**————— 3/8/2017 9:12:29 PM ————————————————————**

Welcome to Minitab, press F1 for help.

**Full Factorial Design**

Factors: 3 Base Design: 3, 8

Runs: 24 Replicates: 3

Blocks: 1 Center pts (total): 0

All terms are free from aliasing.

Design Table (randomized)

Run A B C

1 + + +

2 + + -

3 + - +

4 - - -

5 + + +

6 - - -

7 + - +

8 + - +

9 - + +

10 - + +

11 - - +

12 - + -

13 + - -

14 + + -

15 - + -

16 - - +

17 + - -

18 + - -

19 + + +

20 + + -

21 - - +

22 - + -

23 - + +

24 - - -

**Results for: Worksheet 2**

**Full Factorial Design**

Factors: 3 Base Design: 3, 8

Runs: 24 Replicates: 3

Blocks: 3 Center pts (total): 0

Block Generators: replicates

All terms are free from aliasing.

Design Table (randomized)

Run Block A B C

1 1 + + -

2 1 + + +

3 1 + - +

4 1 - + +

5 1 - - +

6 1 + - -

7 1 - - -

8 1 - + -

9 2 - - +

10 2 - + -

11 2 - - -

12 2 - + +

13 2 + - -

14 2 + - +

15 2 + + +

16 2 + + -

17 3 + + -

18 3 + - +

19 3 - + -

20 3 - - -

21 3 + - -

22 3 - - +

23 3 + + +

24 3 - + +

**Factorial Regression: Response( ti versus Blocks, Size of cont, Level of hot, Water type**

Analysis of Variance

Source DF Adj SS Adj MS F-Value P-Value

Model 9 703.432 78.159 520.89 0.000

Blocks 2 0.048 0.024 0.16 0.853

Linear 3 674.505 224.835 1498.41 0.000

Size of container 1 158.363 158.363 1055.41 0.000

Level of hot plate 1 507.362 507.362 3381.31 0.000

Water type 1 8.780 8.780 58.51 0.000

2-Way Interactions 3 28.580 9.527 63.49 0.000

Size of container\*Level of hot plate 1 18.463 18.463 123.04 0.000

Size of container\*Water type 1 3.590 3.590 23.92 0.000

Level of hot plate\*Water type 1 6.527 6.527 43.50 0.000

3-Way Interactions 1 0.300 0.300 2.00 0.179

Size of container\*Level of hot plate\*Water type 1 0.300 0.300 2.00 0.179

Error 14 2.101 0.150

Total 23 705.533

Model Summary

S R-sq R-sq(adj) R-sq(pred)

0.387362 99.70% 99.51% 99.12%

Coded Coefficients

Term Effect Coef SE Coef T-Value P-Value

Constant 10.9535 0.0791 138.53 0.000

Blocks

1 -0.029 0.112 -0.25 0.803

2 0.063 0.112 0.57 0.581

Size of container -5.1375 -2.5687 0.0791 -32.49 0.000

Level of hot plate -9.1957 -4.5978 0.0791 -58.15 0.000

Water type -1.2097 -0.6048 0.0791 -7.65 0.000

Size of container\*Level of hot plate 1.7542 0.8771 0.0791 11.09 0.000

Size of container\*Water type 0.7735 0.3867 0.0791 4.89 0.000

Level of hot plate\*Water type 1.0430 0.5215 0.0791 6.60 0.000

Size of container\*Level of hot plate\*Water type -0.2235 -0.1118 0.0791 -1.41 0.179

Term VIF

Constant

Blocks

1 1.33

2 1.33

Size of container 1.00

Level of hot plate 1.00

Water type 1.00

Size of container\*Level of hot plate 1.00

Size of container\*Water type 1.00

Level of hot plate\*Water type 1.00

Size of container\*Level of hot plate\*Water type 1.00

Regression Equation in Uncoded Units

Response( time in minutes) = 10.9535 - 2.5687 Size of container - 4.5978 Level of hot plate

- 0.6048 Water type

+ 0.8771 Size of container\*Level of hot plate

+ 0.3867 Size of container\*Water type

+ 0.5215 Level of hot plate\*Water type

- 0.1118 Size of container\*Level of hot plate\*Water type

Equation averaged over blocks.

Alias Structure

Factor Name

A Size of container

B Level of hot plate

C Water type

Aliases

I

Block 1

Block 2

A

B

C

AB

AC

BC

ABC

Fits and Diagnostics for Unusual Observations

Response(

time in

Obs minutes) Fit Resid Std Resid

4 7.033 7.660 -0.627 -2.12 R

14 12.133 11.541 0.592 2.00 R

R Large residual

**Effects Plot for Response( time in minutes)**

**Half Normal Effects Plot for Response( time in minutes)**

**Effects Pareto for Response( time in minutes)**

**Residual Plots for Response( time in minutes)**

**Residuals from Response( time in minutes) vs Blocks**

**Residuals from Response( time in minutes) vs Response( time in minutes)**

**Prediction for Response( time in minutes)**

**Prediction for Response( time in minutes)**

Regression Equation in Uncoded Units

Response( time in minutes) = 10.9535 - 2.5687 Size of container - 4.5978 Level of hot plate

- 0.6048 Water type + 0.8771 Size of container\*Level of hot

plate + 0.3867 Size of container\*Water type + 0.5215 Level of

hot plate\*Water type - 0.1118 Size of container\*Level of hot

plate\*Water type

Equation averaged over blocks.

