engineering proceedings

MDPI

Supplementary Materials

Optimisation of Biodiesel Production from Waste Margarine Oil Using Response Surface Methodology †

Pascal Mwenge [1,*], Salvation Muthubi [1] and Hilary Rutto [2]

[1] Department of Chemical and Metallurgical Engineering, Vaal University of Technology, Vanderbijlpark 1900, South Africa; salvationm@vut.ac.za (S.M.).
[2] Department of Chemical Engineering, Durban University of Technology, Durban 4000, South Africa.; hilaryr@vut.ac.za (H.R.)
* Correspondence: 211124052@edu.vut.ac.za; Tel.: +27-16-950-7830
† Presented at the 5th International Electronic Conference on Applied Sciences—Nanosciences, Chemistry and Materials Science (ASEC 2024), 4–6 December 2024.
Available online: https://sciforum.net/event/ASEC2024.

Table S1. Experimental runs with yield.

Run	Methanol to oil ratio	Catalyst Ratio	Time	Temperature	Yield
	mol/mol	Wt. %	Minutes	°C	%
1	9	0.9	60	30	59.79
2	9	0.9	60	50	90.13
3	9	0.9	60	50	88.57
4	9	1.5	60	50	86.51
5	9	0.9	30	50	70.54
6	9	0.9	60	70	88.13
7	9	0.3	60	50	57.85
8	12	0.6	75	60	79.84
9	6	0.6	45	40	58.17
10	12	1.2	45	40	72.92
11	9	0.9	60	50	89.07
12	6	1.2	45	60	74.23
13	9	0.9	90	50	86.68
14	6	1.2	75	60	80.28
15	9	0.9	60	50	88.01
16	3	0.9	60	50	49.46
17	9	0.9	60	50	89.52
18	15	0.9	60	50	81.12
19	6	0.6	75	40	63.23
20	12	0.6	45	60	67.53
21	12	1.2	75	40	75.53

Table S2. Fit statistics.

Std. Dev.	1.26	**R^2**	0.9970
Mean	76.05	Adjusted R^2	0.9900
C.V. %	1.65	Predicted R^2	0.7929
		Adeq Precision	37.7310

Table S3. Final equation in terms of actual factors.

Yield	**=**	
−69.64891		

+6.24927	Methanol to oil ratio
+4.15937	Catalyst Ratio
+1.38296	Time
+1.58422	Temperature
+3.42361	Methanol to oil ratio * Catalyst Ratio
+0.010583	Methanol to oil ratio * Time
+0.096375	Methanol to oil ratio * Temperature
−0.241944	Catalyst Ratio * Time
+1.80875	Catalyst Ratio * Temperature
+0.008908	Time * Temperature
−0.674774	Methanol to oil ratio^2
−48.33854	Catalyst Ratio^2
−0.012191	Time^2
−0.039055	Temperature^2

Table S4. Optimisation solutions.

Number	Methanol to oil ratio (ml/mol)	Catalyst Ratio (wt. %)	Time (Minutes)	Temperature (°C)	Yield (%)	StdErr(Yield) (%)	Desirability	
1	10.770	0.961	70.233	48.675	93.011	0.599	1.000	
2	13.294	1.086	78.656	48.813	91.760	1.349	1.000	
3	9.580	0.940	64.519	51.748	93.564	0.569	1.000	
4	8.025	1.335	55.125	60.750	94.810	1.208	1.000	
5	9.600	0.960	63.000	52.000	94.024	0.576	1.000	
6	11.084	0.748	78.680	59.289	91.242	0.999	1.000	
7	9.600	1.440	63.000	52.000	93.940	1.155	1.000	
8	11.906	1.113	59.646	52.459	99.100	0.942	1.000	Selected
9	7.350	1.215	68.250	63.000	93.124	1.074	1.000	
10	11.254	1.045	79.949	57.013	102.566	1.239	1.000	

