Lab 8: Parallel vs. Series Flow

Group Number: _______ Section Number:________

Name ___________________________________

Other team members ____

(Circle the name of the person who acted as leader/coordinator this week--make sure you get a turn every 4th lab)

SAFETY SECTION:

Remember to note the safety issues with operating the Pump Cart that you determined in Lab 5 and that are mentioned in Lab 6, one of which was that you should not run the pump for long times with zero flow rate.

Please alert the instructor or TA if you have a safety incident. As always, long pants, closed toed shoes and safety glasses must be worn at all times.

Begin your lab by holding a team planning session (3 minutes):

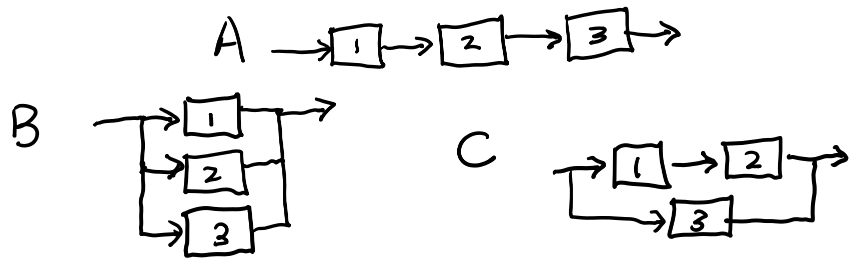
1. Review the lab and read the safety section if you haven't already.
2. One person should serve as leader/coordinator. All team members should strive to take make the team function better through various roles: observer, recorder, devil's advocate, etc. Ask for each other's input and opinions, help each other, and try to come to consensus after an appropriate amount of brainstorming and analysis.
3. Make a plan for how you will complete the lab activities. Each person should fill out their own lab report as activities are completed. At the end of the hour, after cleaning up, get the TA to initial the end of your report.

Background: We typically think of pumps, piping, valves, and other fittings as operating in series, meaning there is a single flow path going through all the devices. However, some situations require that piping and pumps be run in parallel rather than just in series. For instance, running two identical pumps in parallel provides redundancy and safety so that if one pump failed the flow rate through the system would not go to zero. This lab is to help you get some intuition about these situations. It is important to understand what happens to the pressure drop and mass flow rate in series vs. parallel arrangements, and how pumps respond to such.

Project: Determine how running in parallel vs. series affects the mass flow rate, pressure drop/rise before discussing how different systems best make use of systems in parallel and series.

Pre-Lab:

You have three devices (1, 2, 3). Each device could be either a pump, a valve, a fitting, or just a length of pipe. We could arrange them in the following ways (flow systems A, B, C):



1. For each flow system (A, B, C), explain with math the relationships between the mass flow rates for the three devices ($\dot{m}_1, \dot{m}_2, \dot{m}_3$), and the overall system flow rate (e.g. $\dot{m}_A$).

2. For each flow system (A, B, C), explain with math the relationships between the pressure drops/rises for the three devices ($\Delta P_1, \Delta P_2, \Delta P_3$) and the overall system pressure drop/rise (e.g. ΔP_A).

Lab:

1. Draw a schematic of the *parallel* flow paths on the pump cart (you do not need to include other parts of the flow path). There is a *primary* path and a *bypass*. Label the fittings or other features along each branch. Use this schematic to answer questions 2-5 below.

2. Which of the two branches of the flow path (primary vs. bypass) during operation do you expect to have a higher flowrate than the other? Explain your reasoning. Assume that the adjustable globe valve on one branch is “halfway” opened.

3. What do you expect the pressure drop across one branch to be relative to the other branch? Explain your reasoning.

4. If you partially open the globe valve (more than it already is, but not completely) what effect will this have on the answers in # 2 and #3 above? Be specific.

5. How would you experimentally measure the flow rates and total pressure drops for each branch of the pump cart? Be specific about what quantities would be collected on the web interface and what you would do with those quantities to get what you need.

6. Now you finally get to run the flow cart! *Verify experimentally* that your answers for questions 2-5 are substantially correct. You will need to use at least two positions (degree of open/close) of the bypass globe valve. Explain your experiment and provide numerical details on flow rates, pressure drops, etc. to make your case.

Discussion:

1. Was anything unexpected or difficult in conducting your experiment? Why?

2. In an operational environment, how does a chemical engineer precisely control the flow rate going to a reactor or separation unit or any other device? (a one-word answer is sufficient)

3. The Alaska pipeline covering 800 miles has 11 pump stations. How does this relate to pumps being used in series?

4. Chemical plants may run pumps in parallel. Think of two possible reasons for this.

Grading Rubric (to be completed by TAs)

	Points	Max
Completed Pre-lab and answered questions correctly and completely		5
Experiment and discussion were convincing		4
Safety and proper operation: **TA initial:______**		1
Total		10