JMP analysis of Chemical Product Experiments

Response Yield: Half fraction of a 4-factor experiment with 4 center points.

Singularity Details

XA*XB*XC = XD
XB*XC = XA*XD
XA*XC = XB*XD
XC = XA*XB*XD
XA*XB = XC*XD
XB = XA*XC*XD
XA = XB*XC*XD
I=XA*XB*XC*XD

Summary of Fit

Rsquare	0.75056
RSquare Adj	0.314039
Root Mean Square Error	14.24096
Mean of Response	41.6
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	7	2440.9400	348.706	1.7194
Error	4	811.2200	202.805	Prob > F
C. Total	11	3252.1600		0.3139

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	1	807.36000	807.360	627.4819
Pure Error	3	3.86000	1.287	Prob > F
Total Error	4	811.22000		0.0001
				Max RSq
				0.9988

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	41.6	4.111012	10.12	0.0005
XA	13.175	5.03494	2.62	0.0590
XB	-7.6	5.03494	-1.51	0.2057
XA*XB	8.025	5.03494	1.59	0.1862
XC	3.05	5.03494	0.61	0.5774
XA*XC	-0.025	5.03494	-0.00	0.9963
XB*XC	0.15	5.03494	0.03	0.9777
XA*XB*XC	0.225	5.03494	0.04	0.9665

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
XA	1	1	1388.6450	6.8472	0.0590
XB	1	1	462.0800	2.2784	0.2057
XA*XB	1	1	515.2050	2.5404	0.1862
XC	1	1	74.4200	0.3670	0.5774
XA*XC	1	1	0.0050	0.0000	0.9963
XB*XC	1	1	0.1800	0.0009	0.9777
XA*XB*XC	1	1	0.4050	0.0020	0.9665

Response Yield: Full factorial with 4 factors and 4 center points.

Summary of Fit

RSquare	0.837737
RSquare Adj	0.22925
Root Mean Square Error	15.56611
Mean of Response	39.305
Observations (or Sum Wgts)	20

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	15	5003.8944	333.593	1.3768
Error	4	969.2151	242.304	Prob > F
C. Total	19	5973.1095		0.4124

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	1	965.35512	965.355	750.2760
Pure Error	3	3.86000	1.287	Prob > F
Total Error	4	969.21512		0.0001
				Max RSq
				0.9994

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	39.305	3.480688	11.29	0.0004
XA	13.53125	3.891528	3.48	0.0254
XB	-7.56875	3.891528	-1.94	0.1237
XA*XB	7.95625	3.891528	2.04	0.1104
XC	2.91875	3.891528	0.75	0.4949
XA*XC	0.19375	3.891528	0.05	0.9627
XB*XC	0.39375	3.891528	0.10	0.9243
XA*XB*XC	0.29375	3.891528	0.08	0.9435

Parameter Estimates (continued)

XD	-0.06875	3.891528	-0.02	0.9868
XA*XD	-0.24375	3.891528	-0.06	0.9531
XB*XD	-0.21875	3.891528	-0.06	0.9579
XA*XB*XD	0.13125	3.891528	0.03	0.9747
XC*XD	0.06875	3.891528	0.02	0.9868
XA*XC*XD	-0.03125	3.891528	-0.01	0.9940
XB*XC*XD	-0.35625	3.891528	-0.09	0.9315
XA*XB*XC*XD	-0.03125	3.891528	-0.01	0.9940

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
XA	1	1	2929.5156	12.0903	0.0254
XB	1	1	916.5756	3.7828	0.1237
XA*XB	1	1	1012.8306	4.1800	0.1104
XC	1	1	136.3056	0.5625	0.4949
XA*XC	1	1	0.6006	0.0025	0.9627
XB*XC	1	1	2.4806	0.0102	0.9243
XA*XB*XC	1	1	1.3806	0.0057	0.9435
XD	1	1	0.0756	0.0003	0.9868
XA*XD	1	1	0.9506	0.0039	0.9531
XB*XD	1	1	0.7656	0.0032	0.9579
XA*XB*XD	1	1	0.2756	0.0011	0.9747
XC*XD	1	1	0.0756	0.0003	0.9868
XA*XC*XD	1	1	0.0156	0.0001	0.9940
XB*XC*XD	1	1	2.0306	0.0084	0.9315
XA*XB*XC*XD	1	1	0.0156	0.0001	0.9940

