Pressure Losses in Pipes

Objective:

To investigate the pressure, drop in pipes due to frictional effects.

Apparatus

- Hampden Model H-6925 Fluid Circuit Demonstrator (Figure 1)
- Thermometer.
- Moody Diagram.

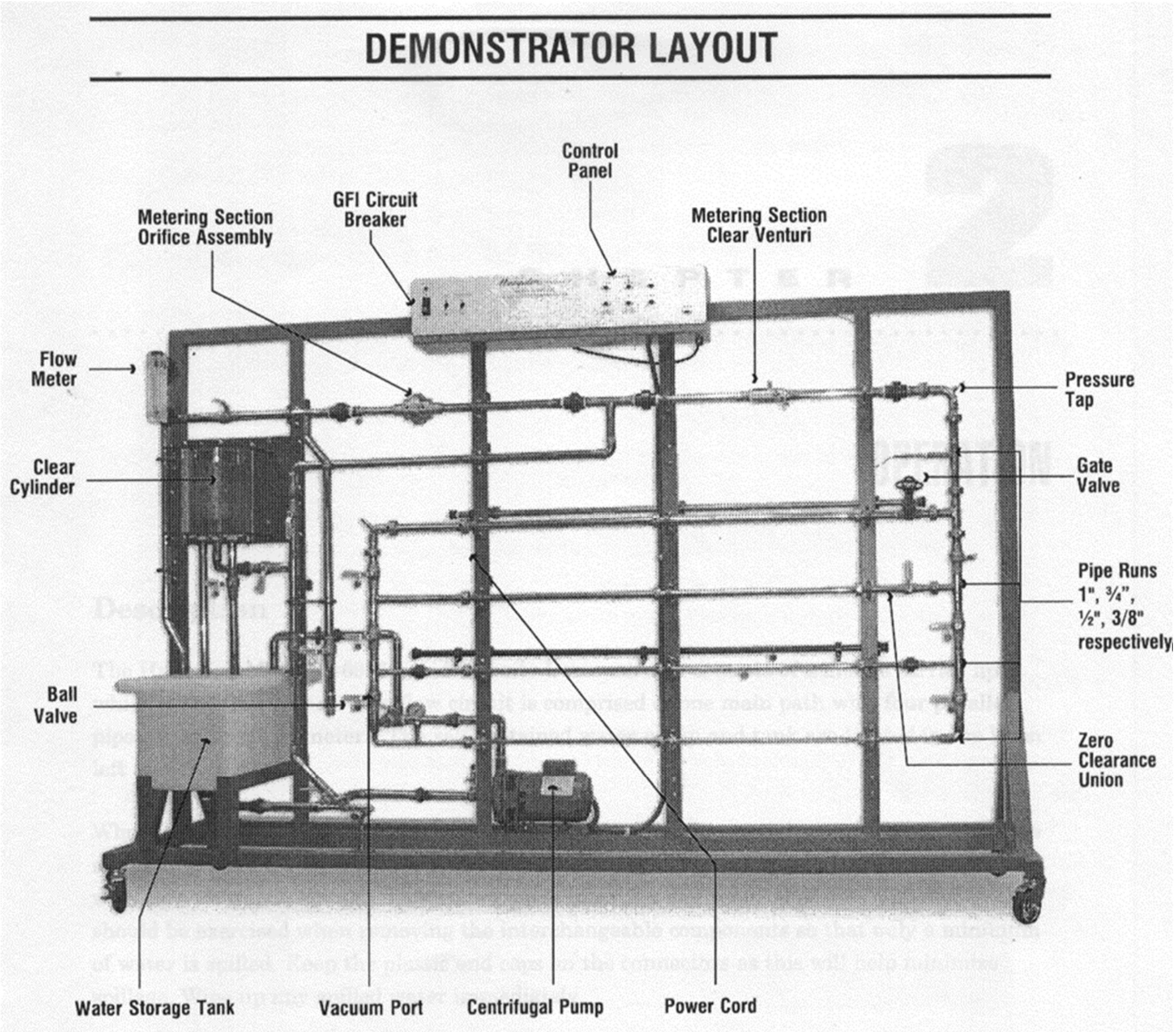

Figure 1: Hampden Model H-6925 Fluid Circuit Demonstrator

Procedure

1. Measure the temperature of the water and use published data to determine the kinematic viscosity of the water.
2. Close all valves.
3. Select a pipe and open the appropriate valves for the flow path; e.g. for the 3/8” **(10.92 mm)** pipe open BV-1, BV-2, BV-3, BV6, BV-14 and the globe valve; see Appendix 2 for a full list.
4. Connect the manometer lines to the tapping points on the pipe. The upstream tapping is connected to the high side of the manifold and is downstream to the low side.
5. Open the ball valve to the pipe being investigated, ensure that the ball valves to all the other pipes are closed.
6. Turn on the pump and use an initial flow rate of around **8 l/min**.
7. Record the manometer readings, the pipe diameter and pipe material. Be sure to allow the readings to stabilise before recording.
8. Repeat Step 7 for 4 more increasing flow rates; not exceeding the maximum of **40 l/min; e.g. 16, 24, 32, 40 l/min.**

   NOTE: For the smallest pipe you will not be able the achieve a flow rate of 40 l/min
9. Repeat Steps 3 to 8 for the other pipes.

Analysis

1. Calculate the experimental head loss from the readings taken and compare them with theoretical predictions.
