	*	*
Inj_Speed*Screw_Speed	1	27.56	27.562	27.562	*	*
3-Way Interactions	2	599.63	599.625	299.813	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	248.06	248.063	248.063	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	351.56	351.562	351.562	*	*
Residual Error	0	*	*	*		
Total	15	1364.44				

#### Estimated Coefficients for Black\_dots using data in uncoded units

Term	Coef
Constant	1575.60
Flow_Rate	1880.99
Inj_Speed	-143.881
Inj_Press	7.46086
Melt_Temp	-97.1324
Viscosity	426.477
Screw_Speed	1157.39
Flow_Rate*Inj_Speed	347.418
Flow_Rate*Inj_Press	-103.756
Flow_Rate*Melt_Temp	-7.21831
Flow_Rate*Viscosity	-143.192
Flow_Rate*Screw_Speed	8.80282

Inj_Speed*Melt_Temp	4.42148
Inj_Speed*Screw_Speed	-52.6176
Flow_Rate*Inj_Speed*Melt_Temp	-1.47887
Flow_Rate*Inj_Press*Melt_Temp	0.440141

## Effects Pareto for Black\_dots

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +

```

```

Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Press*Melt_Temp + Flow_Rate*Inj_Speed*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

## Factorial Fit: Black\_dots versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Black\_dots (coded units)

Term	Effect	Coef
Constant		13.750
Flow_Rate	0.750	0.375
Inj_Speed	0.500	0.250
Inj_Press	-1.000	-0.500
Melt_Temp	-4.000	-2.000
Viscosity	-0.750	-0.375
Screw_Speed	-2.000	-1.000
Flow_Rate*Inj_Speed	1.750	0.875
Flow_Rate*Inj_Press	-3.250	-1.625
Flow_Rate*Melt_Temp	0.250	0.125
Flow_Rate*Viscosity	-5.500	-2.750
Flow_Rate*Screw_Speed	-0.250	-0.125
Inj_Speed*Melt_Temp	-0.000	-0.000
Inj_Speed*Screw_Speed	0.500	0.250
Flow_Rate*Inj_Speed*Melt_Temp	-5.750	-2.875
Flow_Rate*Inj_Press*Melt_Temp	7.250	3.625

S = \* PRESS = \*

Analysis of Variance for Black\_dots (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	89.500	89.500	14.917	*	*

Flow_Rate	1	2.250	2.250	2.250	*	*
Inj_Speed	1	1.000	1.000	1.000	*	*
Inj_Press	1	4.000	4.000	4.000	*	*
Melt_Temp	1	64.000	64.000	64.000	*	*
Viscosity	1	2.250	2.250	2.250	*	*
Screw_Speed	1	16.000	16.000	16.000	*	*
2-Way Interactions	7	177.000	177.000	25.286	*	*
Flow_Rate*Inj_Speed	1	12.250	12.250	12.250	*	*
Flow_Rate*Inj_Press	1	42.250	42.250	42.250	*	*
Flow_Rate*Melt_Temp	1	0.250	0.250	0.250	*	*
Flow_Rate*Viscosity	1	121.000	121.000	121.000	*	*
Flow_Rate*Screw_Speed	1	0.250	0.250	0.250	*	*
Inj_Speed*Melt_Temp	1	0.000	0.000	0.000	*	*
Inj_Speed*Screw_Speed	1	1.000	1.000	1.000	*	*
3-Way Interactions	2	342.500	342.500	171.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	132.250	132.250	132.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	210.250	210.250	210.250	*	*
Residual Error	0	*	*	*		
Total	15	609.000				

Estimated Coefficients for Black\_dots using data in uncoded units

Term	Coef
Constant	448.392
Flow_Rate	1729.34
Inj_Speed	-62.5369
Inj_Press	4.55569
Melt_Temp	-73.8911
Viscosity	310.270
Screw_Speed	924.974
Flow_Rate*Inj_Speed	251.643
Flow_Rate*Inj_Press	-79.8122
Flow_Rate*Melt_Temp	-6.22066
Flow_Rate*Viscosity	-103.286
Flow_Rate*Screw_Speed	-1.17371
Inj_Speed*Melt_Temp	3.25941
Inj_Speed*Screw_Speed	-40.9969
Flow_Rate*Inj_Speed*Melt_Temp	-1.07981
Flow_Rate*Inj_Press*Melt_Temp	0.340376

## Effects Pareto for Black\_dots

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +

```

```

Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.  
Totally confounded terms were removed from the analysis.

