**ChE 320\_Spr\_17\_HW 8 Solution**

**These two ANOVA problems are to be completed using manual calculations.**

**5-78**

a)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Temp | Replicates | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |  |
| 100 | 21.8 | 21.9 | 21.7 | 21.6 | 21.7 | 21.5 | 21.8 | 152.00 |  |
| 125 | 21.7 | 21.4 | 21.5 | 21.5 |  |  |  | 86.10 |  |
| 150 | 21.9 | 21.8 | 21.8 | 21.6 | 21.5 |  |  | 108.6 |  |
| 175 | 21.9 | 21.7 | 21.8 | 21.7 | 21.6 | 21.8 |  | 130.5 |  |
| Total | | | | | | | | 477.20 |  |

Squares:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Temp | Replicates | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |  |
| 100 | 475.24 | 479.61 | 470.89 | 466.56 | 470.89 | 462.25 | 475.24 | 3300.68 |  |
| 125 | 470.89 | 457.96 | 462.25 | 462.25 |  |  |  | 1853.35 |  |
| 150 | 479.61 | 475.24 | 475.24 | 466.56 | 462.25 |  |  | 2358.90 |  |
| 175 | 479.61 | 470.89 | 475.24 | 470.89 | 466.56 | 475.24 |  | 2838.43 |  |
| Total | | | | | | | | 10351.36 |  |

=22-1=21

=4-1=3



SST=



SSE=SST-SSTreatements= 0.4582-0.1391 = 0.3191







P(F3,18>2.62) 🡪 0.05<P-value<0.1

Summary of Analysis of Variance for Density:

Source DF SS MS F P

Firing T 3 0.1391 0.0464 2.62 0.083

Error 18 0.3191 0.0177

Total 21 0.4582

Fail to reject H0 because the P-value is not small. There is not sufficient evidence to indicate that the four firing temperatures affect the density of the brick at 0.05 level of significance.

b) From the ANOVA table the P-value = 0.083 or 0.05<P-value<0.1

**5-80**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Coating** | **Replicates** | | | | **Total** | **Avg** |
| **1** | **2** | **3** | **4** |  |
| **1** | 143 | 141 | 150 | 146 | 580 | 145 |
| **2** | 152 | 149 | 137 | 143 | 581 | 145.25 |
| **3** | 134 | 133 | 132 | 127 | 526 | 131.5 |
| **4** | 129 | 127 | 132 | 129 | 517 | 129.25 |
| **5** | 147 | 148 | 144 | 142 | 581 | 145.25 |
|  |  |  |  |  | 2785 |  |

**Squares:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Coating** | **Replicates** | | | | **Total** |
| **1** | **2** | **3** | **4** |
| **1** | 20449 | 19881 | 22500 | 21316 | 84146 |
| **2** | 23104 | 22201 | 18769 | 20449 | 84523 |
| **3** | 17956 | 17689 | 17424 | 16129 | 69198 |
| **4** | 16641 | 16129 | 17424 | 16641 | 66835 |
| **5** | 21609 | 21904 | 20736 | 20164 | 84413 |
|  |  |  |  |  | 389115 |

=20-1=19

=5-1=4



SST=



SSE=SST-SSTreatements= 1303.75-1060.75 = 243.00







P(F4,15>16.36) 🡪 P-value<0.01

Analysis of Variance for Conductivity:

Source DF SS MS F P

Coating 4 1060.5 265.1 16.36 0.000

Error 15 243.3 16.2

Total 19 1303.7

Reject H0. There is a significant difference among the five coating types in their effect on conductivity.

From the graphical procedure to compare the means the standard deviation used is sqrt(16.2/4) = 2.01 and this standard deviation times 6 equals 6(2.01) = 12. A plot of the mean conductivity follows. From the standard deviation and the plot of the means it appears that there is not a significant difference among coating types 1, 2, nd 5. Also, there is not a significant difference between coating types 3 and 4. However, the levels in the coating type (1, 2, 5) group differ significantly from the levels in the coating type (3, 4) group.

