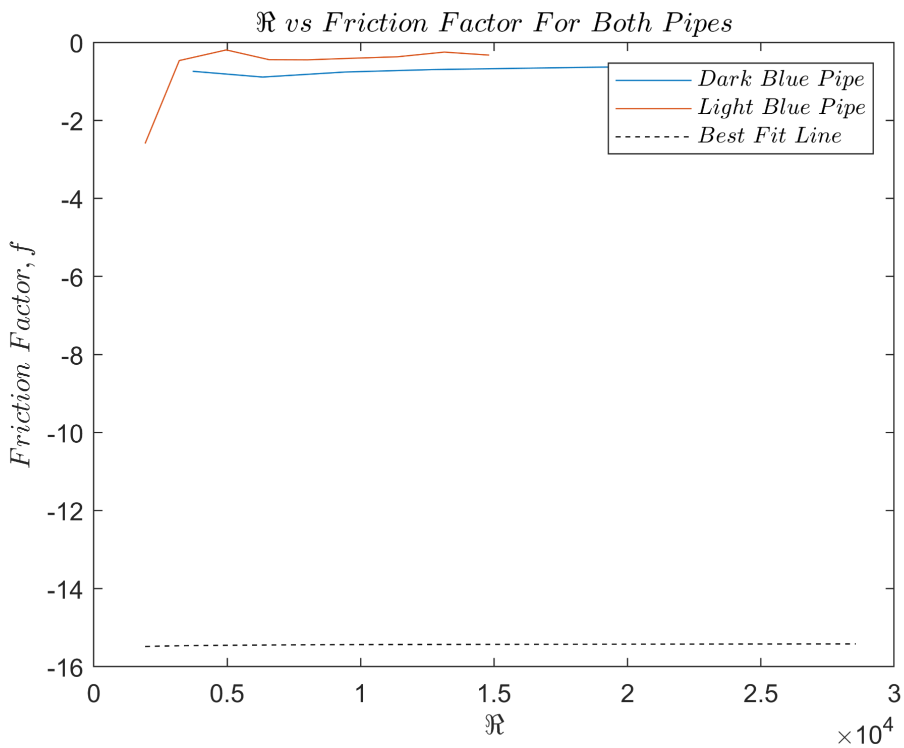
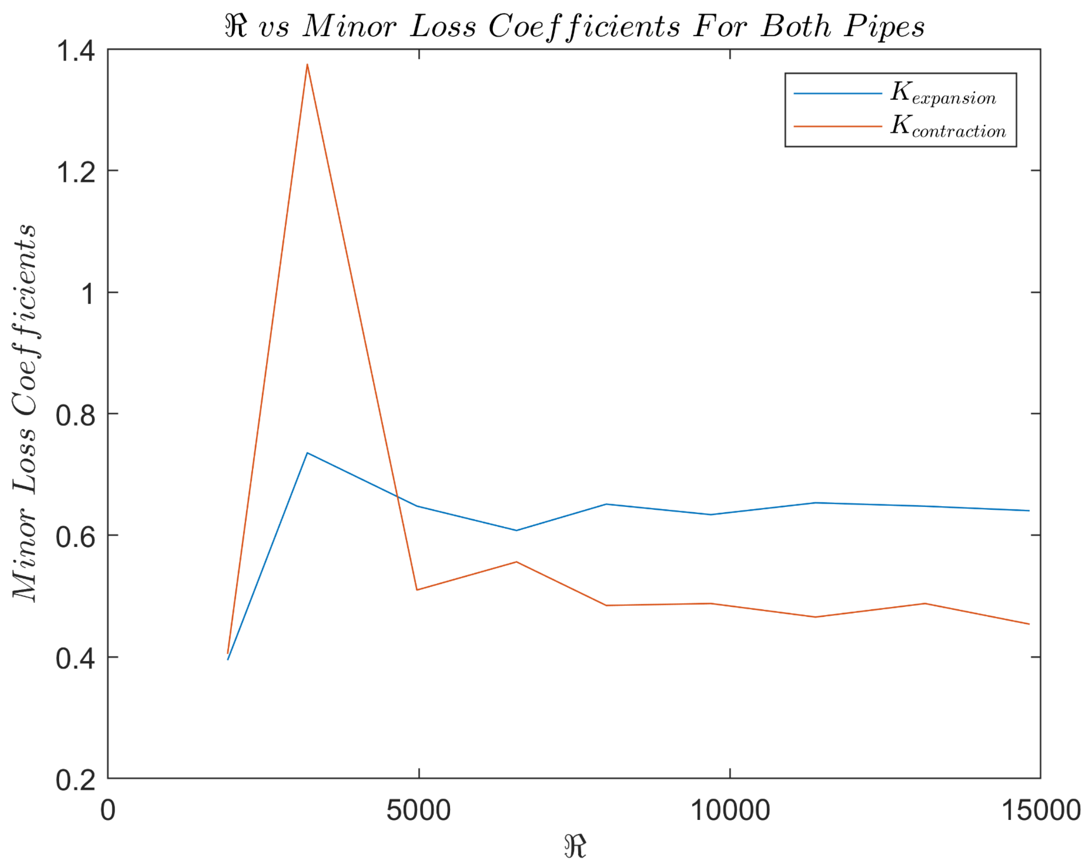
<u>Technical Memo Lab 3: Pressure Losses in a Pipe System</u>

