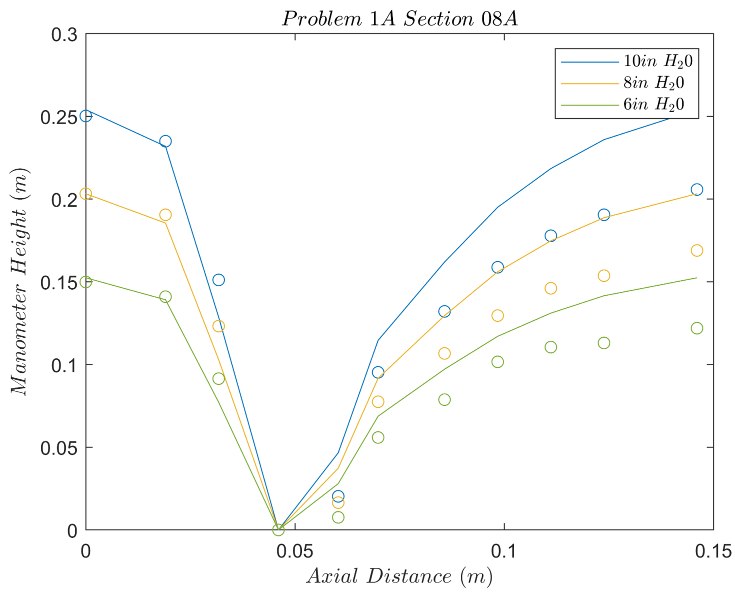
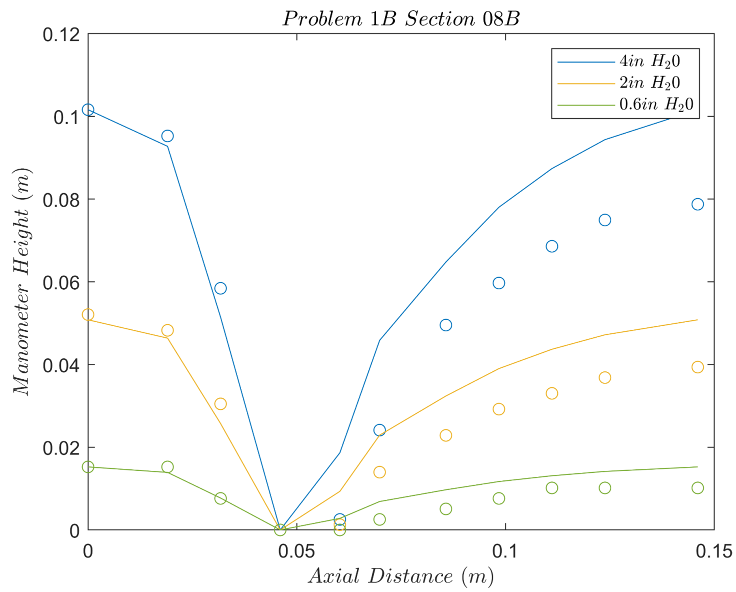
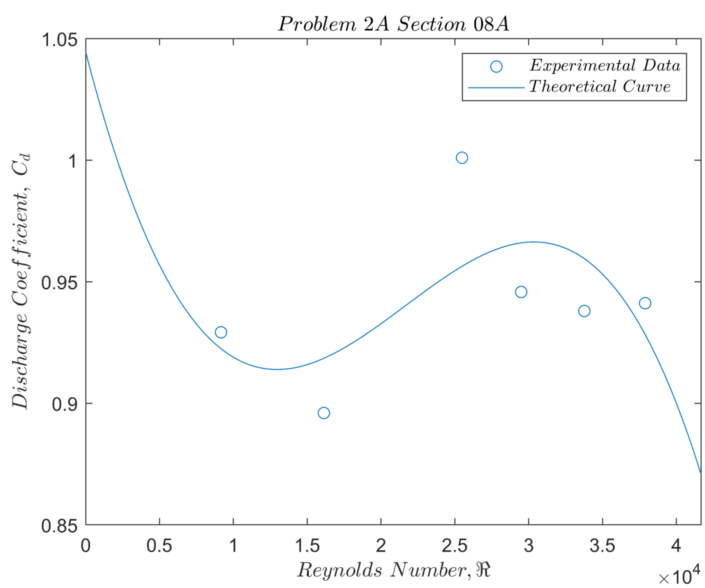
Technical Memo Lab 1: Flow Through a Venturi Meter

1. Presentation of the pressure distribution across the Venturi meter by plotting h vs. distance at every station for all 6 runs.