2. Both experimental and theoretical predictions should be included in a table; include relative error.

Theory

Darcy Equation

$$h_L = \frac{flu^2}{2gd}$$

Where:

$h_L = head\ loss\ (m)$
$f = Darcy\ fiction\ factor$
$l = length\ of\ pipe\ (m)$
$u = mean\ velocity\ of\ flow\ in\ pipe\ (m/s)$
$d = diameter\ of\ pipe\ (m)$

Reynolds Number

$$Re = \frac{\rho u d}{\mu}$$

Where:

$\rho = mass\ density\ (kg/m^3)$
$u = mean\ velocity\ of\ flow\ in\ pipe\ (m/s)$
$d = diameter\ of\ pipe\ (m)$
$\mu = dynamic\ viscosity\ Pa \cdot s$

Observations/Readings

Pipe 1: Diameter = 10.92 mm

Flowrate (l/min)	Manometer Reading (mmHg)	Manometer Reading (m)	Reynolds Number Re	Theoretical loss h_L (m)

Pipe 2: Diameter = 13.84 mm

Flowrate (l/min)	Manometer Reading (mmHg)	Manometer Reading (m)	Reynolds Number Re	Theoretical loss h_L (m)

Pipe 3: Diameter = 19.94 mm

Flowrate (l/min)	Manometer Reading (mmHg)	Manometer Reading (m)	Reynolds Number Re	Theoretical loss h_L (m)

Pipe 4: Diameter = 26.04 mm

Flowrate (l/min)	Manometer Reading (mmHg)	Manometer Reading (m)	Reynolds Number Re	Theoretical loss h_L (m)

Specifications

Pipe Material: Type X Copper

Pipe Number counting from the lower pipe	*Inside Diameters*		*Nominal Roughness*	
	Imperial (nominal)	*Metric (actual)*	*Imperial*	*Metric*
1 (Lowest)	3/8”	10.92 mm	5×10^{-6} ft	1.5×10^{-3} mm
2	1/2"	13.84 mm	5×10^{-6} ft	1.5×10^{-3} mm
3	3/4"	19.94 mm	5×10^{-6} ft	1.5×10^{-3} mm
4 (Highest)	1”	26.04 mm	5×10^{-6} ft	1.5×10^{-3} mm