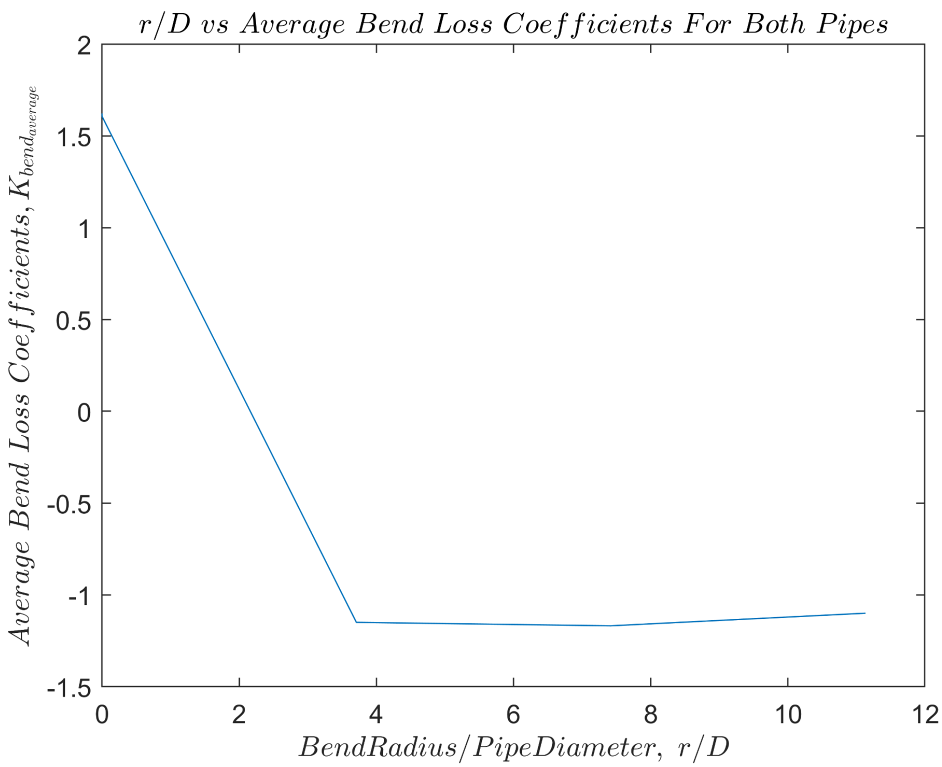
1. Plot of friction factor coefficient vs Reynolds number. Both pipe systems had straight pipe for their final stretch. The dark blue pipe had its final stretch be the normal, small diameter of 13.7mm. The light blue pipe had its final stretch be the larger diameter of 26.4mm. The best fit line was poorly made because of bad initial guesses for the power function. In addition, it still doesn't make sense that we would combine the plots into a best fit line, because they ended up using different pipe diameters. Also, for the power function, the diameter of the pipe is needed. Because we used two different diameters, it was unclear which one to use.



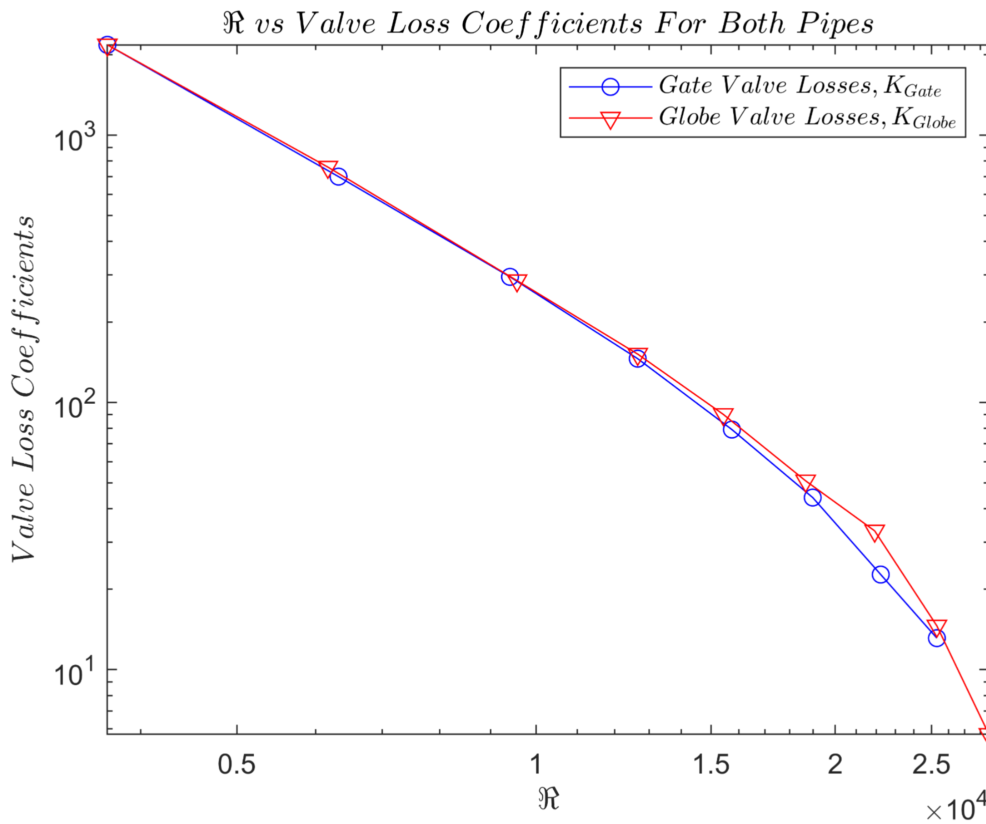
2. Plot of minor losses for sudden contraction and sudden expansion. This was done on the light blue pipe. Entering the larger pipe diameter (in its final stretch), it experienced a sudden expansion. Exiting that larger pipe, it experienced a sudden contraction, since right after, just before the end of the flow, it went back into the small diameter pipes.



