**PROCON**

**PROCESS CONTROL LABORATORY**

**TEMPERATURE PROCESS RIG**

**PROCON Lab 2B – TPR: On-Off / PID Control**

**Lab Assignment**

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

* **Temperature On-Off Control**
* **PID Control of Temperature**

**Automatic On/Off Control Questions**

1. Explain the meaning of the hysteresis value when applied to on/off heater control. What effect does the level of hysteresis have on the performance of a system?

Amount by which your variable could deviate from the desired value until the heater turns off/on. This introduces inefficiencies and lag into the system

1. Is using the heater to control the outlet temperature of the radiator (T5) an example of ***inverting*** or **non-inverting** on/off control? *Circle your answer.*

***Prior to answering question #3*:** Invert the A (+) and B (-) terminals and switch the control variable to be the cooling fan instead of the heater. Experiment with setting the reference point at different places (using the current source) and observe the result.

1. When using the cooling fan instead of the heater to control T5, should the on/off control be **inverting** or ***non-inverting***? *Circle your answer.*

**P-Control of Temperature Questions**

1. Identify the following items of hardware:

a) the measurement instrument: Thermistor

b) the measured variable: T5 Temperature

c) the (entire) feedback path: temperature -> transmitter -> display interface -> process controller -> servo

d) the actuator : the servo valve

1. On The CM30 controller the control effort output (i.e. servo valve position) is shown on the **TOP** or **MIDDLE** or ***BOTTOM*** of the display (Circle one).
2. Comment on the ability of the controller to track a step change in desired temperature.

The controller can follow the new set point pretty well, but it takes time for the measured variable to increase until it reaches steady-state. There is also a steady-state error depending on the size of the PB band.

1. While trying to regulate a constant temperature, how does the controller control effort change when the cooling fan is turned on and why?

It takes more effort and time because the fan lowers the temperature when the controller wants the temperature to increase.

1. Comment on how the response changes when changing the proportional band (PB) from 20 to 3 (use approximate values for settling time, overshoot, and offset).

When the PB is low. The system displayed oscillatory behavior as the servo is constantly trying to open and close in order to try and keep up with the response. The settling time decreases, and we didn’t observe any overshoot. The steady-state offset also decreases from around 10 degrees to only 3 degrees. Settling time from 1min -> 30 secs for PB 20 -> 3 .

1. How does the process variable (T5) respond if the proportional band is set too low?

The process variable will have almost zero steady-state error but the servo might oscillate to try and keep it in that state.

**PI-Control of Temperature Questions**

1. Set the proportional band to 20 and turn off integral control. Set the T5 set point to an intermediate temperature, such that the servo valve is neither fully open nor fully closed. After the system is allowed to reach steady state, turn on the cooling fan and observe the response. Repeat the procedure with integral action turned on with an integral time of 20s. Compare the responses.

When Tr (Ki) = 0: The system oscillates around a steady-state of about 30 degrees with a 2 degree amplitude. With the fan on the amplitude of the steady-state decreases to about 1.

When Tr (Ki) = 20s: The system oscillates around our set point of 32 degrees still with zero average error and 3 degree error amplitude. The Ki caused the system to overshoot but at least it is oscillating around the set point.

1. What is the effect of decreasing the integral time (reset rate)?

Decreasing the Tr causes the servo to take shorter to respond and the response more drastic than before. The system also oscillates less.

**PID-Control of Temperature Questions**

1. Would you consider this system and process variable (T5) suitable for PID control? Why or why not?

T5 is too slow of a system to be suitable for PID. Because derivative control responds to the change in the error of the system and since change is pretty slow in this system, the derivative control won’t do too much in terms of control. Overall it would be better to just have a PI system.

1. Define the areas of lag associated with the Temperature Process Rig.

The time it takes for the temperature at the measurement point T5 to reach steady state. The flow rate in the pipes could also be a source of lag in the system.