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Head Losses in Piping Systems: A test bench for educational purposes

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Abstract: *According to the Canadian Engineering Accreditation Board (BCAPG), one of the twelve qualities that an engineering student must acquire is the ability to investigate. This means that it must be able to study complex problems using methods involving experiments, analysis and interpretation of data and synthesis of information in order to formulate valid conclusions.*

It is therefore proposed to design a test bench for the characterization of losses in piping systems. One of the most common problems in fluid mechanics is the estimation of pressure loss. It is the objective of this experiment to enable pressure loss measurements to be made on several small bore pipe circuit components such as pipe bends valves and sudden changes in the area of flow.

Using this bench, the aim is to obtain the pressure drop for different experimental conditions of flows (flow rate, different pipe and singularities).

This paper provides details on the measures applicable to head losses in piping systems. It also gives the instructors more opportunities to make meaningful teaching points for the subjects being introduced to the students. Students will develop an experimental method from the analysis of these standards. We also developed an assessment grid to validate the investigation quality. Students will be observed on site to validate performing experiments quality.

Keywords: *Test bench, pedagogical approach, experimental investigation, minor losses, major losses, assessment grid.*

1. Theory

In Bernoulli's equation as shown below, hf represents the head loss due to friction between the fluid and the internal surface of the constant diameter pipe as well as the friction between the adjacent fluid layers.

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{f1-2}$$

The head losses (hf) in pipe due to friction can be determined using Darcy-Weisback equation

$$h_f = f\frac{L}{D}\frac{V^2}{2g}$$

Where:

f = Friction factor

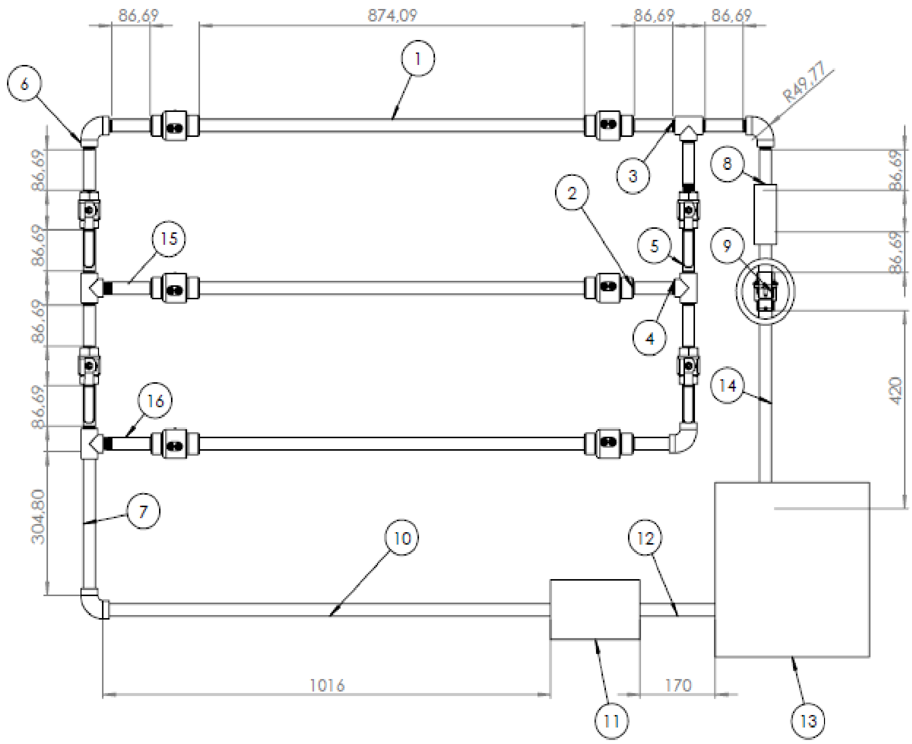
L = Length

V = Mean velocity (Q/A)

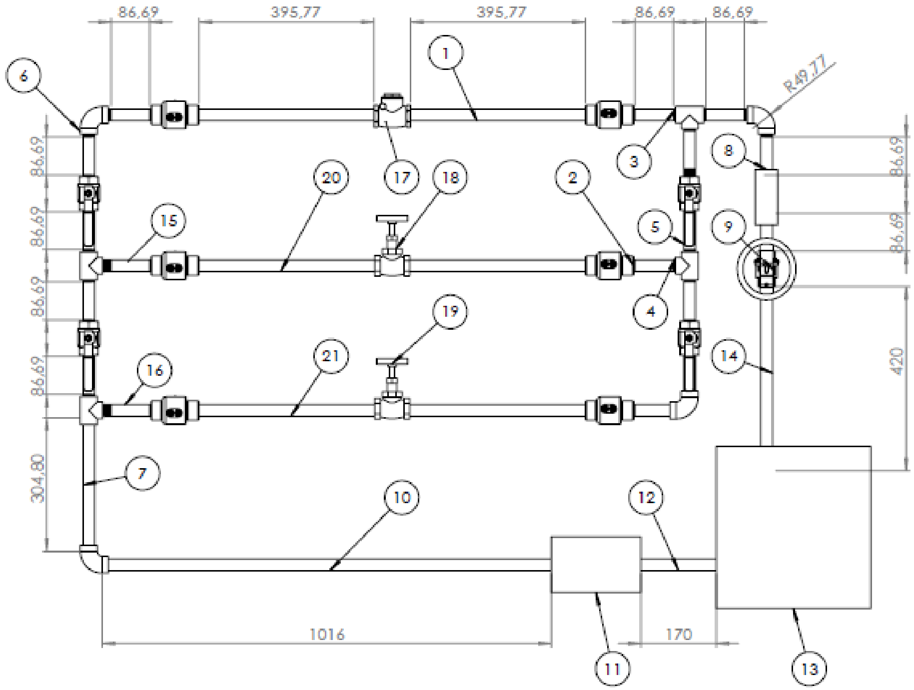
g = Gravity

D = Constant diameter

2. Test Bench (head loss hf)



3. Test Bench (loss coefficient k)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4. Measurements

TABLE I: EXPERIMENT DATA

Pipe section type	Diameter	Volumetric flow rate	Inlet pressure	Outlet pressure
PVC	1in			
Galvanized steel	1 in			
Copper	3/4in			
Gate valve	1in			
Globe valve	1in			

5. Test Procedure

1. In this experiment, pipes made of different materials (PVC, copper and galvanized steel) are compared.
2. Switch on the pump and slowly open the control valve until maximum, and wait for a while in order to remove any air bubble in the flowing pipe ,
3. Identify which inlet flowing pressure (P1) and outlet flowing pressure (P2),
4. Adjust desired flow by way of inflow valve.
5. Determine several suitable flow rates Q. Record the values of P1 and P2 of the inlet and the outlet of water manometer flowing pressures as Q is changed.
6. Plot the measured values of pressure drop versus Reynolds number and compare it with the values obtained from theoretical relationships.

6. Results

1. Calculate the loss of coefficient (K) and head loss (hf) for each of the flow types.
2. Compare the calculated value with the theoretical value and discuss the possible reasons for different values.
3. Discuss the effect of fluid velocity, pipe roughness and pipe diameter on the value of the loss coefficient (K) and hence friction loss in the pipe.
4. Briefly discuss factors contributing to errors or inaccuracy in experimental data and propose recommendations to improve the results.

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