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
Flow_Rate*Inj_Press*Melt_Temp*Viscosity +
Flow_Rate*Inj_Speed*Viscosity*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
Flow_Rate*Inj_Press*Viscosity*Screw_Speed

```



$\text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Viscosity} \times \text{Screw\_Speed} + \text{Inj\_Press} \times \text{Melt\_Temp} \times \text{Viscosity}$   
 $\text{Flow\_Rate} \times \text{Inj\_Press} \times \text{Melt\_Temp} + \text{Flow\_Rate} \times \text{Inj\_Speed} \times \text{Screw\_Speed} +$   
 $\text{Inj\_Speed} \times \text{Melt\_Temp} \times \text{Viscosity} + \text{Inj\_Press} \times \text{Viscosity} \times \text{Screw\_Speed}$

## Factorial Fit: Black\_dots versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Black\_dots (coded units)

Term	Effect	Coef
Constant		13.000
Flow_Rate	-0.750	-0.375
Inj_Speed	2.000	1.000
Inj_Press	-2.500	-1.250
Melt_Temp	-5.500	-2.750
Viscosity	0.750	0.375
Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed	3.250	1.625
Flow_Rate*Inj_Press	-4.750	-2.375
Flow_Rate*Melt_Temp	-1.250	-0.625
Flow_Rate*Viscosity	-4.000	-2.000
Flow_Rate*Screw_Speed	1.250	0.625
Inj_Speed*Melt_Temp	1.500	0.750
Inj_Speed*Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed*Melt_Temp	-4.250	-2.125
Flow_Rate*Inj_Press*Melt_Temp	5.750	2.875

S = \* PRESS = \*

Analysis of Variance for Black\_dots (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	167.500	167.500	27.917	*	*
Flow_Rate	1	2.250	2.250	2.250	*	*
Inj_Speed	1	16.000	16.000	16.000	*	*
Inj_Press	1	25.000	25.000	25.000	*	*
Melt_Temp	1	121.000	121.000	121.000	*	*
Viscosity	1	2.250	2.250	2.250	*	*
Screw_Speed	1	1.000	1.000	1.000	*	*
2-Way Interactions	7	222.000	222.000	31.714	*	*
Flow_Rate*Inj_Speed	1	42.250	42.250	42.250	*	*
Flow_Rate*Inj_Press	1	90.250	90.250	90.250	*	*
Flow_Rate*Melt_Temp	1	6.250	6.250	6.250	*	*
Flow_Rate*Viscosity	1	64.000	64.000	64.000	*	*
Flow_Rate*Screw_Speed	1	6.250	6.250	6.250	*	*
Inj_Speed*Melt_Temp	1	9.000	9.000	9.000	*	*
Inj_Speed*Screw_Speed	1	4.000	4.000	4.000	*	*
3-Way Interactions	2	204.500	204.500	102.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	72.250	72.250	72.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	132.250	132.250	132.250	*	*
Residual Error	0	*	*	*		
Total	15	594.000				

Estimated Coefficients for Black\_dots using data in uncoded units

Term	Coef
Constant	-593.366
Flow_Rate	1706.81
Inj_Speed	-21.5228

Inj_Press	6.60640
Melt_Temp	-53.3840
Viscosity	228.242
Screw_Speed	719.904
Flow_Rate*Inj_Speed	189.671
Flow_Rate*Inj_Press	-64.3192
Flow_Rate*Melt_Temp	-6.92488
Flow_Rate*Viscosity	-75.1174
Flow_Rate*Screw_Speed	5.86854
Inj_Speed*Melt_Temp	2.43913
Inj_Speed*Screw_Speed	-32.7941
Flow_Rate*Inj_Speed*Melt_Temp	-0.798122
Flow_Rate*Inj_Press*Melt_Temp	0.269953

## Effects Pareto for Black\_dots

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

$$\begin{aligned}
& I + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Press} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} + \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Viscosity} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} + \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Press} + \text{Inj\_Speed} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Melt\_Temp} + \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} + \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Screw\_Speed} + \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}
\end{aligned}$$

## Factorial Fit: Black\_dots versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Black\_dots (coded units)

Term	Effect	Coef
Constant		13.250
Flow_Rate	-0.250	-0.125
Inj_Speed	1.500	0.750
Inj_Press	-2.000	-1.000
Melt_Temp	-5.000	-2.500
Viscosity	0.250	0.125
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	2.750	1.375
Flow_Rate*Inj_Press	-4.250	-2.125
Flow_Rate*Melt_Temp	-0.750	-0.375
Flow_Rate*Viscosity	-4.500	-2.250
Flow_Rate*Screw_Speed	0.750	0.375
Inj_Speed*Melt_Temp	1.000	0.500
Inj_Speed*Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed*Melt_Temp	-4.750	-2.375
Flow_Rate*Inj_Press*Melt_Temp	6.250	3.125

S = \* PRESS = \*

#### Analysis of Variance for Black\_dots (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	129.500	129.500	21.583	*	*
Flow_Rate	1	0.250	0.250	0.250	*	*
Inj_Speed	1	9.000	9.000	9.000	*	*
Inj_Press	1	16.000	16.000	16.000	*	*
Melt_Temp	1	100.000	100.000	100.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	193.000	193.000	27.571	*	*
Flow_Rate*Inj_Speed	1	30.250	30.250	30.250	*	*
Flow_Rate*Inj_Press	1	72.250	72.250	72.250	*	*
Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	81.000	81.000	81.000	*	*
Flow_Rate*Screw_Speed	1	2.250	2.250	2.250	*	*
Inj_Speed*Melt_Temp	1	4.000	4.000	4.000	*	*
Inj_Speed*Screw_Speed	1	1.000	1.000	1.000	*	*
3-Way Interactions	2	246.500	246.500	123.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	90.250	90.250	90.250	*	*
Flow_Rate*Inj_Press*Melt_Temp	1	156.250	156.250	156.250	*	*
Residual Error	0	*	*	*		
Total	15	569.000				

#### Estimated Coefficients for Black\_dots using data in uncoded units

Term	Coef
Constant	-246.113
Flow_Rate	1714.32
Inj_Speed	-35.1941
Inj_Press	5.92283
Melt_Temp	-60.2197
Viscosity	255.585
Screw_Speed	788.261
Flow_Rate*Inj_Speed	210.329
Flow_Rate*Inj_Press	-69.4836
Flow_Rate*Melt_Temp	-6.69014
Flow_Rate*Viscosity	-84.5070
Flow_Rate*Screw_Speed	3.52113
Inj_Speed*Melt_Temp	2.71256
Inj_Speed*Screw_Speed	-35.5284
Flow_Rate*Inj_Speed*Melt_Temp	-0.892019
Flow_Rate*Inj_Press*Melt_Temp	0.293427

### Effects Pareto for Black\_dots

#### Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed

