

Lab 6: Pump Curve and Efficiency

Group Number: _____ Section Number: _____

Name _____

Other team members _____

SAFETY SECTION:

Remember to note the safety issues with operating the Pump Cart that you previously determined. In addition, it is important to note the following principles that will prevent damage to the pump motor and control circuitry:

1. Water flowing through the pump acts as a coolant. Therefore, you should not operate the pump at zero flowrate for more than around 1 minute, as this could cause the motor to overheat.
2. The motor is rated at 2 hp or 1500 W. If you run the motor above 100% speed, carefully monitor the power to make sure it does not exceed this amount.
3. Turn off the pump before turning off the main power.

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 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. **This is one of the longer labs:** additional time will be needed before and after the lab time to complete the calculations.

Background: Pumps are fundamental to chemical engineering processes. This lab helps you better understand pumps by measuring an efficiency and a pump curve for the centrifugal pump on the cart. A second important principle to learn is that valves are used to control flow rate.

Project: You will control the pump and control valve, and collect needed data, using a web interface. Do the pre-lab, get a laboratory-provided laptop, go to the cart, and perform the indicated activities.

1. **Pre-Lab Preparation:** Answer the following questions to prepare for the data collection and analysis

- a. What is the equation to calculate a pump or compressor efficiency?

- b. The equation to calculate shaft work delivered to the fluid in terms of readily measured flow quantities is $\dot{W}_s = \dot{V} \Delta P$. Define the quantities on the right side of the equation. Which particular ΔP on the Pump Cart needs to be measured?

- c. How does one measure electrical work delivered to the pump? Be specific about what two quantities need to be measured (hint: you did this in the How Big is Big lab).

- d. What is pressure head? How would you calculate pressure head from readily measured flow quantities?

2. Operating Software: Familiarize yourself with the software used to control this apparatus.

- a. Make sure water is present in the tank on the Pump Cart
- b. Login into the laptop using one student's CAEDM credential.
- c. Open the *Pale Moon* web browser; it will direct you to the Fundamentals Lab website.
- d. Go to "ChEn 285", then "Pump Cart".
- e. Click on the link for the unit you are working on. It may take a full minute to load.
- f. Right click and request control of the apparatus (when finished with your lab, right click and release control).
- g. Turn on "Main Power".
- h. Turn on pump.

- i. **Explore:** What is the difference between *manual* vs. *auto* control? How does this affect the control valve position? Note that the actual flow rate may not match the *set point*.

- j. Determine limits: Set the control valve (and all hand-operated valves) fully open to see what is the maximum flowrate that can be achieved with this system at 100% pump speed. What is the maximum?

3. Collect Pump Data:

- a. Determine a set of flow rates (at least six values) that span the full range of flow rates possible with this system, including zero flow rate. Set the motor rotation at 100% speed and use the position of the control valve to maintain flow at the values you specify. Collect needed data at each operating point to determine pump head and pump efficiency. It is possible to use the web interface to collect the data for you, download an Excel sheet with the data, and average the data so you can get more reliable pressure readings. Summarize your data below in a table.
- b. Repeat the steps in part **a** at a significantly different pump motor speed. Attempt to use the same flow rate values where possible. Do not choose a pump motor speed below 30%, as it will damage the pump.
- c. When you are done collecting data, turn off the pump, then the main power, then release control of the experiment by right clicking and selecting "Release control".

- d. Comment on the shape of the pump and efficiency curves and how this information would assist an engineer making design decisions in a real operating environment. Also comment on how you could modify the pump cart in order to extend the pump curve to lower head values (and higher flow rates).

Grading Rubric (to be completed by TAs)

	Points	Max
Completed Activities and write-up		7
Accurate calculations		4
Pump curve included and formatted correctly		3
Safety and cleanup: TA initial: _____		1
Total		15