Response Yield: Response surface analysis of a central composite design

Summary of Fit

RSquare	0.997499
RSquare Adj	0.994806
Root Mean Square Error	1.220031
Mean of Response	40.47143
Observations (or Sum Wgts)	28

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	14	7718.8070	551.343	370.4081
Error	13	19.3502	1.488	Prob > F
C. Total	27	7738.1571		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	10	15.490182	1.54902	1.2039
Pure Error	3	3.860000	1.28667	Prob > F
Total Error	13	19.350182		0.4932
				Max RSq
				0.9995

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	52.504042	0.507511	103.45	<.0001
XA&RS	13.74574	0.272815	50.38	<.0001
XB&RS	-7.554296	0.272815	-27.69	<.0001
XC&RS	2.8724935	0.272815	10.53	<.0001
XD&RS	-0.210553	0.272815	-0.77	0.4540
XA*XA	-9.08189	0.405798	-22.38	<.0001
XB*XA	7.95625	0.305008	26.09	<.0001
XB*XB	-0.004148	0.405798	-0.01	0.9920
XC*XA	0.19375	0.305008	0.64	0.5363
XC*XB	0.39375	0.305008	1.29	0.2192
XC*XC	-7.656459	0.405798	-18.87	<.0001
XD*XA	-0.24375	0.305008	-0.80	0.4386
XD*XB	-0.21875	0.305008	-0.72	0.4859
XD*XC	0.06875	0.305008	0.23	0.8252
XD*XD	-0.104179	0.405798	-0.26	0.8014

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
XA&RS	1	1	3778.6793	2538.624	<.0001
XB&RS	1	1	1141.2789	766.7435	<.0001
XC&RS	1	1	165.0144	110.8614	<.0001
XD&RS	1	1	0.8866	0.5956	0.4540
XA*XA	1	1	745.5465	500.8793	<.0001
XB*XA	1	1	1012.8306	680.4483	<.0001
XB*XB	1	1	0.0002	0.0001	0.9920
XC*XA	1	1	0.6006	0.4035	0.5363
XC*XB	1	1	2.4806	1.6666	0.2192
XC*XC	1	1	529.8809	355.9890	<.0001
XD*XA	1	1	0.9506	0.6387	0.4386
XD*XB	1	1	0.7656	0.5144	0.4859
XD*XC	1	1	0.0756	0.0508	0.8252
XD*XD	1	1	0.0981	0.0659	0.8014

Response Yield: Reduced model response surface analysis

Summary of Fit

Rsquare	0.996742
RSquare Adj	0.995811
Root Mean Square Error	1.095682
Mean of Response	40.47143
Observations (or Sum Wgts)	28

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	7712.9462	1285.49	1070.779
Error	21	25.2109	1.20	Prob > F
C. Total	27	7738.1571		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	8	11.312568	1.41407	1.3227
Pure Error	13	13.898333	1.06910	Prob > F
Total Error	21	25.210902		0.3140
				Max RSq
				0.9982

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	52.449908	0.387382	135.40	<.0001
XA&RS	13.74574	0.245009	56.10	<.0001
XB&RS	-7.554296	0.245009	-30.83	<.0001
XC&RS	2.8724935	0.245009	11.72	<.0001
XA*XA	-9.098157	0.357221	-25.47	<.0001
XB*XA	7.95625	0.273921	29.05	<.0001
XC*XC	-7.672727	0.357221	-21.48	<.0001

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
XA&RS	1	1	3778.6793	3147.538	<.0001
XB&RS	1	1	1141.2789	950.6545	<.0001
XC&RS	1	1	165.0144	137.4525	<.0001
XA*XA	1	1	778.7571	648.6836	<.0001
XB*XA	1	1	1012.8306	843.6605	<.0001
XC*XC	1	1	553.8531	461.3447	<.0001

Contour Profiler

Horiz	Vert	Factor	Current X
◉	○	XA	0.333
○	◉	XB	-0.625
○	○	XC	0

	Response	Contour	Current Y	Lo Limit	Hi Limit
—	Yield	40	59.083895	20	60