

Supplementary material

Multi-Objective Optimization of ETBE Intensified Processes Considering Economic, Environmental and Inherent Safety Aspects

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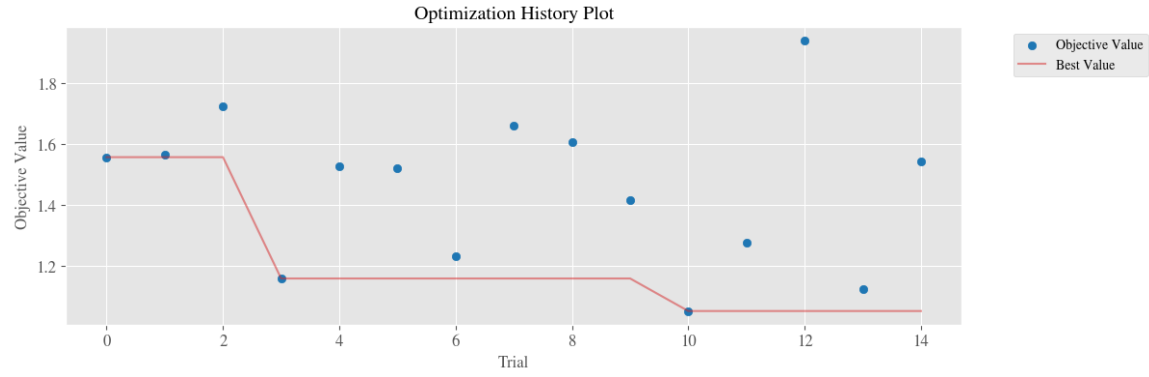


Figure S1. Optimization history plot for the RDC flowsheet.

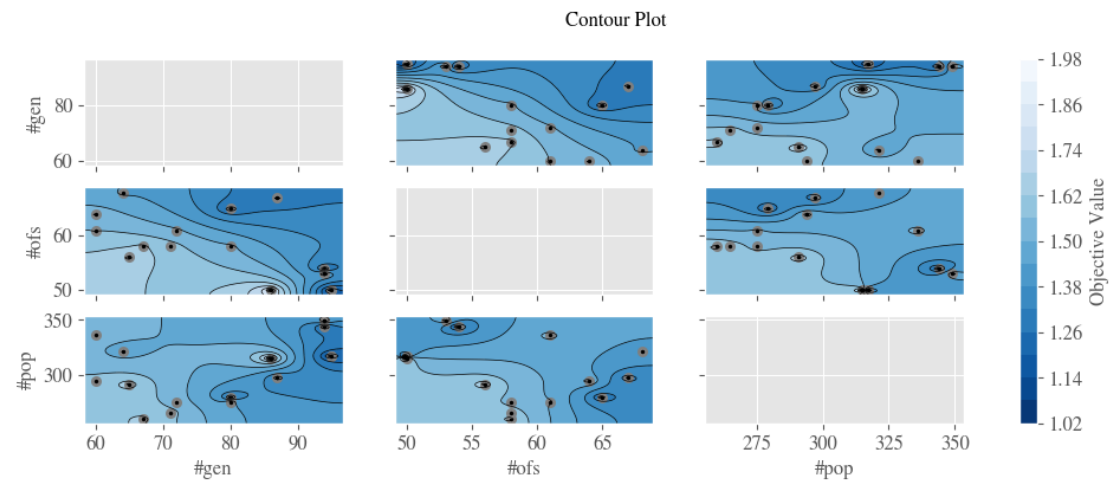


Figure S2. Contour plot for the optimized parameter of the NSGA-II (RDC flowsheet).

Table S1. Computational time for the RDC flowsheet.

