**ANSWER KEY - LABORATORY EXERCISE 5**
**TEMPERATURE CONTROL LOOP CHARACTERISTICS**

2. PREPARATION

PV-1 (Temp): From 0 DegF to 500 DegF Span: 500 DegF
Feed Rate: From 0 GPM to 400 GPM Span: 400 GPM
PV-2 (Fuel): From 0 KCFH to 100 KCFH Span: 100 KCFH

Type of Valve — Equal Percentage

Pressure Drop Ratio — 1.0

3. TESTING THE PROCESS

| Process Flow | 140 GPM | | 220 GPM | | 300 GPM | | 380 GPM | |
|---|---|---|---|---|---|---|---|---|
| Process Flow, % | 35% | | 55% | | 75% | | 95% | |
| Controller Output | 10% | 13% | 25% | 28% | 35% | 38% | 42% | 45% |
| Δ Valve, % | 3% | | 3% | | 3% | | 3% | |
| Fuel Flow, KCFH | 12.8 | 14.07 | 20.5 | 22.2 | 28 | 30.8 | 34.8 | 38.3 |
| ΔFuel Flow, KCFH | 1.27 | | 1.7 | | 2.8 | | 3.5 | |
| ΔFuel Flow, % | 1.27% | | 1.7% | | 2.8% | | 3.5% | |
| Temperature, $^0$F | 270 | 296 | 274 | 301 | 275 | 302 | 270 | 297 |
| ΔTemperature, $^0$F | 26 | | 27 | | 27 | | 26 | |
| ΔTemperature, % | 5.2% | | 5.4% | | 5.4% | | 5.2% | |
| $K_{P1}\left(\frac{\Delta Temp,\%}{\Delta Valve,\%}\right)$ | 1.73 | | 1.8 | | 1.8 | | 1.73 | |
| $K_{P2}\left(\frac{\Delta Temp,\%}{\Delta Fuel,\%}\right)$ | 4.09 | | 3.18 | | 1.93 | | 1.49 | |
| Dead Time, mins | 7 mins | | 6 mins | | 4 mins | | 3.75 mins | |
| Time Const, mins | 11 mins | | 9 mins | | 8 mins | | 7 mins | |

4. CONFIRMATION OF OBSERVATIONS

4.1 Feedback Control, Equal Percentage Valve. Process flow: 300 GPM

... SP at 300 DegF. Acceptable response? — Yes

... SP at 250 DegF. Acceptable response? — Yes

Increase process flow to 380 GPM.

... compare response now to when process flow was 300 GPM

About the same, or a bit more sluggish

Decrease process flow to 220 GPM

... compare response now to when process flow was 300 GPM

About the same

Decrease process flow to 140 GPM

... compare response now to when process flow was 300 GPM

About the same

4.2 Feedback Control, Linear Valve

Process flow 300 GPM.

... Set point 300 DegF. Acceptable response? Yes

... Set point 250 DegF. Acceptable response? Yes

Process flow 140 GPM

... Set point 300 DegF. Acceptable response? No

... what is happening...? Loop has become unstable

4.3 Cascade Control

... process flow 300 GPM. Acceptable response? Yes

... process flow 380 GPM. Acceptable response? Yes

... compare response now to when process flow was 300 GPM

Slightly more sluggish

... decrease process flow gradually to 140 GPM

Loop becomes increasingly more aggressive