```

$$\begin{aligned}
& \text{Inj\_Press} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} + \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Viscosity} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} + \text{Inj\_Press} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Press} + \text{Inj\_Speed} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Melt\_Temp} + \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} + \text{Melt\_Temp} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Screw\_Speed} + \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \\
& \quad \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}
\end{aligned}$$

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

$$\begin{aligned}
& \text{Flow\_Rate} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Viscosity} + \text{Melt\_Temp} * \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Viscosity} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Inj\_Press} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Viscosity} + \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Screw\_Speed} \\
& \text{Viscosity} + \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Inj\_Press} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} * \text{Melt\_Temp} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} + \text{Inj\_Press} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Press} + \text{Inj\_Speed} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Melt\_Temp} + \text{Viscosity} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Viscosity} + \text{Inj\_Speed} * \text{Inj\_Press} + \text{Melt\_Temp} * \text{Screw\_Speed} \\
& \text{Flow\_Rate} * \text{Screw\_Speed} + \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Inj\_Press} * \text{Screw\_Speed} \\
& \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Melt\_Temp} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Screw\_Speed} + \\
& \quad \text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity} \\
& \text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} + \\
& \quad \text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}
\end{aligned}$$

## Factorial Fit: Black\_dots versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Black\_dots (coded units)

Term	Effect	Coef
Constant		13.250
Flow_Rate	-0.250	-0.125
Inj_Speed	1.500	0.750

Inj_Press	-2.000	-1.000
Melt_Temp	-5.000	-2.500
Viscosity	0.250	0.125
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	2.750	1.375
Flow_Rate*Inj_Press	-4.250	-2.125
Flow_Rate*Melt_Temp	-0.750	-0.375
Flow_Rate*Viscosity	-4.500	-2.250
Flow_Rate*Screw_Speed	0.750	0.375
Inj_Speed*Melt_Temp	1.000	0.500
Inj_Speed*Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed*Melt_Temp	-4.750	-2.375
Flow_Rate*Inj_Speed*Screw_Speed	6.250	3.125