2. Discharge Coefficient vs Reynold's Number



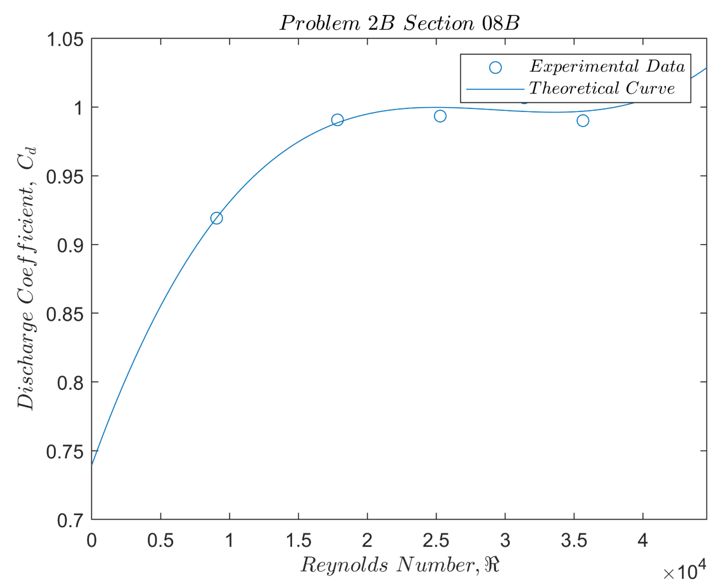
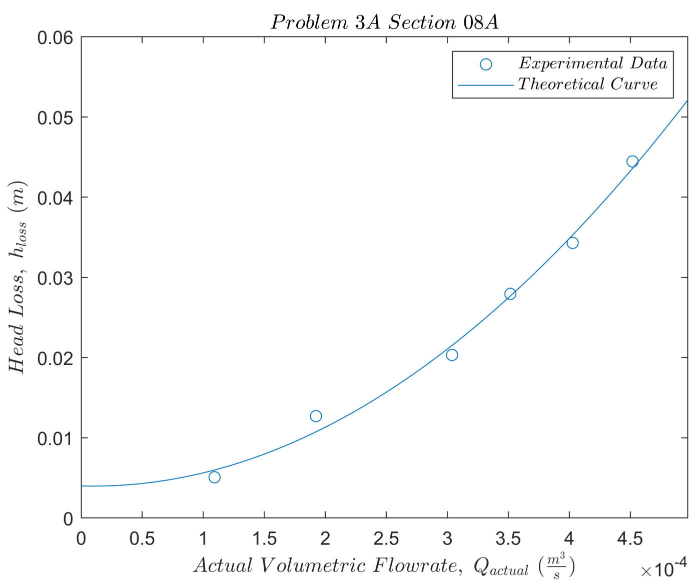
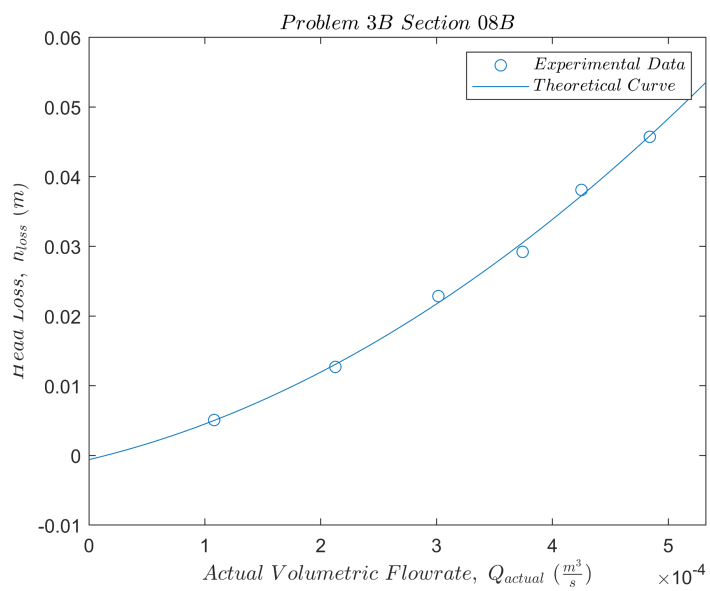


