Theory:

A Bourden tube is a device that measures gauge pressure. A Bourden is a flat tube formed into a C or a spiral. As the tube is pressurized, the cross-section of the tube goes from flat to more circular. This causes a strain in the tube which, in turn, causes the tube to try to straighten out. This is then mechanically amplified by gears and the gauge pressure shown by an arrow pointing to a number.

Experiment:

Adjustable Height Gate

Square Cross-section

Bourdon Tube

Q

Relationships:

You can determine the velocity at any point from the volume flow rate (*Q*), as well as the cross-sectional area:

 $v=\frac{Q}{A}$ (1)

Steady, incompressible flow:

 $\frac{P\_{1}}{γ}+Z\_{1}+\frac{v\_{1}^{2}}{2g}=\frac{P\_{2}}{γ}+Z\_{2}+\frac{v\_{2}^{2}}{2g}$ (2)

Because the external pressure is zero, and the height is not changing appreciably, equation (2) simplifies to:

$$P\_{1}=\left[\frac{v\_{2}^{2}-v\_{1}^{2}}{2g}\right]\*γ$$

 $⇒P\_{1}=\left[\frac{v\_{2}^{2}-v\_{1}^{2}}{2}\right]\*ρ$ (3)

Requirements:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Run #** | **H** | **Volume**  | **Time** | **P** | **Q** | **A** | **P1** |
| **(mm)** | **(Liters)** | **(seconds)** | **(kPa)** | **m3/sec** | **mm2** | **kPa** |
| **1** |  |   |   |  |   |  |   |
| **2** |  |   |   |  |   |  |   |
| **3** |  |   |   |  |   |  |   |
| **4** |  |   |   |  |   |  |   |
| **5** |  |   |   |  |   |  |   |
| **6** |  |   |   |  |   |  |   |
| **7** |  |   |   |  |   |  |   |
| **8** |  |   |   |  |   |  |   |
| **9** |  |   |   |  |   |  |   |
| **10** |  |   |   |  |   |  |   |

Lab:

1. Record the initial temperature of the water
2. With the adjustable gate completely open, free from the flow of water, turn the volumetric bench supply to max flow.
3. Record the volume and time for at least 30 seconds
4. For subsequent runs lower the adjustable height gates by H/10 intervals until you have completely stopped the flow out of the system by closing off the adjustable gate.
5. Record the volume and time for each interval for at least 30 seconds.

Report:

After gathering the required data, compute the required values; compute the calculated P and compare this with the measured P from the bourdon tube. Calculate the percent-error at each point. Plot the percent-error vs. velocity. Does it go up or down with increases in velocity; is it a linear relationship? How much should the tube be adjusted to be properly calibrated?

Questions:

1. In the experimental procedure, we did not account for the headloss of the pipe and fitting between points (1) and (2). What would the effect of this headloss be on the experiment if it was taken into consideration?
2. Would the headloss increase or decrease as the gate was lowered?
3. The Bourden tube is made mainly for quasi-static loads. During the experiment, did you give ample time for the pressure to equalize? If not, how would this affect the data?