SUPPLEMENTARY DATA

Response 1 Filling Level

ANOVA for Response Surface Reduced Quadratic Model

Analysis of variance table [Partial sum of squares - Type III]

Source	**Sum of Squares**	**df**	**Mean Square**	**F Value**	**p-value Prob > F**	
Model	1896.45	7	270.92	3048.81	< 0.0001	significant
A-vFOM	11.38	1	11.38	128.12	< 0.0001	
B-mDCP	761.33	1	761.33	8567.62	< 0.0001	
C-LP	1003.58	1	1003.58	11293.77	< 0.0001	
AB	3.76	1	3.76	42.36	< 0.0001	
AC	95.32	1	95.32	1072.72	< 0.0001	
BC	14.03	1	14.03	157.91	< 0.0001	
C^2	7.03	1	7.03	79.16	< 0.0001	
Residual	19.28	217	0.089			
Lack of Fit	19.15	67	0.29	321.62	< 0.0001	significant
Pure Error	0.13	150	8.887E-004			
Cor Total	1915.73	224				

The Model F-value of 3048.81 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob > F" less than 0.0500 indicate model terms are significant.

In this case A, B, C, AB, AC, BC, C++2+- are significant model terms.

Values greater than 0.1000 indicate the model terms are not significant.

If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.

The "Lack of Fit F-value" of 321.62 implies the Lack of Fit is significant. There is only a 0.01% chance that a "Lack of Fit F-value" this large could occur due to noise.

Significant lack of fit is bad -- we want the model to fit.

Std. Dev.	0.30	R-Squared	0.9899
Mean	6.91	Adj R-Squared	0.9896
C.V. %	4.31	Pred R-Squared	0.9890
PRESS	20.98	Adeq Precision	233.913

The "Pred R-Squared" of 0.9890 is in reasonable agreement with the "Adj R-Squared" of 0.9896.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your ratio of 233.913 indicates an adequate signal. This model can be used to navigate the design space.

Factor	**Coefficient Estimate**	**df**	**Standard Error**	**95% CI Low**	**95% CI High**	**VIF**
Intercept	6.66	1	0.034	6.59	6.73	
A-vFOM	-0.32	1	0.028	-0.37	-0.26	1.00
B-mDCP	2.60	1	0.028	2.55	2.66	1.00
C-LP	2.59	1	0.024	2.54	2.63	1.00
AB	0.26	1	0.040	0.18	0.34	1.00
AC	1.13	1	0.034	1.06	1.20	1.00
BC	0.43	1	0.034	0.36	0.50	1.00
C^2	0.38	1	0.042	0.29	0.46	1.00

Final Equation in Terms of Coded Factors:

Filling Level =

+6.66
-0.32 * A
+2.60 * B
+2.59 * C
+0.26 * A * B
+1.13 * A * C
+0.43 * B * C
+0.38 * C^2

Final Equation in Terms of Actual Factors:

Filling Level =

+8.80505
-0.14573 * vFOM
+9.91801E-003 * mDCP
-0.25377 * LP
+1.61680E-004 * vFOM * mDCP
+2.01317E-003 * vFOM * LP
+7.72392E-004 * mDCP * LP
+1.91372E-003 * LP^2

The Diagnostics Case Statistics Report has been moved to the Diagnostics Node.

In the Diagnostics Node, Select Case Statistics from the View Menu.

Proceed to Diagnostic Plots (the next icon in progression). Be sure to look at the:

1) Normal probability plot of the studentized residuals to check for normality of residuals.
2) Studentized residuals versus predicted values to check for constant error.
3) Externally Studentized Residuals to look for outliers, i.e., influential values.
4) Box-Cox plot for power transformations.

If all the model statistics and diagnostic plots are OK, finish up with the Model Graphs icon.

3 Factors: A, B, C (A=paddle wheel speed, b=dcp mass, c=laser position)

Design Matrix Evaluation for Response Surface Quadratic Model

No aliases found for Quadratic Model

Aliases are calculated based on your response selection,

taking into account missing datapoints, if necessary.

Watch for aliases among terms you need to estimate.

Degrees of Freedom for Evaluation

Model	9
Residuals	215
Lack Of Fit	65
Pure Error	150
Corr Total	224

A recommendation is a minimum of 3 lack of fit df and 4 df for pure error.

This ensures a valid lack of fit test.

Fewer df will lead to a test that may not detect lack of fit.

