

## ANSWER KEY - LABORATORY EXERCISE 12 TUNING LEVEL CONTROL LOOPS

### 2.0 WHY LIQUID LEVEL CONTROL IS DIFFERENT

Default tuning

|       |                    |
|-------|--------------------|
| Gain  | 1.0                |
| Reset | 1.4 minutes/repeat |

Data from Laboratory Exercise 7

|                |          |
|----------------|----------|
| T <sub>R</sub> | 6.61 min |
| K <sub>V</sub> | 1.83     |

... approximately like quarter-decay? Yes

$$\frac{K_C K_V T_I}{T_R} = \frac{1.0 \times 1.0 \times 1.4}{6.61} = 0.211$$

(1.0 used for K<sub>V</sub>, rather than 1.83, since we are talking now about a cascade loop.)

0.211 is close to 0.2, so we should expect about a quarter-decay.

Change gain from 1.0 to 0.5

... decrease the oscillation No

Change gain from 0.5 to 0.25

... decrease the oscillation No

... as gain was decreased? Amplitude increased; period got longer.

### 3.0 CALCULATION OF TUNING PARAMETERS

| Decay Ratio  | K <sub>C</sub> | T <sub>I</sub> |
|--------------|----------------|----------------|
| Crit. Damped | 1.48           | 17.86          |
| 0.05         | 1.0            | 4.89           |
| 0.25         | 0.64           | 1.96           |

4.0 TESTING THE RESPONSE

| Decay Ratio  | Level Arrest Time | Period          | Outflow Arrest Time | Max Outflow Change |
|--------------|-------------------|-----------------|---------------------|--------------------|
| Crit. Damped | 8.7<br>(8.93)     | N/A             | 17.5<br>(17.86)     | 11.38%<br>(11.3%)  |
| 0.05         | 7.0<br>(7.09)     | 39.0<br>(39.51) | 14.2<br>(14.18)     | 13.55%<br>(13.4%)  |
| 0.25         | 6.25<br>(6.31)    | 28.5<br>(29.26) | 12.4<br>(12.64)     | 15.55%<br>(15.5%)  |

Observed value = XX.X

Calculated value = (XX.X)

... which form of response do you like best?

0.05 decay ratio looks pretty good to me

Without Cascade

Gain  
Reset

0.55  
4.89 minutes/repeat

AutoLoad On

...maximum deviation from set point?

8.67%

5.0 NON-LINEAR CONTROL

...maximum deviation from set point?

23%

Gain = 10. Reset = 30 minutes/repeat

...maximum deviation from set point?

7%

...observe the response...

Persistent, small amplitude cycle about set point.

6.0 AVERAGING LEVEL CONTROL

Set point:  
Process Variable:  
Error  
Controller Output:

50.00%  
56.60%  
6.60%  
83.01%

Calculated Output:

$$5 \times 6.60 + 50.0$$

83.00%

... agree with actual?

Yes (to within a round-off error)

Load just below 100%. Process variable?

58.49%

Load and controller output just above 0%. Process variable?

40.83%

AutoLoad On

... PV remain at set point?

No

Maximum value of PV?

58.96%

Minimum value of PV?

42.85%

Gain = 2.0

... PV remain within bounds of 25% to 75%

Yes