3. Plot of minor loss coefficients from bends, for both systems. The equation to calculate the minor losses for the bends, takes into account the straight lengths (via the major losses), because we didn't actually measure purely across the bend. We used the manometers before and after the bends, and in between those two readings, were the straight sections, as well as the bends The Blasius approximation for the friction factors of the straight pipes of $f = 0.785/Re^{0.25}$ for each loss coefficient used. Each bend had its own loss coefficient for each flow rate. So for 9 flow rates, and 5 different bends, there were a total of 45 bend loss coefficients. However, for each bend, its coefficient for each flowrate was averaged into one value, $K_{bend_{average}}$.



4. Minor loss coefficients of a gate valve vs a globe valve. The dark blue pipe system used a gate valve, and the light blue pipe system used a globe valve. This was plotted against the Reynolds number, in a log-log plot.



1. What is major loss and minor loss? How do they differ?

   Major losses are the head losses from straight section of pipe. Minor losses are head losses from components, such as valves, contractions, bends, and so on.

2. How does how does the friction factor vary with Reynolds number?

   For laminar flows, which all flows in this lab were, the equation for friction factor is $f = \frac{64}{Re}$. So in laminar flows, as Reynolds number increases, the friction factor goes down.

3. How does pipe diameter affect the friction factor?

   For laminar flows, which all flows in this lab were, the equation for friction factor is $f = \frac{64}{Re}$. The reynolds number is calculated via $Re = \frac{\rho v D}{\mu}$. It can be seen that as pipe diameter,D, increases, the Reynolds number increases. This larger Reynolds Number results in a lower friction factor.

4. How does the minor loss coefficient of the expansion vary with Reynolds number?

   The minor loss coefficient of a sudden expansion can be found with the equation:

   $$K_{expansion} = \frac{g\pi^2 D^4_{small}}{8Q}(h_{manometer-in} - h_{manometer-out}) + 1 - (\frac{D_{small}}{D_{large}})^4$$

   Graphically, it can be seen that the Reynolds number has a non-linear relationship with the minor loss coefficient of the expansion. But unless dimensional analysis is applied, it is difficult to see a connection.

5. How does the minor loss coefficient of the contraction vary with Reynolds number?

   The minor loss coefficient of a sudden contraction can be found with the equation:

   $$K_{expansion} = \frac{g\pi^2 D^4_{small}}{8Q}(h_{manometer-in} - h_{manometer-out}) - 1 + (\frac{D_{small}}{D_{large}})^4$$

   Graphically, it can be seen that the Reynolds number has a non-linear relationship with the minor loss coefficient of the contraction. But unless dimensional analysis is applied, it is difficult to see a connection.

6. How does the average minor loss coefficient of the bend vary with the dimen- sionless quantity R/D?

   Assuming no change in diameter from one end of the bend to the other, and using the small diameter, D_{small}, as the default diameter, the equation for the minor loss coefficient of a bend can be found with the equation:

$$K_{bend} = \frac{g\pi^2 D^4_{small}}{8Q^2}(h_{manometer-in} - h_{manometer-out} + z_1 - z_2) + f\frac{L}{D_{small}}$$

   Where L, is the total length of the straight section between the manometers, and the friction factor coefficient can be found with the equation using the Blasius approximation: $f = 0.0785 * Re$, in which the Reynolds number can be found with: $Re = \frac{4\rho Q}{\pi\mu D_{small}}$

   As the ratio of R/D increases, the loss coefficient decreases. This makes sense, since if the ratio R/D is larger, the flow is smooth, and isn't as sharp.

7. How does the minor loss coefficient of the valve vary with Reynolds number?

   As the Reynolds number increases, the loss coefficient decreases