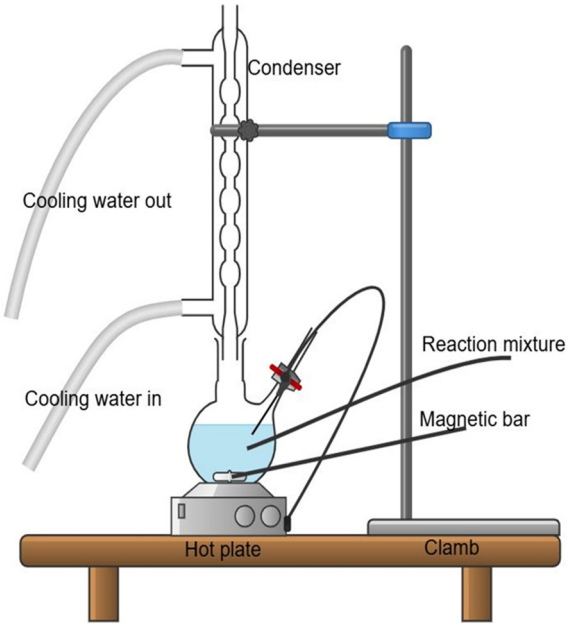


Figure S1. Experimental setup [19].

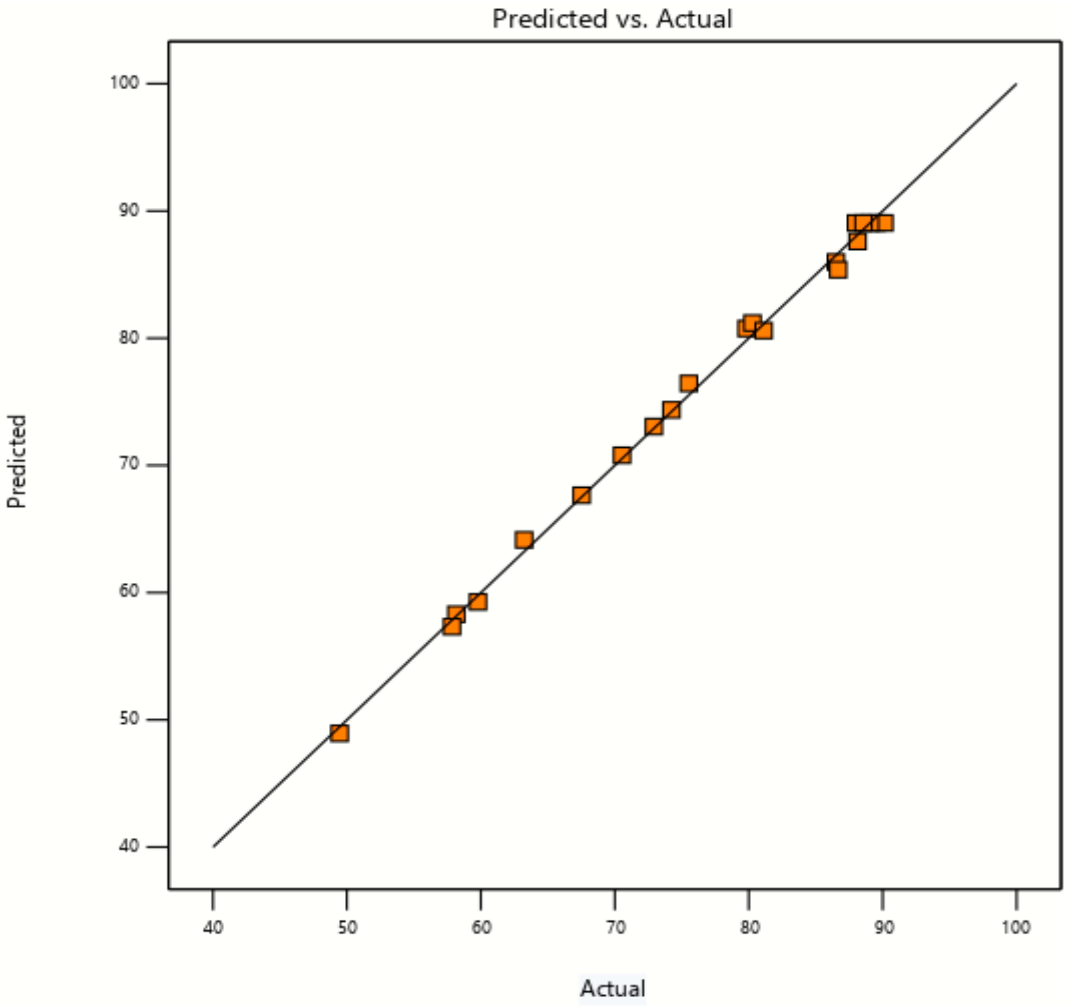
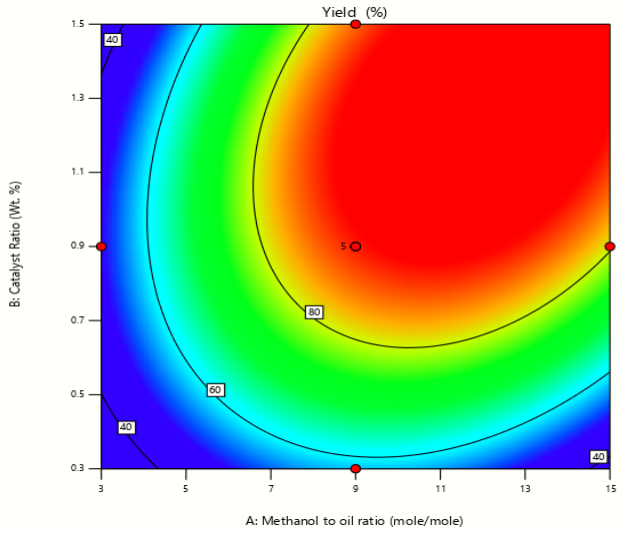
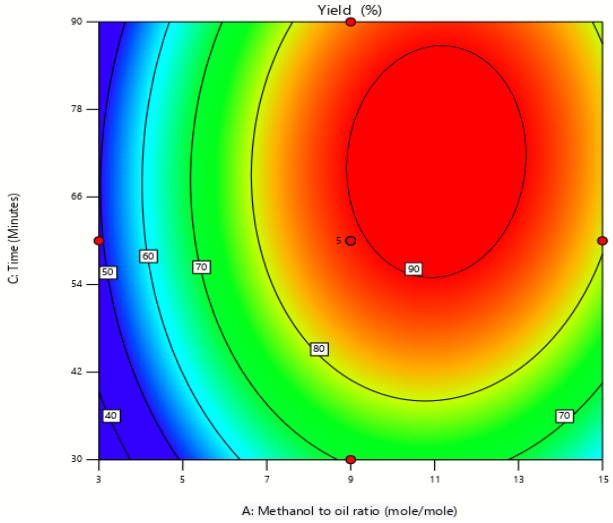


Figure S2. Plot of actual vs predicted yield. Figure S2 represent the experimental versus predicted yield as obtained in RSM, this depicts how the experimental points are closed to the predicted yield.



(a)



(b)