Appendix A

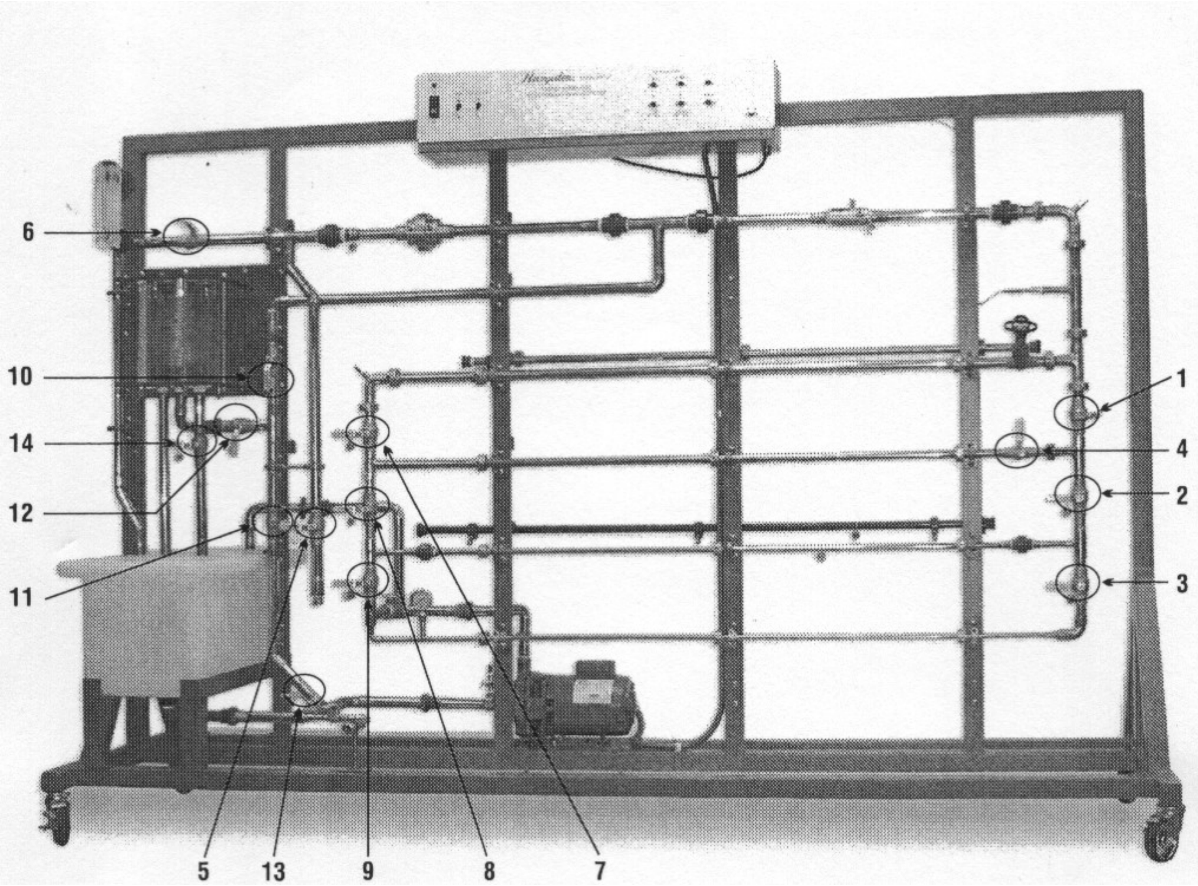

Figure 2: Ball Valve Layout

Appendix 2: Flow Paths

Flow Paths	
Pipe Diameter	**Close ALL valves and OPEN the following**
1” (*26.04 mm*)	7, 8, 9, 13, Gate
3/4” (*19.94 mm*)	1, 4, 8, 9, 13
1/2” (*13.84 mm*)	1, 2, 9,13
3/8” (*10.92 mm*)	1, 2, 3, 13