**PROCON**

**PROCESS CONTROL LABORATORY**

**LEVEL/FLOW PROCESS RIG**

**PROCON Lab 2A – BPR: On-Off/PID Control**

**Lab Assignments**

Turn on the Process Interface (38-200) and Process Controller (38-300). Open the Espial Course Presenter and go to Lab 2. Perform the practicals in following sections:

* **Float Level Transmitter**
* **On/Off Solenoid** **Control**
* **P-, PI-, and PID Control of Level**
* **P-, PI-, and PID Control of Flow**

**On/Off Control**

1. What is the process range in % level when the hysteresis is set to minimum and what is the process range when the hysteresis is set to maximum?

Minimum: set at 90% range is

Maximum: It went outside the process range of the tank

1. Had you used the relay to turn the pump on and off to control the level (we did not do this as it would diminish the operating life of the pump), would this have required a(n) ***inverting*** or **non-inverting** comparator? *Circle your answer.*

**Proportional Control of Level Questions**

1. Identify the following items of hardware:

a) the measurement instrument: The float level meter

b) the measured variable: The level height in percentage

c) the (entire) feedback path : Sensor -> transmitter -> interface -> controller -> actuator

d) the actuator : The servo valve

1. On the CM30 Controller (circle top or bottom display):
2. the measured (or process) variable is shown at the ***TOP*** or **MIDDLE** or **BOTTOM** of the display

b) the desired level (or set point) is shown at the **TOP** or ***MIDDLE*** or **BOTTOM** of the display

**Joined the other group because our servo broke**

1. What is the value of proportional band that caused the measured value to begin sustained oscillations? What was the approximate offset in % just before the onset of sustained oscillations?

PB = 4

offset = about 20%

**PI-Control of Level Questions**

1. With PI-control, can you reduce the offset produced by proportional control to zero? If so, record the value of PB and Tr that yielded this result. Can other combinations of these two parameters yield a response with no offset?

At PB = 37 Tr =40 the offset is zero

At PB = 17 and Tr =70 the offset is also zero. So yes other combinations of these 2 parameters yield no offset.

1. How readily did the system oscillate when the integral action was turned on? What value of Tr triggered oscillations? (Set PB = 25 here)

It starts oscillating at about Tr = 17

1. Explain how PB and Tr can be traded off against each other to produce a desired control action. Why must the integral action be large if PB is large (explain each step linking these two parameters)?

PB and Tr are directly correlated and the efforts have to cancel each other out to produced a desired control action. As PB increases the system rises faster but also overshoots more so a higher Tr can help mitigate the large overshoot by giving more integral effort to correct the overshoot by eventually coming to a zero steady state error, but it will also oscillate around the set point.

**PID-Control of Level Questions**

1. How does adding derivative control affect the system response, particularly when the set point is changed by a large amount or when a large error is introduced?

The derivative control sees the large change in error and takes control action by increasing rise time and decreasing the overshoot. The system gains faster with derivative control implemented.

**Proportional Control of Flow Questions**

1. What is the value of proportional band that caused the measured value to experience sustained oscillations?

PB = 45 is the value to experience sustained oscillations

1. Compare the values of proportional band that caused sustained oscillations when controlling level and flow? Why are the two values different for level and flow?

They are different because we changed the variable and they respond differently to our control efforts.

1. When the proportional band was just high enough for there to be no oscillation, there was the variable offset. How does the offset for controlling flow compare with the offset found when controlling level?

Offset is about 44%. The offset is bigger for flow than level because they respond in a different way.

1. Why are controlling flow and controlling level so different? In terms of control effort, what should you be aware of when choosing the type of control to be implemented?

Because flow has a faster response than level because we are directly measuring inside the pipe and flow is a more steady since it is a product of the flow rate. Since flow has a much faster response using the PID control would be more suitable than using PID for the level variable. The level variable can be controlled with only PI pretty well. You should be aware of the response time e.g rise/settling time and overshoot percentage.

**PI-Control of Flow Questions**

1. With PI-control, can you reduce the offset produced by proportional control to zero? If so, record the value of PB and Tr that yielded this result. Can other combinations of these two parameters yield a response with no offset?

PB = 46 Tr = 16 produced a zero offset.

PB = 72 Tr = 8 also produced a zero offset..

**PID-Control of Flow Questions**

1. What is the reason for any oscillation when the measured value is increasing towards the set point?

The reason is the rise time is too fast when it is approaching the set point so it overshoots and the controller can’t predict where the response is going. However, by implementing derivative control it will be able to see the change in error in the future.

1. Can you see any problems with adding derivative control and how can PB changed to mitigate this problem?

By adding derivative control it might amplify the noise in the system since the flow system is pretty noisy compared to the level variable. The PB should be increased to reduce the gain on the noise from the measurement.

1. Would you consider this process variable (flow) suitable for PID control? Why or why not? (Hint: Compare how the flow rate responds to changes in control effort as compared to how the level responds.)

It’s more suitable than Level because the flow rate has a faster control response. And the derivative control will help with overshooting and oscillation in the system as a consequence of the fast response.