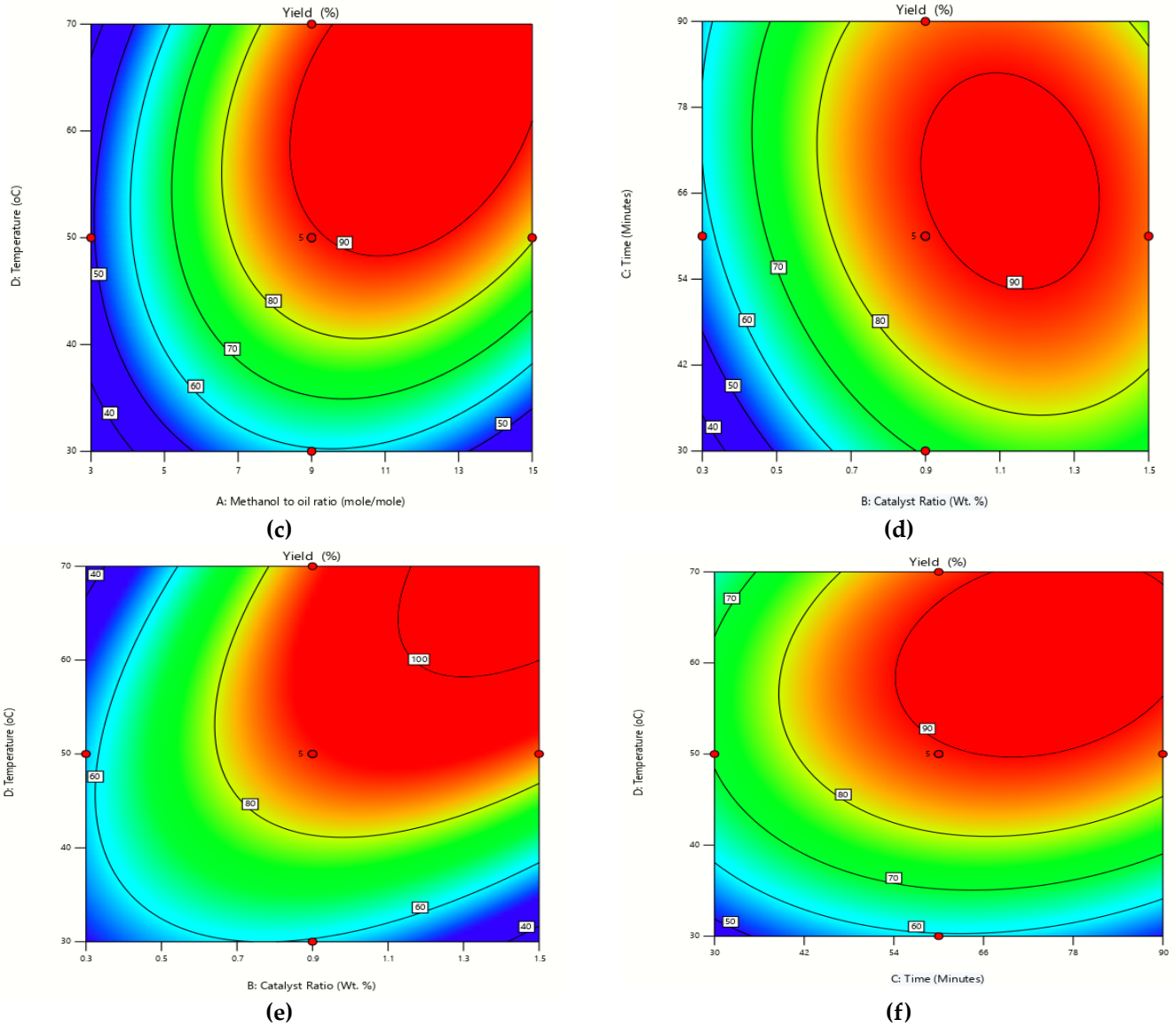


Figure S3. Contour plots of effects of process parameters on biodiesel yield; (a) effect of interaction of methanol to oil ratio and catalyst ratio at constant temperature of 50 °C and 60 minutes; (b) effect of interaction of methanol to oil ratio and time at constant temperature of 50 °C and catalyst ratio of 0.9 wt. %; (c)effect of interaction of methanol to oil ratio and temperature at constant time of 60 minutes and catalyst ratio of 0.9 wt. %; (d) effect of interaction of catalyst ratio and time at constant methanol to oil ratio of 9 and temperature of 50 °C; (e) effect of interaction of catalyst ratio and temperature at constant methanol to oil ratio of 9 and time of 60 minutes; (f) effect of interaction of temperature and time at constant methanol to oil ratio 9 of and catalyst ratio of 0.9 wt.%. .