S = \* PRESS = \*

Analysis of Variance for Black\_dots (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	129.500	129.500	21.583	*	*
Flow_Rate	1	0.250	0.250	0.250	*	*
Inj_Speed	1	9.000	9.000	9.000	*	*
Inj_Press	1	16.000	16.000	16.000	*	*
Melt_Temp	1	100.000	100.000	100.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	193.000	193.000	27.571	*	*
Flow_Rate*Inj_Speed	1	30.250	30.250	30.250	*	*
Flow_Rate*Inj_Press	1	72.250	72.250	72.250	*	*
Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	81.000	81.000	81.000	*	*
Flow_Rate*Screw_Speed	1	2.250	2.250	2.250	*	*
Inj_Speed*Melt_Temp	1	4.000	4.000	4.000	*	*
Inj_Speed*Screw_Speed	1	1.000	1.000	1.000	*	*
3-Way Interactions	2	246.500	246.500	123.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	90.250	90.250	90.250	*	*
Flow_Rate*Inj_Speed*Screw_Speed	1	156.250	156.250	156.250	*	*
Residual Error	0	*	*	*		
Total	15	569.000				

Estimated Coefficients for Black\_dots using data in uncoded units

Term	Coef
Constant	-246.113
Flow_Rate	129.812
Inj_Speed	-35.1941
Inj_Press	5.92283
Melt_Temp	-60.2197
Viscosity	255.585
Screw_Speed	788.261
Flow_Rate*Inj_Speed	10.7981
Flow_Rate*Inj_Press	-1.99531
Flow_Rate*Melt_Temp	19.7183
Flow_Rate*Viscosity	-84.5070
Flow_Rate*Screw_Speed	-260.563
Inj_Speed*Melt_Temp	2.71256
Inj_Speed*Screw_Speed	-35.5284
Flow_Rate*Inj_Speed*Melt_Temp	-0.892019
Flow_Rate*Inj_Speed*Screw_Speed	11.7371

## Effects Pareto for Black\_dots

Alias Structure

```
I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed
```

Alias Information for Terms in the Model.

Totally confounded terms were removed from the analysis.

```
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp
Flow_Rate*Inj_Speed + Inj_Press*Viscosity
Flow_Rate*Inj_Press + Inj_Speed*Viscosity
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
```

$\text{Inj\_Speed} * \text{Viscosity} * \text{Screw\_Speed} + \text{Inj\_Press} * \text{Melt\_Temp} * \text{Viscosity}$   
 $\text{Flow\_Rate} * \text{Inj\_Speed} * \text{Screw\_Speed} + \text{Flow\_Rate} * \text{Inj\_Press} * \text{Melt\_Temp} +$   
 $\text{Inj\_Speed} * \text{Melt\_Temp} * \text{Viscosity} + \text{Inj\_Press} * \text{Viscosity} * \text{Screw\_Speed}$

## Factorial Fit: Black\_dots versus Flow\_Rate, Inj\_Speed, ...

Estimated Effects and Coefficients for Black\_dots (coded units)

Term	Effect	Coef
Constant		13.250
Flow_Rate	-0.250	-0.125
Inj_Speed	1.500	0.750
Inj_Press	-2.000	-1.000
Melt_Temp	-5.000	-2.500
Viscosity	0.250	0.125
Screw_Speed	-1.000	-0.500
Flow_Rate*Inj_Speed	2.750	1.375
Flow_Rate*Inj_Press	-4.250	-2.125
Flow_Rate*Melt_Temp	-0.750	-0.375
Flow_Rate*Viscosity	-4.500	-2.250
Flow_Rate*Screw_Speed	0.750	0.375
Inj_Speed*Melt_Temp	1.000	0.500
Inj_Speed*Screw_Speed	-0.500	-0.250
Flow_Rate*Inj_Speed*Melt_Temp	-4.750	-2.375
Flow_Rate*Inj_Speed*Screw_Speed	6.250	3.125