Power at 5 % alpha level to detect signal/noise ratios of

Term	StdErr**	VIF	Ri-Squared	0.5 Std. Dev.	1 Std. Dev.	2 Std. Dev.
A	0.094	1.00	0.0000	75.2 %	99.9 %	99.9 %
B	0.094	1.00	0.0000	75.2 %	99.9 %	99.9 %
C	0.082	1.00	0.0000	86.2 %	99.9 %	99.9 %
AB	0.13	1.00	0.0000	46.3 %	96.2 %	99.9 %
AC	0.12	1.00	0.0000	57.7 %	99.1 %	99.9 %
BC	0.12	1.00	0.0000	57.7 %	99.1 %	99.9 %
A^2	0.16	1.00	0.0000	87.8 %	99.9 %	99.9 %
B^2	0.16	1.00	0.0000	87.8 %	99.9 %	99.9 %
C^2	0.14	1.00	0.0000	94.1 %	99.9 %	99.9 %

**Basis Std. Dev. = 1.0

Standard errors should be similar within type of coefficient. Smaller is better.

Ideal VIF is 1.0. VIFs above 10 are cause for alarm, indicating coefficients are poorly estimated due to multicollinearity.

Ideal Ri-squared is 0.0. High Ri-squared means terms are correlated with each other, possibly leading to poor models.

If the design has multilinear constraints multicollinearity will exist to a greater degree, thus increasing the VIFs and the Ri-squareds, rendering these statistics useless.

Use FDS instead.

Power is an inappropriate tool to evaluate response surface designs.

Use precision-based metrics provided in this program via fraction of design space (FDS) statistics.

Click on the Graphs button at the top of this screen, look for the [?] button on the FDS Tool for detailed instructions.

Be sure to set the Model (on previous screen) to be an estimate of the terms you expect to be significant.

Measures Derived From the (X'X)^-1 Matrix

Std	Leverage	Point Type
1	0.0883	Unknown
2	0.0883	Unknown
3	0.0883	Unknown
4	0.0616	Unknown
5	0.0616	Unknown
6	0.0616	Unknown
7	0.0883	Unknown
8	0.0883	Unknown
9	0.0883	Unknown
10	0.0535	Unknown
11	0.0535	Unknown

12	0.0535	Unknown
13	0.0368	Unknown
14	0.0368	Unknown
15	0.0368	Unknown
16	0.0535	Unknown
17	0.0535	Unknown
18	0.0535	Unknown
19	0.0483	Unknown
20	0.0483	Unknown
21	0.0483	Unknown
22	0.0349	Unknown
23	0.0349	Unknown
24	0.0349	Unknown
25	0.0483	Unknown
26	0.0483	Unknown
27	0.0483	Unknown
28	0.0535	Unknown
29	0.0535	Unknown
30	0.0535	Unknown
31	0.0368	Unknown
32	0.0368	Unknown
33	0.0368	Unknown
34	0.0535	Unknown
35	0.0535	Unknown
36	0.0535	Unknown
37	0.0883	Unknown
38	0.0883	Unknown
39	0.0883	Unknown
40	0.0616	Unknown
41	0.0616	Unknown
42	0.0616	Unknown
43	0.0883	Unknown
44	0.0883	Unknown
45	0.0883	Unknown
46	0.0535	Unknown
47	0.0535	Unknown
48	0.0535	Unknown
49	0.0368	Unknown
50	0.0368	Unknown
51	0.0368	Unknown
52	0.0535	Unknown
53	0.0535	Unknown
54	0.0535	Unknown
55	0.0287	Unknown
56	0.0287	Unknown
57	0.0287	Unknown

58	0.0221	Unknown
59	0.0221	Unknown
60	0.0221	Unknown
61	0.0287	Unknown
62	0.0287	Unknown
63	0.0287	Unknown
64	0.0268	Unknown
65	0.0268	Unknown
66	0.0268	Unknown
67	0.0235	Unknown
68	0.0235	Unknown
69	0.0235	Unknown
70	0.0268	Unknown
71	0.0268	Unknown
72	0.0268	Unknown
73	0.0287	Unknown
74	0.0287	Unknown
75	0.0287	Unknown
76	0.0221	Unknown
77	0.0221	Unknown
78	0.0221	Unknown
79	0.0287	Unknown
80	0.0287	Unknown
81	0.0287	Unknown
82	0.0535	Unknown
83	0.0535	Unknown
84	0.0535	Unknown
85	0.0368	Unknown
86	0.0368	Unknown
87	0.0368	Unknown
88	0.0535	Unknown
89	0.0535	Unknown
90	0.0535	Unknown
91	0.0483	Unknown
92	0.0483	Unknown
93	0.0483	Unknown
94	0.0349	Unknown
95	0.0349	Unknown
96	0.0349	Unknown
97	0.0483	Unknown
98	0.0483	Unknown
99	0.0483	Unknown
100	0.0268	Unknown
101	0.0268	Unknown
102	0.0268	Unknown
103	0.0235	Unknown

