

**Faculty of Engineering**

**Mechanical Engineering Department**

**Fluid Mechanics Lab, ENME 312**

**Exp.4**

**“DISCHARGE THROUGH AN ORIFICE-METER”**

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**Group Number (#2)**

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**Abstract:**

In this experiment we use a hydraulic bench that have an orifice-meter that used to measure the volumetric flow rate of fluids and measuring the discharge, velocity and the contraction coefficients at different flow rates of water through it. And to observe the relationship between the different flow rates and the change in head pressure, The experiment was done by using the orifice-meter and hydraulic bench, for the first reading the valve on the hydraulic bench was fully opened and the maximum head pressure was recorded Ho, as well as the head pressure from the jet of water Hcwas measured using a Pitot-tube assembly and finally, for the first reading, the diameter of the jet at vena contractadc was measured. For the rest of the experiment another 8 different runs were taken, and different flow rates were adjusted for different runs. In order to measure the mass flow rate for each run, the time taken for the water to fill the weight tank and raise the weight arm was recorded. The values of Cu, Cc and Cd does not exceed one and that’s because it’s a ratios between the actual values and the ideal values which supposed to be less than 1. Mass flow rate was measured experimentally and theoretically. A graph was drawn to show that the values obtained in the laboratory were close to the theoretical values, even before drawing the graph, that the relationship between the two values is linear since the same value is being compared experimentally and theoretically.

**Objective:**

The purpose of this experiment is to identify the orifice-meter and to measure the discharge, velocity at different flow rates for water through an orifice-meter. To know how to calculate the value of the coefficient of discharge (Cd), the coefficient of contraction (Cc) and the coefficient of velocity (Cu).

**Data and calculation:**

**For part one:**

**(**$ H\_{C}=348mm H\_{o}=385 mm 4 kg d\_{c}=12.mm d\_{o}=13 mm$**)**

**For part two:**

 Table (1) represent the data for part 2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Run | Time(sec) | h0(mm) | q(kg/m3) | Sqrt h | c |
| 1 | 40.97 | 340 | 0.000293 | 0.583095 | 1.257603 |
| 2 | 42.63 | 309 | 0.000281 | 0.555878 | 1.288707 |
| 3 | 44.82 | 282 | 0.000268 | 0.531037 | 1.191418 |
| 4 | 45.37 | 253 | 0.000264 | 0.502991 | 1.241066 |
| 5 | 47.53 | 231 | 0.000252 | 0.480625 | 1.250342 |
| 6 | 50.37 | 204 | 0.000238 | 0.451664 | 1.273784 |
| 7 | 53.53 | 182 | 0.000224 | 0.426615 | 1.292323 |
| 8 | 55.97 | 161 | 0.00214 | 0.401248 | 1.307856 |

**To calculate the coefficient of velocity (Cu):**

$C\_{u}= \frac{u\_{c}}{u\_{o}}= \sqrt{\frac{H\_{c}}{H\_{o}}}$……… (1)

Where:

- Uc: the actual velocity.

- Uo: the ideal velocity.

- Hc: the height of water in the tube using the Pitot tube.

- Ho: the level of water when the overflow is reached.

$$C\_{u}=\sqrt{\frac{H\_{c}}{H\_{o}}}==0.973329$$

**To calculate the coefficient of contraction (Cc):**

$C\_{c}= \frac{a\_{c}}{a\_{o}}$ ….. (2)

Where;

- ac: the cross-section of the vena contract.

- ao: the cross-section of the orifice.

$$C\_{c}=\frac{a\_{c}}{a\_{o}}=\frac{d\_{c}^{2}\_{}}{d\_{o}^{2}}=\frac{12^{2}}{13^{2}}=0.931967$$

**To calculate the coefficient of discharge (Cd):**

$C\_{d}=\frac{Q}{Q\_{o}}= \frac{Q}{\sqrt{2gH\_{o}}×a\_{o}}$……… (3)

Where:

- Q: the actual discharge.

- Qo: the discharge that would take place if the jet discharged at the ideal velocity without reduction of area.

$$C\_{d}=\frac{Q}{Q\_{O}}=\frac{Q}{\sqrt{2gH\_{o }}a\_{o}}=\frac{0.347\*10^{-3}}{0.000133\*\sqrt{2\*9.81\*0.38}}=0.681$$

$C\_{d}= C\_{c}$\* $C\_{u}$= $0.8520$\* $0.955=0.907111$

Figure (1) represent the variation of Q vs $\sqrt{H\_{o}}$

**Discussion of results:**

 In part one of the experiment the value of the coefficient of discharge (Cd), the coefficient of contraction (Cc) and the coefficient of velocity (Cu) was found, and each one of them is less than 1 and that’s because these coefficient s are ratios between the actual value and the ideal value, and because the ideal value is always bigger than the actual value the ratio is less than 1.

It's obvious that the relationship between Q actual and square of root of Ho for sharp orifice " Figure 1" is linear with slope equals to 1.18

 When talking about the errors, we face different types of errors like errors in measuring the time of filling the weight tank, errors in reading the water level in the tubes, errors in the hydraulic bench and the valves.

**Conclusion:**

In this experiment, the flow of fluid through an Orifice Meter was observed. It is clear that the flow of the fluid depends on the diameter of the flow line, in which the average velocity of the flow is reduced when the flow rate or discharge rate is reduced. The reduction of the velocity and discharge rate is a result of the losses in the total energy of the flow due to the collision happening with the orifice wall and also due to friction. These losses depend on the flow rate and on the shape of the orifice edges. Because there are more powerful collision in the sharp edge orifice causing more loss of energy:

From observing the values of Cu, Cc and Cd we found that the value of each one of them does not exceed 1 and that’s because it’s a ratios between the actual values and the ideal values which suppose be to less than one.

The value of the mass flow rate was evaluated experimentally , in the experimental way the mass of water was divided on the time needed to fill the tank.

We faced different types of errors such as: measuring the time of filling the weight tank reading the water level in the tubes and errors in the hydraulic bench and the valves.