Table is for Group B:

Run	$h_{entrance} - h_{throat}(m)$	$Q_{actual}\ (\frac{m^3}{s})$	$Q_{Theoretical}\ (\frac{m^3}{s})$	C_d	Re
1	0.248920	4.840159×10^{-4}	4.799946×10^{-4}	1.008378	4.058922×10^{4}
2	0.236220	4.250434×10^{-4}	4.293202×10^{-4}	0.990038	3.564382×10^{4}
3	0.224790	3.742803×10^{-4}	3.718022×10^{-4}	1.006665	3.138687×10^{4}
4	0.213360	3.015588×10^{-4}	3.035753×10^{-4}	0.993358	2.528850×10^{4}
5	0.200660	2.126441×10^{-4}	2.146601×10^{-4}	0.990608	1.783217×10^{4}
6	0.190500	1.080641×10^{-4}	1.175742×10^{-4}	0.919114	9.062178×10^{3}

3. Experimental Head Loss Plotted, and estimated with a parabolic curve





It can be clearly seen that major head loss along a pipe increases quadratically, just as the formula in Fluids predicted.

1. How many pressure taps do you need to use in order to use a Venturi as a flow measuring device? Where should these taps be located?

   You really only need three manometers to use a Venturi as a flow meter to measure theoretical flow rate, discharge coefficient, and head loss:

   - The first two manometers go on the entrance (or near it), and directly on the throat. This way, you can measure the theoretical Volumetric flow rate, with h_1 and D_1 being set at the entrance, and h_2 and D_2 being set at the throat.

     ☆ Outputs ? volumetric flow rate, $\dot{V}$

     i) $C_d = \dfrac{Q_{actual}}{Q_{theoretical}}$

     $$a)\ Q_{theo} = \frac{\pi}{4} D_1^2 D_2^2 \sqrt{\frac{2g(h_1-h_2)}{D_1^4 - D_2^4}}$$

     ① → A "entrance"

     ② → D "throat"

     $$= \underbrace{\frac{\pi}{4} D_1^2 D_2^2 \sqrt{\frac{2g}{D_1^4 - D_2^4}}}_{\text{constant eqn}} \sqrt{(h_1-h_2)}$$

   - The actual flow rate can be measured with a bucket and a timer. Then, with both the actual flow rate found, and the theoretical flow rate calculated, the discharge coefficient can be calculated.
   - The last manometer should be set at the very end of the pipe (or near it) so that total head loss across the entire venturi and pipe can be found. Then, with three points, a parabola can be solved for.

2. Which section of the Venturi does the measured pressure deviate most from the theoretical prediction?

   The theoretical manometer heights, and therefore, the theoretical pressures start to deviate from the theory after the flow exits the venturi, and travels down the rest of the pipe.

3. Explain what may be causing the discrepancies between experiment and theory

   The equation we set up came from the bernoulli equation, which does not account for head loss. This is why pressures are less after the venturi. As axial distance increases, head loss increases quadratically. We should have started with the extended bernoulli, aka, the extended mechanical energy equation.

4. How would you change (or redesign) the Venturi to get a better pressure recovery?

   Shortening the pipe seems like the most obvious, efficient, and effective solution, since the shorter the total pipe is, the substantially lower head loss becomes. If not possible to do so, increasing the pipe diameter might work for a while, as head loss is also affected by the diameter of the pipe, as shown in the colebrook formula.

5. What is the effect of Reynolds number on the discharge coefficient?

   The reynolds number generally tends to trend the discharge coefficient upwards, however, being a cubic approximation, the reynolds number might sink the discharge coefficient.

6. How does increasing the Reynolds number of the Venturi flow affect the pressure distributions between the actual and theoretical results?

   Increasing the reynolds number would increase the major head loss, further deviating the actual pressures along the pipe from the theoretical pressures.