S = \* PRESS = \*

Analysis of Variance for Black\_dots (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	6	129.500	129.500	21.583	*	*
Flow_Rate	1	0.250	0.250	0.250	*	*
Inj_Speed	1	9.000	9.000	9.000	*	*
Inj_Press	1	16.000	16.000	16.000	*	*
Melt_Temp	1	100.000	100.000	100.000	*	*
Viscosity	1	0.250	0.250	0.250	*	*
Screw_Speed	1	4.000	4.000	4.000	*	*
2-Way Interactions	7	193.000	193.000	27.571	*	*
Flow_Rate*Inj_Speed	1	30.250	30.250	30.250	*	*
Flow_Rate*Inj_Press	1	72.250	72.250	72.250	*	*
Flow_Rate*Melt_Temp	1	2.250	2.250	2.250	*	*
Flow_Rate*Viscosity	1	81.000	81.000	81.000	*	*
Flow_Rate*Screw_Speed	1	2.250	2.250	2.250	*	*
Inj_Speed*Melt_Temp	1	4.000	4.000	4.000	*	*
Inj_Speed*Screw_Speed	1	1.000	1.000	1.000	*	*
3-Way Interactions	2	246.500	246.500	123.250	*	*
Flow_Rate*Inj_Speed*Melt_Temp	1	90.250	90.250	90.250	*	*
Flow_Rate*Inj_Speed*Screw_Speed	1	156.250	156.250	156.250	*	*
Residual Error	0	*	*	*		
Total	15	569.000				

Estimated Coefficients for Black\_dots using data in uncoded units

Term	Coef
Constant	-246.113
Flow_Rate	129.812
Inj_Speed	-35.1941
Inj_Press	5.92283



Melt_Temp	-60.2197
Viscosity	255.585
Screw_Speed	788.261
Flow_Rate*Inj_Speed	10.7981
Flow_Rate*Inj_Press	-1.99531
Flow_Rate*Melt_Temp	19.7183
Flow_Rate*Viscosity	-84.5070
Flow_Rate*Screw_Speed	-260.563
Inj_Speed*Melt_Temp	2.71256
Inj_Speed*Screw_Speed	-35.5284
Flow_Rate*Inj_Speed*Melt_Temp	-0.892019
Flow_Rate*Inj_Speed*Screw_Speed	11.7371

## Effects Pareto for Black\_dots

## Half Normal Effects Plot for Black\_dots

Alias Structure

```

I + Flow_Rate*Inj_Speed*Inj_Press*Viscosity +
    Flow_Rate*Melt_Temp*Viscosity*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Flow_Rate + Inj_Speed*Inj_Press*Viscosity + Melt_Temp*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Screw_Speed
Inj_Speed + Flow_Rate*Inj_Press*Viscosity + Inj_Press*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Inj_Press + Flow_Rate*Inj_Speed*Viscosity + Inj_Speed*Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Melt_Temp + Flow_Rate*Viscosity*Screw_Speed + Inj_Speed*Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Viscosity + Flow_Rate*Inj_Speed*Inj_Press + Flow_Rate*Melt_Temp*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Screw_Speed + Flow_Rate*Melt_Temp*Viscosity + Inj_Speed*Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed + Inj_Press*Viscosity +
    Flow_Rate*Inj_Press*Melt_Temp*Screw_Speed +
    Inj_Speed*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Inj_Press + Inj_Speed*Viscosity +
    Flow_Rate*Inj_Speed*Melt_Temp*Screw_Speed +
    Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Melt_Temp + Viscosity*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Screw_Speed +
    Inj_Speed*Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Viscosity + Inj_Speed*Inj_Press + Melt_Temp*Screw_Speed +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp*Viscosity*Screw_Speed
Flow_Rate*Screw_Speed + Melt_Temp*Viscosity +
    Flow_Rate*Inj_Speed*Inj_Press*Melt_Temp +
    Inj_Speed*Inj_Press*Viscosity*Screw_Speed
Inj_Speed*Melt_Temp + Inj_Press*Screw_Speed +
    Flow_Rate*Inj_Speed*Viscosity*Screw_Speed +
    Flow_Rate*Inj_Press*Melt_Temp*Viscosity
Inj_Speed*Screw_Speed + Inj_Press*Melt_Temp +
    Flow_Rate*Inj_Speed*Melt_Temp*Viscosity +
    Flow_Rate*Inj_Press*Viscosity*Screw_Speed
Flow_Rate*Inj_Speed*Melt_Temp + Flow_Rate*Inj_Press*Screw_Speed +
    Inj_Speed*Viscosity*Screw_Speed + Inj_Press*Melt_Temp*Viscosity
Flow_Rate*Inj_Speed*Screw_Speed + Flow_Rate*Inj_Press*Melt_Temp +
    Inj_Speed*Melt_Temp*Viscosity + Inj_Press*Viscosity*Screw_Speed

```