Hello! Today, we’ll be exploring how a Venturimeter works.

A Venturimeter consists of a pipe with a narrowing section. The fluid enters with a flow rate, Q in, and exits with a flow rate, Q out. Since we're dealing with incompressible fluids and smooth pipes, the principle of conservation of mass tells us that the flow rates in and out must be equal. This principle holds true at every point along the Venturimeter: at the inlet, the middle, and the outlet. To break it down further, flow rate is the product of the cross-sectional area and the fluid’s velocity at any given point. Using the diameters of the Venturimeter that we’ve designed, we can calculate these areas. Notice how the velocity in the middle, V middle, must be greater than the velocity at the inlet, V in, due to the smaller cross-sectional area. We'll use this relationship later on. By rearranging the equation for flow rate, we can solve for velocity at any point in the Venturimeter.

With these velocities in hand, we can apply Bernoulli’s Equation which describes the conservation of energy in a fluid flow. Essentially, how the pressure, velocity, and height change over its path. Since our Venturimeter is horizontal, we can ignore any changes in height. This simplifies Bernoulli’s Equation, leaving us to focus on the pressures and velocities. Now, isolating the pressures, we know that because V middle is higher than V in, the pressure at the throat P middle must be lower than the pressure at the inlet P in. As can be seen in this equation. Substituting our known values for flow rate and density into Bernoulli’s equation, we can solve for the pressure difference. The values for flow rate was found by timing the filling of a 2 liter beaker and convert to Liters per minute. This pressure difference tells us how much more pressure there is at the inlet compared to the throat, a critical factor in determining the flow characteristics through the Venturimeter. Using this formula which compares hydrostatic pressures in two columns, we can solve for the theoretical difference in column height. Here g is the gravitational constant. We find that there should theoretically be only 2.1517 millimeter in difference between the columns.

We will now walk through the demonstration of a real Venturimeter. The model has an input diameter of 10 mm and throat diameter of 5 mm. A pump is hooked to the input of venturimeter, and we can compare the piezometers’ heights. One issue with this model is that the inner surface has many ridges due to the 3d printing process. This hinders the flow capability and causes major losses along the device. We know that there must be major losses due to the drastic difference between the input and output stage’s heights. The main takeaway of the central pressure being lower than the input can very clearly be seen as the liquid climbs less of its tube.

Thank you for listening.