Variable Setting

Size of container large

Level of hot plate high

Water type normal

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

4.47233 0.223643 (3.99267, 4.95200) (3.51300, 5.43167)

Variable Setting

Size of container large

Level of hot plate high

Water type salty

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

4.85567 0.223643 (4.37600, 5.33533) (3.89633, 5.81500)

Variable Setting

Size of container large

Level of hot plate medium

Water type salty

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

11.4777 0.223643 (10.9980, 11.9573) (10.5183, 12.4370)

Variable Setting

Size of container small

Level of hot plate high

Water type salty

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

7.689 0.223643 (7.20933, 8.16867) (6.72967, 8.64833)

Variable Setting

Size of container small

Level of hot plate medium

Water type salty

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

17.3723 0.223643 (16.8927, 17.8520) (16.4130, 18.3317)

Variable Setting

Size of container large

Level of hot plate medium

Water type normal

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

12.7333 0.223643 (12.2537, 13.2130) (11.7740, 13.6927)

Variable Setting

Size of container small

Level of hot plate medium

Water type normal

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

20.622 0.223643 (20.1423, 21.1017) (19.6627, 21.5813)

Variable Setting

Size of container small

Level of hot plate high

Water type normal

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

8.40567 0.223643 (7.92600, 8.88533) (7.44633, 9.36500)

Variable Setting

Size of container small

Level of hot plate medium

Water type salty

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

17.3723 0.223643 (16.8927, 17.8520) (16.4130, 18.3317)

Variable Setting

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Level of hot plate high

Water type normal

Prediction is averaged over blocks.

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Variable Setting

Size of container large

Level of hot plate high

Water type salty

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

4.85567 0.223643 (4.37600, 5.33533) (3.89633, 5.81500)

Variable Setting

Size of container large

Level of hot plate high

Water type normal

Prediction is averaged over blocks.

Fit SE Fit 95% CI 95% PI

4.47233 0.223643 (3.99267, 4.95200) (3.51300, 5.43167)

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**Main Effects Plot for Response( time in minutes)**

**Interaction Plot for Response( time in minutes)**

**Main Effects Plot for Response( time in minutes)**

**Interaction Plot for Response( time in minutes)**

**Cube Plot (fitted means) for Response( time in minutes)**

**Cube Plot**

**Cube Plot (fitted means) for Response( time in minutes)**

**Response Optimization: Response( time in minutes)**

Parameters

Response Goal Lower Target Upper Weight Importance

Response( time in minutes) Minimum 4.383 21.066 1 1

Variable Ranges

Variable Values

Size of container large

Level of hot plate medium, high

Water type normal, salty

Solution

Response(

Level time in

Size of of hot minutes) Composite

Solution container plate Water type Fit Desirability

1 large high normal 4.47233 0.994645

Multiple Response Prediction

Variable Setting

Size of container large

Level of hot plate high

Water type normal

Response Fit SE Fit 95% CI 95% PI

Response( time in minutes) 4.472 0.224 (3.993, 4.952) (3.513, 5.432)

**Optimization Plot**

**Prediction for Response( time in minutes)**

Multiple Response Prediction

Variable Setting

Size of container large

Level of hot plate high

Water type normal

Response Fit SE Fit 95% CI 95% PI

Response( time in minutes) 4.472 0.224 (3.993, 4.952) (3.513, 5.432)

**Prediction for Response( time in minutes)**

Multiple Response Prediction

Variable Setting

Size of container large

Level of hot plate high

Water type normal

Response Fit SE Fit 95% CI 95% PI

Response( time in minutes) 4.472 0.224 (3.993, 4.952) (3.513, 5.432)

**Prediction for Response( time in minutes)**

Multiple Response Prediction

Variable Setting

Size of container large

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Response Fit SE Fit 95% CI 95% PI

Response( time in minutes) 4.472 0.224 (3.993, 4.952) (3.513, 5.432)

**Scatterplot of StdOrder vs FITS1**

**————— 3/9/2017 10:16:19 PM ————————————————————**

Welcome to Minitab, press F1 for help.

Retrieving project from file: ‘C:\Users\knshah7\Desktop\Minitab.MPJ’

**Results for: Worksheet 2**

**Factorial Regression: Response( ti versus Blocks, Size of cont, Level of hot, Water type**

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Source DF Adj SS Adj MS F-Value P-Value

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Level of hot plate 1.00

Water type 1.00

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- 0.1118 Size of container\*Level of hot plate\*Water type

Equation averaged over blocks.

Alias Structure

Factor Name

A Size of container

B Level of hot plate

C Water type

Aliases

I

Block 1

Block 2

A

B

C

AB

AC

BC

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Fits and Diagnostics for Unusual Observations

Response(

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Obs minutes) Fit Resid Std Resid

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14 12.133 11.541 0.592 2.00 R

R Large residual

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**Half Normal Effects Plot for Response( time in minutes)**

**Effects Pareto for Response( time in minutes)**

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