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LAB (2): CENTRIFUGAL PUMP PERFORMANCE

Introduction

The most common machine for causing liquids to flow through piping systems is the centrifugal pump. The centrifugal pump is well suited to situations requiring moderate to high flowrates and modest increases in head (or pressure). Typical applications include municipal water supply systems, circulating water heating and cooling system for buildings, pumps in dishwashers and clothes washing machines and the cooling water circulating pump in an automobile engine.

Objective

In this experiment we get the performance curve of the pump using the experiment model shown in figure 1

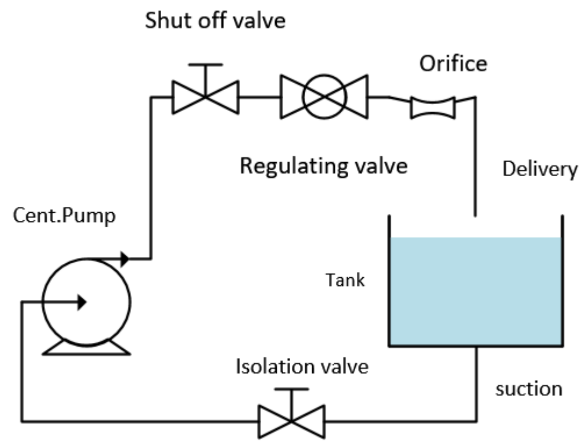


Figure 1 Experiment flow diagram

Procedures:

1. We power on the pump
2. We operate the pump at constant certain speed
3. At certain valve opening we:
   1- Take pressure gauge readings before and after pump $(H_{ms}\,, H_{md})$ shown in fig 3
   2- Measure the reading of the orifice manometer to measure the flowrate (y) fig 2
4. We keep varying valve opening to find different values for Hms, Hmd and H
5. We do the calculations and record the results in a table

Equations

Orifice pressure drop

$$H = y * (\frac{SG_{hg}}{SG_f} - 1)$$

Flow rate

$$Q = C_d * A_o * \sqrt{2gh}$$

$$A_o = \frac{\pi}{4} d_0^2 = 4.5239 * 10^{-3}$$

$where\ C_d = 0.65\ \&\ d_{orifice} = 2.4\ cm$

Manometeric head

$$H_m = H_{md} - H_{ms}$$

Figure 2 Manometer reading

Readings

$y\ [cm]$	$Hms\ [bar]$	$Hmd\ [bar]$
6.8	-0.35	0.25
5	-0.3	0.49
4	-0.25	0.55
3	-0.2	0.6
2	-0.16	0.7
1	0.1	0.95
0	0.1	1.2

Figure 2 pressure gauges

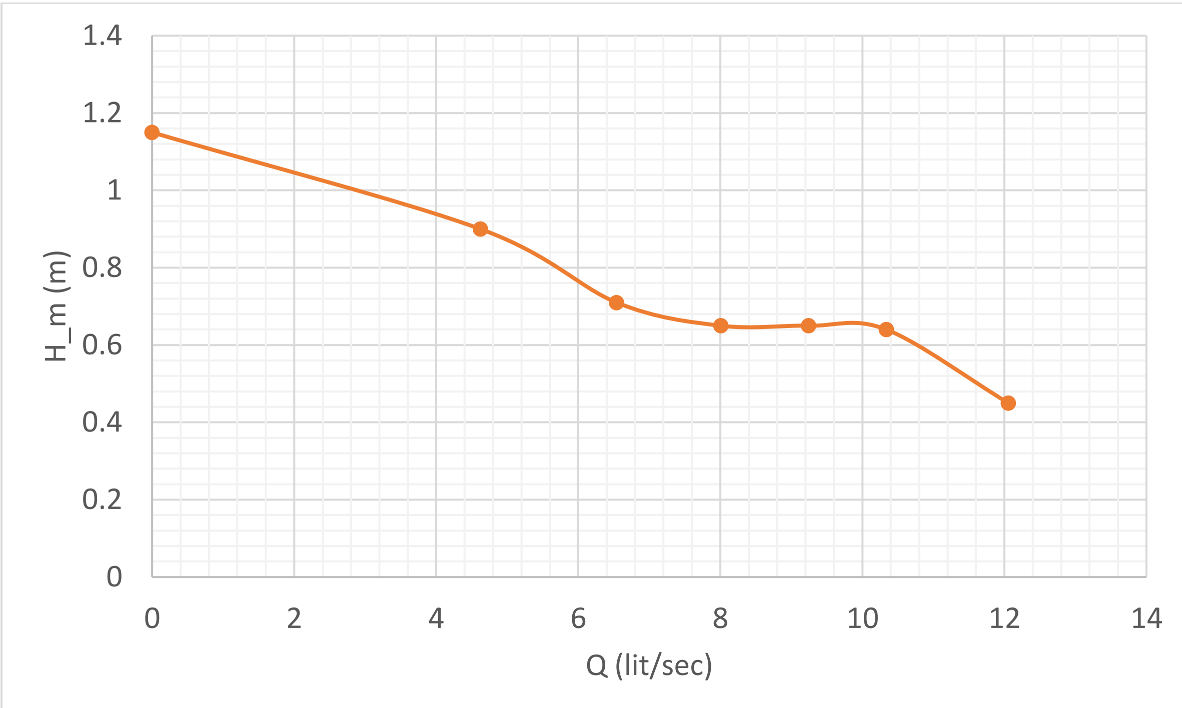
Calculations

$y\ [cm]$	$H[cm]$	$Q[lit/sec]$	$Hms - error\ [bar]$	$Hmd - error\ [bar]$	$Hm\ [bar]$
6.8	85.68	12.05	-0.25	0.2	0.45
5	63	10.33	-0.2	0.44	0.64
4	50.4	9.242	-0.15	0.5	0.65
3	37.8	8	-0.1	0.55	0.65
2	25.2	6.535	-0.06	0.65	0.71
1	12.6	4.621	0	0.9	0.9
0	0	0	0	1.15	1.15

Sources of error:

We need to keep in mind that accurate values could not be achieved due to some unavoidable factors such as the condition of the water hoses that were partially bent.

- Human error in measurements.
- Zero error due to deflection of manometer spring:
    1- about - 0.1 bar on suction side and
    2- 0.05 on delivery side
- Bends error in water hoses making a pressure drop



Comments:

- The curve represents the performance or the behavior of the pump under varying the flow rate supplied to the system upon gradually opening the valve. This is called the performance curve of the pump.
- We noticed that when we fully closed the valve we recorded the maximum head that the pump could achieve which is called shut-off head, the pump was noisy and vibrated excessively at this point as it was far from the best efficiency point.
- While we were increasing the flow rate supplying the system the head that the pump was able to achieve was in continues decrement.