Lab 6

Direct Acting Control of the Thermal Chamber.

Purpose:

In the Labs 1 through 4, the control system is set to Reverse Acting. This is the default setting. In Reverse Acting when the controlled variable rises (temperature in this system) the controller output decreases to reduce the current flowing through the cement resistor heater elements in bringing the controlled variable back to Set Point The airflow acts as a disturbance.

In a Direct Acting controller, when the controlled variable increases, the controller output also increases. In this lab, Direct Acting is set so that the disturbance potentiometer Pot A1 sets a value of heat to the chamber. The controller output adjusts the fan which acts to adjust the amount of cooling to control the temperature. If the temperature goes above Set Point, the controller output increases causing the fan cooling air to increase.

Procedure:

1) Download Arduino IDE and load the code Complete Temperature Control C/C++ Code
2) Make sure 12 VDC power supply plugged in. Connecting the computer USB port to the Arduino Nano will power up the LCD Display and Nano , however the power to the heater requires the 12VDC power supply.
3) On the Arduino IDE menu, go to Tools and click on Serial Plotter. This will open up the serial plotter screen on the PC.
4) Set the Disturbance potentiometer Pot A1 to 15. It provides a fixed amount of heat to the thermal chamber by setting the current to the cement resistor heaters.
5) Using the remote, observing the mapping diagram, and aiming the remote at the remote receiver mounted on the interface board:
    a) Click on the **Forward** key to set the controller to Direct Acting.
    b) Adjust the Proportional to 2% by clicking on the **<PB** key.
    c) Adjust the integral to 44 sec by clicking on the **>INT** key
    d) Adjust the derivative to 11 sec by clicking on the **<Der** key
6) Adjust the Set Point to 50 deg C and observe on the serial plotter screen, the LM35R temperature (the temperature of the sensor in between the 2 cement resistor heating elements. Wait until steady state and note the peak overshoot.
   Peak value ~ 51 deg C
7) Create a disturbance by increasing the disturbance potentiometer to 17% and observe the operation of the temperature and fan.
   As the temperature rises the fan increases speed, ultimately bringing back the temperature to Set Point
8) Create a second disturbance by taking a sheet of paper and loosely placing it on the surface of the fan to constrict airflow.
   Observe that the constricted airflow causes the temperature to rise with a subsequent increase in fan speed to bring the temperature back to Set Point

Summary

Reverse and Direct Acting controllers are switched in code by changing the error calculation

For reverse acting control, the error is Set Point – Process.

For direct acting control, the error is Process – Set Point.

The decision as to which controller to use depends on the Manipulated Variable. With the Chamber, if the manipulated variable is current to the heaters, Reverse Acting is chosen. If the manipulated variable is air flow, Direct Action is chosen.