

## CM3215 ChemE Transport Lab:

### *Analysis of a Centrifugal Pump*

#### Pre-laboratory Assignment

Read through the section on centrifugal pumps in your transport book (Morrison, 2013). Review the handout on pumping head (see web handouts page). Prepare data tables in your laboratory notebook for recording data for this lab per this handout; be sure to include units in your tables. Prepare a safety section in your laboratory notebook detailing all safety issues associated with this laboratory.

**Prelab Task:** Your lab station consists of the Lossy® Pump (everything between the Krum Peerless pump suction and the first pressure-tap downstream of the orifice) and the system (all the tubing and fittings from the first pressure tap downstream of the orifice to the suction side of the Krum Peerless pump, including Tank 2). Calculate the system curves for the system for the situations when WV-05 is in the following three states: 0.5 turn open (i.e. 180° turn), 1.0 turn open (360° turn), 1.5 turns open (fittings and tube lengths given in Assignment 6). What head needs to be supplied to produce 1 *gpm* for each of these three configurations of the system?

Write the answers to this question in your laboratory notebook. These will be checked during the prelab meeting. The correct answers will be posted after that meeting.

#### Introduction

When a manufacturer produces a pump, the performance capabilities of that pump need to be available for the customers. In this experiment we measure the pump performance curve for your station's *Lossy® pump*, a pump we define using the

laboratory pump and other fittings at the station. **The Lossy® pump is defined with the valves set to send flow through the 1/2" copper tube.** The suction of the lossy pump is the suction of the lab centrifugal pump (Krum Peerless pump); the discharge of the Lossy® pump is the first pressure tap after the orifice plate in the orifice flow meter.

**Theory:** See lecture.

#### Experimental Procedure

*Measure and report an equation for the pump characteristic curve for the Lossy® pump at your station over the widest range of flow rates possible. Follow a safe procedure that gives you the appropriate data. Include appropriate error analysis. Address other objectives as indicated in the Data Analysis section.*

#### Shut Down Procedure

1. Close needle valve WV-5.
2. Turn off pump P-01.
3. Close valves WV-1, WV-2, and WV-3.
4. Close WV-10 and drain T-02 by opening DV-02.
5. Disconnect measuring devices from any pressure taps; turn off the DC power for the DP meter (south wall).
6. Dry off any wet surfaces with paper towels.
7. Turn off all the electronic devices and properly store them.

#### Data Analysis

1. Take the data so that you can do the most appropriate error analysis. Be sure to randomize the order of the trials to avoid unrecognized systematic error.
2. From your experimental data, determine and plot pumping head ( $H_p$ ) for the Lossy® pump as a function of capacity  $Q$  (*gpm*);

- include appropriate error bars on both head and capacity. Fit the data to a curve and report the equation for the curve. Use all individual data points in the least-squares fitting; do not use mean values in the trendline fitting.
- Using the theoretical system-head curves calculated in a previous assignment (*Assignment 6: System Head Curves*), what do you predict for the operating points (head and capacity) for your Lossy® pump if it were used against those three calculated systems?
  - When you *actually operate* your station's Lossy® pump against the systems you studied in Assignment 6, what are the observed operating points that the Lossy® pump produces? Please discuss any discrepancies between what you predict the operating points to be and what you observe the operating points to be. Give some thought to how to present your results in a clear way (choose table or graph carefully for best communication of your results).
  - Record your pump characteristic curve fit (the equation) and the graph in your lab notebook.
  - What is the source of the greatest uncertainty (error) in your experimental data for your Lossy® pump characteristic curve? What assumption is the source of the greatest sensitivity in your theoretical system-head curves? Justify your answers quantitatively in your report.
  - Attach raw data tables as an appendix (do not include raw data tables in the body of the report).

- Morrison, Faith A, "What is Pumping Head?" handout for fluid mechanics courses at Michigan Technological University, Houghton, MI; available at [www.chem.mtu.edu/~fmorriso/cm310/pump.pdf](http://www.chem.mtu.edu/~fmorriso/cm310/pump.pdf), accessed 3/19/2012.
- Morrison, Faith A., *An Introduction to Fluid Mechanics*, Cambridge University Press, New York, 2013, Chapter 9.

## References