104	0.0235	Unknown
105	0.0235	Unknown
106	0.0268	Unknown
107	0.0268	Unknown
108	0.0268	Unknown
109	0.0260	Unknown
110	0.0260	Unknown
111	0.0260	Unknown
112	0.0260	Unknown
113	0.0260	Unknown
114	0.0260	Unknown
115	0.0260	Unknown
116	0.0260	Unknown
117	0.0260	Unknown
118	0.0268	Unknown
119	0.0268	Unknown
120	0.0268	Unknown
121	0.0235	Unknown
122	0.0235	Unknown
123	0.0235	Unknown
124	0.0268	Unknown
125	0.0268	Unknown
126	0.0268	Unknown
127	0.0483	Unknown
128	0.0483	Unknown
129	0.0483	Unknown
130	0.0349	Unknown
131	0.0349	Unknown
132	0.0349	Unknown
133	0.0483	Unknown
134	0.0483	Unknown
135	0.0483	Unknown
136	0.0535	Unknown
137	0.0535	Unknown
138	0.0535	Unknown
139	0.0368	Unknown
140	0.0368	Unknown
141	0.0368	Unknown
142	0.0535	Unknown
143	0.0535	Unknown
144	0.0535	Unknown
145	0.0287	Unknown
146	0.0287	Unknown
147	0.0287	Unknown
148	0.0221	Unknown
149	0.0221	Unknown

150	0.0221	Unknown
151	0.0287	Unknown
152	0.0287	Unknown
153	0.0287	Unknown
154	0.0268	Unknown
155	0.0268	Unknown
156	0.0268	Unknown
157	0.0235	Unknown
158	0.0235	Unknown
159	0.0235	Unknown
160	0.0268	Unknown
161	0.0268	Unknown
162	0.0268	Unknown
163	0.0287	Unknown
164	0.0287	Unknown
165	0.0287	Unknown
166	0.0221	Unknown
167	0.0221	Unknown
168	0.0221	Unknown
169	0.0287	Unknown
170	0.0287	Unknown
171	0.0287	Unknown
172	0.0535	Unknown
173	0.0535	Unknown
174	0.0535	Unknown
175	0.0368	Unknown
176	0.0368	Unknown
177	0.0368	Unknown
178	0.0535	Unknown
179	0.0535	Unknown
180	0.0535	Unknown
181	0.0883	Unknown
182	0.0883	Unknown
183	0.0883	Unknown
184	0.0616	Unknown
185	0.0616	Unknown
186	0.0616	Unknown
187	0.0883	Unknown
188	0.0883	Unknown
189	0.0883	Unknown
190	0.0535	Unknown
191	0.0535	Unknown
192	0.0535	Unknown
193	0.0368	Unknown
194	0.0368	Unknown
195	0.0368	Unknown

196	0.0535	Unknown
197	0.0535	Unknown
198	0.0535	Unknown
199	0.0483	Unknown
200	0.0483	Unknown
201	0.0483	Unknown
202	0.0349	Unknown
203	0.0349	Unknown
204	0.0349	Unknown
205	0.0483	Unknown
206	0.0483	Unknown
207	0.0483	Unknown
208	0.0535	Unknown
209	0.0535	Unknown
210	0.0535	Unknown
211	0.0368	Unknown
212	0.0368	Unknown
213	0.0368	Unknown
214	0.0535	Unknown
215	0.0535	Unknown
216	0.0535	Unknown
217	0.0883	Unknown
218	0.0883	Unknown
219	0.0883	Unknown
220	0.0616	Unknown
221	0.0616	Unknown
222	0.0616	Unknown
223	0.0883	Unknown
224	0.0883	Unknown
225	0.0883	Unknown
Average =	0.0444	

Watch for leverages close to 1.0. Consider replicating these points or make sure they are run very carefully.