

Faculty of engineering

Mechanical engineering department

Fluid mechanics Laboratory

ENME312

Section NO.1

Experiment NO.8

"CENTRIFUGAL PUMP POWER MEASUREMENTS"

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**Abstract :**

 This experiment aims to know some basics of the centrifugal pump and its operation and to determine the overall efficiency. The radial pump was used in this experiment. Readings were taken from the machine to find the overall efficiency. The angular velocity of the centrifugal pump is adjusted. Then the following measurements are recorded: force, voltage, current, inlet pressure and outlet pressure at different volumetric flow rate. There were a clear linear relation between volume flow rate (Q) and mechanical power (Wm) as well a linear relation between volume flow rate (Q) and power required to drive the pump (We). The relationship between the head and the volume flow rate was also linear.

 After doing this experiment, the maximum efficiency of the pump was founded to be 49.1% at volumetric flow rate of 3.5 L/s.

**Objectives:**

1- To be familiar with some basic centrifugal pump characteristics and operations.

2- To define the centrifugal pump, and know how it is work, and the processes that occur through it.

3- To determine overall efficiency.

4- To find a relationship between volume flow rate and mechanical power, electrical power, water head and overall efficiency.

5- To measure the performance of a centrifugal pump and compare the results to the manufacturer’s specifications.

**Calculations:**

Sample calculation for run #1:

The following equation was used to calculate the power required to derive the pump:

 We = V\* I (1)

Where:

We : Power required to drive the pump (watt).

V : Voltage (Volt).

I : Current (Ampere).

Substitute V=180 V and I=3.8 A in equation (1) to find power required to drive the pump:

We =185\*2.8

We =518WJ

The next equation was used to calculate mechanical power

 $W\_{m}=\frac{2πNT}{60}$ (2)

Where:

$W\_{m}$ : Mechanical power (Watt).

 N : Angular velocity $\left( RPM\right).$

 T : Torque (N.m) .

The following equation was used to find the torque:

 T=0.165\*F (3)

Where:

F : the force (N)

Substitute F=10 N in equation (3) to find the torque:

T=0.165\*8

T=1.32 N.m

Substitute N=2500 RPM and T=1.65 N.m in equation (2) to find the mechanical power:

$$W\_{m}=\frac{2\*3.14\*2500\*1.32}{60}$$

$$W\_{m}=345.4W $$

The following equation is used to find head of water:

$$ H=\frac{∆P}{ρg} (4)$$

Where:

$∆p$ : Difference pressure (pascal).

$ρ$ : Water density (1000 Kg/$m^{3}$).

g : gravitational acceleration ($9.81 m/s^{2}$).

 Substitute $p\_{2}=1.8 bar $,$p\_{1}=0 bar ,ρ=1000kg/m^{3}$ and g= 9.8 m/$s^{2} $ in equation (4) to find the head of water at run #1:

$$H= \frac{\left(0.2+0.02\right)\*10^{5}}{1000\*9.8}$$

$$H=2.24 m$$

This equation was used to find overall efficiency:

$ ῃ=\frac{ρgQH}{W\_{e}}$ (5)

Where:

$ Q $: The volumetric flow rate ($m^{3}/sec)$.

$W\_{e}:$ Power required to drive the pump (Watt).

Substitute$ ρ=1000kg/m^{3}$,g= 9.8m/$s^{2}$,Q=0.001$m^{3}/s$ ,H=2.24m and $W\_{e}$=1349 W in equation (5) to find overall efficiency:

$$η=\frac{1000\*9.8\*0.001\*2.24}{518}×100$$

η= 4.24%

**Results:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run | Q | P1 | P2 | V | I | F | T | Wm | We | Efficiency |
| 1 | 0 | 0 | 1.8 | 185 | 2.8 | 8 | 1.32 | 345.4 | 518 | 0 |
| 2 | 0.7 | 0 | 1.75 | 180 | 3.3 | 10 | 1.65 | 431.75 | 594 | 206.3568 |
| 3 | 1.2 | 0 | 1.8 | 178 | 3.8 | 12 | 1.98 | 518.1 | 676.4 | 319.5357 |
| 4 | 1.8 | 0 | 1.75 | 180 | 4.2 | 14 | 2.31 | 604.45 | 756 | 416.925 |
| 5 | 2.4 | 0 | 1.7 | 180 | 5 | 16 | 2.64 | 690.8 | 900 | 453.6144 |
| 6 | 3 | 0 | 1.55 | 180 | 5.6 | 18 | 2.97 | 777.15 | 1008 | 461.5955 |
| 7 | 3.6 | 0 | 1.38 | 180 | 6 | 20 | 3.3 | 863.5 | 1080 | 460.2852 |
| 8 | 4.2 | 0 | 1.1 | 180 | 6.8 | 22 | 3.63 | 949.85 | 1224 | 377.685 |

Table (1) : data table inlet and outlet pressure, volume flow rate ,force ,voltage, current power ,head and efficiency .

Figure (1) : Mechanical power versus Volumetric flow rate and Electrical power versus Volumetric flow rate.

Figure (2) : Power required to drive the pump versus Volumetric flow rate

Figure (3): Head and efficiency versus flow rate.

**Discussion of Results:**

 We can see from the tables that our results and relations agree with the theoretical one to somehow, but not exactly due to some sources of errors, for example: the indicator of the ammeter and voltmeter was oscillated (not stable), the valve hand was difficult to move, eye level was not proper, the indicator of the inlet pressure gage (P1) was approximately changed in a very small radial displacement (invisible).