Trial	Duration (hh:mm:ss)	Trial	Duration (hh:mm:ss)
1	3:58:29	8	4:12:27
2	6:31:34	9	4:51:57
3	3:47:27	10	4:21:57
4	10:13:33	11	6:43:40
5	5:37:18	12	6:32:18
6	4:28:56	13	3:44:14
7	8:46:28	14	7:37:10
Average time per-trial:		5 h 49 m	

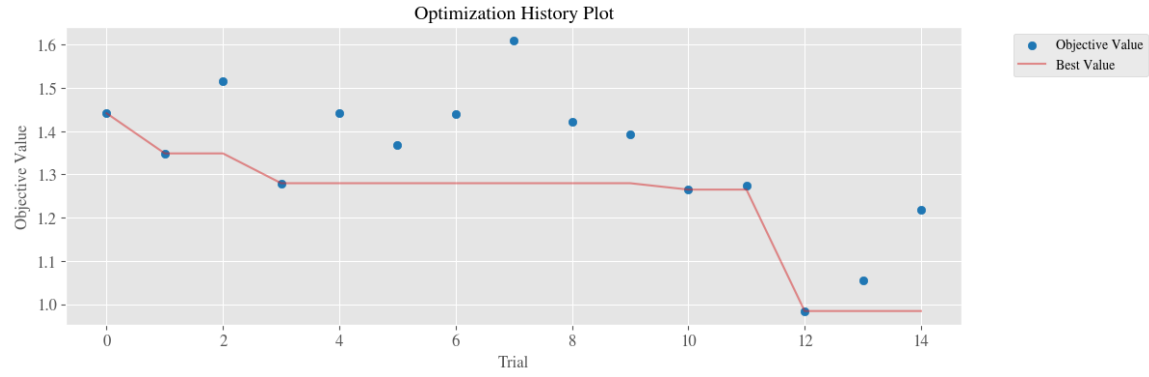


Figure S3. Optimization history plot for the DWC flowsheet.

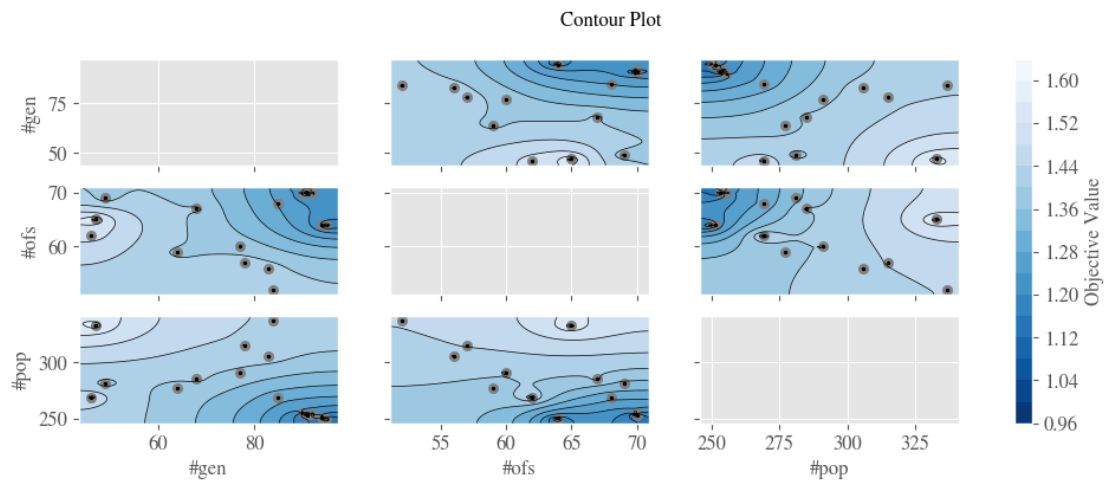


Figure S4. Contour plot for the optimized parameter of the NSGA-II (DWC flowsheet).

Table S2. Computational time for the DWC flowsheet.

Trial	Duration (hh:mm:ss)	Trial	Duration (hh:mm:ss)
1	1:32:12	8	4:33:09
2	0:44:50	9	3:44:15
3	4:57:01	10	5:35:06
4	3:35:20	11	6:10:27
5	3:00:53	12	6:41:32
6	3:08:17	13	5:46:51
7	1:10:56	14	6:31:46
Average time per-trial:		4 h 10 m	

