Measurement of Friction Pressure in a Piping System

Instructor Module

Overview

Fluid friction and the associated pressure drops in stretches of pipes is a reality in refineries and chemical processing plants. Sometimes it is more practical to understand friction pressure drops in existing systems of pipes by performing a test and measuring the pressure drop at various rates. Plotting the data allows a friction pressure curve to be developed that can be used on a daily basis to examine what if scenarios in the daily operation of the plant. For a thin Newtonian fluid like water pumped through systems of pipes, the curve is often plotted on log-log paper and becomes two straight lines with a pivot point. The line at the low rates represents the friction drops with the fluid in laminar flow and the line with a larger slope at the high rates represents the friction

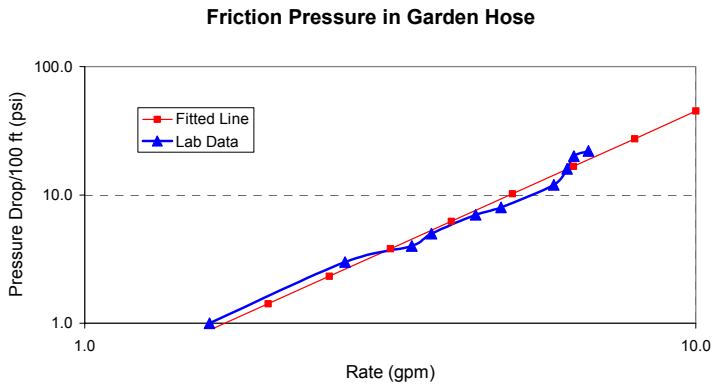

Figure 1 Friction Pressure Measured in Garden Hose

pressure drops with the fluid in turbulent flow. The friction diagram shown in Figure 1 was developed from performing this lab. Water is in turbulent flow at rates too low in small diameter hoses to observe a pressure drop, so the pivot point is not evident. A linear regression was run and a straight line was fitted through the data. The students will be generating similar curves in their own experiments and simply drawing a straight line through their data points.

In this module, the participants will develop a friction curve for a simple Newtonian fluid (water) through a simple tubular (garden hose) by measuring the pressure drops and rates across the hose length. From this data the participant will develop a friction curve for the fluid. Then through a series or questions and problems the participants will learn about unit conversions, an application of kinematics, friction pressure models and practical problem solving using the curve that was developed..

Objectives

1. The student will learn to apply the kinematics equations to calculate the velocity of a jet of water and convert the velocity to ft/s.

2. The participant will learn the fluid mechanics of pumping fluid down a length of pipe.

3. The participant will learn logarithmic graphing by plotting pressure drop and rate data on log-log paper.

4. The participant will learn common unit conversions that might be encountered in the work place.

5. The participant will calculate the Reynolds's number to determine what is the critical rate for turbulent flow for water in a hose.

6. The participant will then be asked to use the curve developed to solve several practical plumbing problems.

Prerequisite Skills

- Calculation of kinematics in two dimensions.
- Knowledge of the difference between gauge and absolute pressure. Also units of pressure.
- Knowledge of fluid density and pressure gradients.
- Calculation of hydrostatic pressure.
- Relationship between fluid velocity, cross sectional area and pump rate. Also units of rate and common conversions.
- Introduction to flow regimes and the calculation of The Reynold's Numbers.
- Calculation of fluid friction pressure drops from gauge measurements.
- Plotting data on log-log paper. Specifically rate and pressure drop data.

Class Preparation Checklist

<u>Equipment Requirements for this Exercise:</u>
The following equipment and materials will be required for each group (2-4) of students:

- Access to a water hydrant with an appropriate connection.
- At least one pressure gauge capable of reading tap pressure graduated at increments of 4 psi or better up to 200 psig.
- A 25 ft of 5/8" garden hose.
- A minimum of 50 ft of 1/2" or 75 ft of 5/8" garden hose.
- A couple of 'Y's to allow the pressure gauges to be screwed in.
- A meter or yardstick.
- A graduated container of at least 4 gal (calibrated 5 gal bucket).
- A stopwatch.
- 2×2 cycle log-log paper.

Additional Information

1. Let the students read through the lab in advance of the laboratory exercise.

2. Allow the participants flexibility to run the lab. Better not to do this lab inside or during cold weather because someone will get wet. Note that when someone gets wet or excessive water is spilled unexpectedly, that this is how people get hurt or environmental spills occur at the refinery.

3. If you have access to better equipment than what is shown here, that is good. However, don't be too concerned about the accuracy of the measurements. Even with crude instruments, the participants should be able to get a reasonable curve.