PROCESS CONTROL
Process Modeling

Introduction

In this exercise you will again make use of the data logging program, PDL, to capture the process dynamics. The data will then be used to evaluate parameters in a mathematical model describing the rate of flow versus the liquid height relationship. This model will then be tested against real-world performance using data not employed in deriving the model.

Experimental

The laboratory instructor provided an overview of the equipment and its operation during Lab one. In this lab, three different data files will be generated by following the procedures outlined below.

A. Data for developing the flow rate model: finding the valve constant

1. Fill both tanks to near the top.

2. Activate the PDL program and use the default setting. Create a unique filename with six characters or less to save your data in. Begin logging data by pressing 9 and open Tank 2's valve to full open, letting the tank drain to nearly empty (leave some water above the sensor).

3. Stop the data logging by clicking on the Options box with the right mouse button and stop the program. Reopen the data logger program and give the next file another new name with six characters or less. Begin logging data and drain Tank 1. You may want to open Tank 2's valve now because you want to start with both tanks nearly empty for the second part of the lab.

4. Stop the data logging program when Tank 1 is empty. The data from this part of the lab will be used to evaluate the valve constant for each tank. You are now ready to collect data about steady state operation of pumps.

B. Steady State Levels

1. Begin data logging with a new filename with pump two going to Tank 2 with an LED reading of 700. The valve on tank 2 should be fully opened as soon as you begin the pump and data logger program. Continue to take data with the pump LED set to 700 until the level in the tank and the data logger show that the height in the tank has stabilized around a constant value for a few minutes (the height should be around 10 cm, plus or minus 2 cm, just so you have an idea of how high to wait for steady state to set in). Steady state occurs because the flow rate from the pump is constant, but the flowrate out is a function of height. When the height in the tank is high enough, the outlet flowrate equals the inlet flowrate at that setting.

2. When the height has reached steady state, turn off the pump. Start pump 1 going to tank 1 with an LED reading of 700 and open Tank 1's valve fully open. Allow tank 1 to reach steady state as Tank 2 did. You will want to open Tank 2's valve at some point to allow the water draining into it to leave. Your output file will have both data sets in it as you approach steady state.

3. When Tank 1 reaches steady state, turn off the pump and close all valves. Stop the data logger program and then copy all three files to disk so you can analyze them later.

Data analysis

You will use your calibrations from the first lab to translate your PDL data to height data. You should then derive an unsteady state model that will allow you to find R, the valve constant (resistance constant) from the height data from the first two files from this lab (one for each tank). Remember that there was no inlet during these runs and you can write a differential equation to derive ln(h) as a function of time that includes the valve constant. Review your homework on how this is done if you don't remember. You should be able to reduce your model down to a linear equation with the valve constant being part of the slope where you know the other constants in the equation.

Once you know the valve constant, you should be able to use your previous calibration curves to estimate the height that should be in the tank when you have the LED for the pumps set to 700 and you have reached steady state. In you need a reminder, set the derivative of your differential equation to zero with an inlet stream added and use your LED versus q_{inlet} from the calibrations in Lab 1 to find the steady state height.

Recall that Area =51.8 sq.cm.

Lab report

Your lab report should show your derivation for finding R along with plots of data that you used to find R. R-squared values should be included on the linear plot you derived from your differential equation. Your report should clearly state your valve constants and then show steady state data appropriate to verify your valve constant.

You are free to be creative in how you fit this information on two pages and the other information you include.