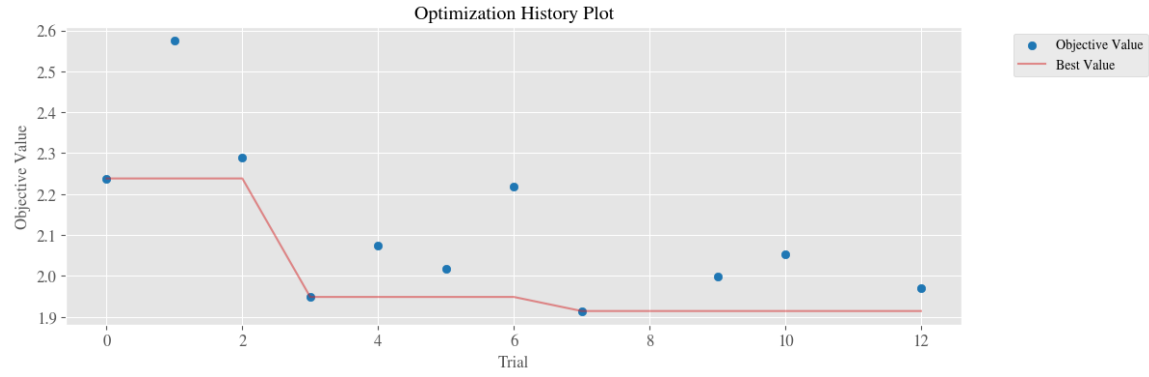


Figure S5. Optimization history plot for the RDWC flowsheet.

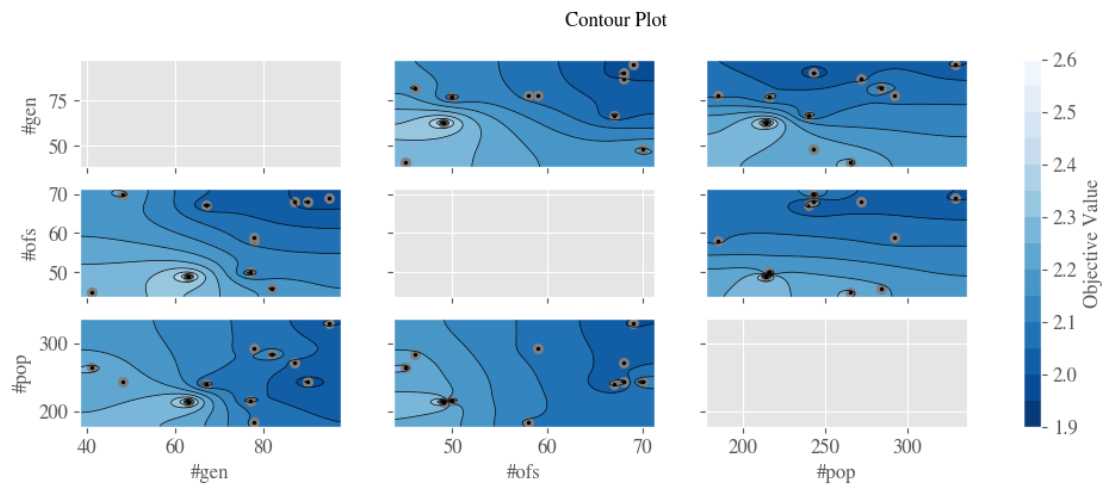


Figure S6. Contour plot for the optimized parameter of the NSGA-II (RDWC flowsheet).

Table S3. Computational time for the RDWC flowsheet.

Trial	Duration (hh:mm:ss)	Trial	Duration (hh:mm:ss)
1	2:41:25	6	9:23:01
2	1:44:36	7	3:29:12
3	0:08:24	8	6:18:03
4	3:45:08	9	6:48:04
5	4:38:49	10	5:43:42
Average time per-trial:		5 h 49 m	

Table S4. Min-Max values of economic, environmental and inherent safety metrics for each flowsheet.

RDC		
Function	Min	Max
TAC (MM\$/yr)	1.05	8.48
FEDI	602.98	927.17
CO ₂ (kt/yr)	7.37	32.94
DWC		
Function	Min	Max
TAC (MM\$/yr)	1.27	3.45
FEDI	634	656
CO ₂ (kt/yr)	6.70	22.93
RDWC		
Function	Min	Max
TAC (MM\$/yr)	0.99	3.62
FEDI	639	757
CO ₂ (kt/yr)	6.80	15.26