

**Faculty of Engineering**

**Mechanical Engineering Department**

**Fluid Mechanics Lab, ENME 312**

**Exp.3**

**“DISCHARGE THROUGH A VENTURI-METER”**

**Dr. mohammad alkaraeen**

**Group Number (#2)**

**Groupmembers:**

**jamal hamad : 1152252**

**sa'id jamjoum : 1152783**

**khalil abu laban :1150521**

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**Abstract:**

 The purpose of this experiment is to identify the venturi-meter and using Bernoulli’s equation and the continuity equation to calculate the values of the volume flow rate and the velocity of the following fluid. And to observe the pressure distribution along the venturi-meter and to compare it with the ideal distribution pressure and use it to observe the effect of changing the cross section area of the pipe on the velocity and the pressure, another aim of the experiment is to know how to calculate the losses in energy along the following pipe using the venturi-meter coefficient. The experiment will be done by using the venturi-meter and a hydraulic bench and make ten different run, for each run the mass flow rate will be measure by using the time needed

to collect the water in the weight tank and to raise the arm of the weight. We will note the principle of continuity.

**Objective:**

 The aim of this experiment is to be familiar with Bernoulli’s equation and the continuity equation. In addition to the pressure distribution along the venturi meter and to compare it with the ideal distribution pressure, and know how to calculate the volume the mass flow rate and the (venturi-meter coefficient) which represent to the amount of losses in energy.

**Useful Equations used in calculation**

Qexp =M/(ρ × t)

Where:

M: Mass = 12 kg, (constant)

T: Time.(sec.)

ρ: Density of water = 1000 kg/m3

c=Qexp/Qtheo

$$Qtheo=Cd a₂\sqrt{\frac{2g(h₁-h₂)}{1-(\frac{a₂}{a₁})\^2}}$$

Where :

Cd = Venturi-meter coefficient.

 Qth: the volume flow rate which is obtained from theories.

 A2: the cross sectional area of section D (2) on the venture-meter.

 g: gravitational attraction= 9.807 m2/s.

 h1: the height of A (1) section of venture-meter.

 h2: the height of D (2) section of venture-meter.

 A1: the cross sectional area of section A (1) on the venture-meter

**Data and Results:**

Table 1: shows the data was taken from exp.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run | TimeSec | hA (1) (mm) | hBmm | hCmm | hD (2) (mm) | hEmm | hFmm | hGmm | hHmm | hJmm | hKmm | hLmm |
| 1 |

|  |
| --- |
| 21.22 |

 | 241 | 225 | 135 | 5 | 31 | 103 | 145 | 172 | 189 | 202 | 209 |
| 2 | 24.52 | 234 |  |  | 10 |  |  |  |  |  |  |  |
| 3 | 27.53 | 217 |  |  | 17 |  |  |  |  |  |  |  |
| 4 | 28.4 | 209 |  |  | 20 |  |  |  |  |  |  |  |
| 5 | 29.28 | 197 | 184 | 119 | 24 | 41 | 95 | 125 | 144 | 157 | 166 | 171 |
| 6 | 31 | 180 |  |  | 28 |  |  |  |  |  |  |  |
| 7 | 32.63 | 166 |  |  | 33 |  |  |  |  |  |  |  |
| 8 | 35.71 | 150 |  |  | 36 |  |  |  |  |  |  |  |
| 9 | 37.76 | 131 |  |  | 39 |  |  |  |  |  |  |  |
| 10 | 47.53 | 105 |  |  | 42 |  |  |  |  |  |  |  |

 Table 2 : shows the data of calculation done in lab (**Results**)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mass f.r** | **Exp Q** | **Theo Q** | **Coeff** | **Sqrt(h1-h2)** |
|  |  |  |  |  |
| 0.565504 | 0.000566 | 0.000468 | 1.209426 | 0.485798 |
|  |  |  |  |  |
| 0.489396 | 0.000489 | 0.000456 | 1.074326 | 0.473286 |
|  |  |  |  |  |
| 0.435888 | 0.000436 | 0.00043 | 1.01265 | 0.447214 |
|  |  |  |  |  |
| 0.422535 | 0.000423 | 0.000418 | 1.00979 | 0.434741 |
|  |  |  |  |  |
| 0.409836 | 0.00041 | 0.0004 | 1.023732 | 0.415933 |
|  |  |  |  |  |
| 0.387097 | 0.000387 | 0.000374 | 1.034976 | 0.388587 |
|  |  |  |  |  |
| 0.36776 | 0.000368 | 0.000351 | 1.047702 | 0.364692 |
|  |  |  |  |  |
| 0.33604 | 0.000336 | 0.000325 | 1.034042 | 0.337639 |
|  |  |  |  |  |
| 0.319149 | 0.000319 | 0.000292 | 1.093198 | 0.303315 |
| 0.252472 | 0.000252 | 0.000242 | 1.045063 | 0.250998 |

Figure(1) Qtheo Vs sqrt(h1-h2)

Figure(2) Coefficient vs Theo Q

**Sample calculation :**

Run #1

m.= mass/time= 12/21.22=0.565504kg/s

$\sqrt{h₁-h₂}$ = 0.485798

$Qtheo=a₂\sqrt{\frac{2g(h₁-h₂)}{1-(\frac{a₂}{a₁})\^2}}$ = $201.1\sqrt{\frac{2\*9.81(241-5)}{1-\left(\frac{201.1}{530.9}\right)^{2}}}=$0.000468

$$u₂=\sqrt{\frac{2g\left(h₁-h₂\right)}{1-\left(\frac{a₂}{a₁}\right)^{2}}}=\sqrt{\frac{2\*9.81\*(182-6)}{1-\left(\frac{201.1}{530.9}\right)^{2}}=}$$

exp. pressure distribution = $\frac{h^{2}-h^{1}}{\frac{u^{2}^{2}}{2g}}=\frac{-176}{\frac{72.58^{2}}{2\*9.81}}=-0.656$

ideal Pressure distribution=$\left(\frac{a₂}{a₁}\right)^{2}- \left(\frac{a₂}{aₙ}\right)^{2}=\left(\frac{201.1}{530.9}\right)^{2}-\left(\frac{201.1}{201.1}\right)^{2}=-$0.6212

**Discussion of results:**

 From table 1 if we compare the value of the head pressure on the inlet and on the throat with the other sections ,we will find that the head pressure on the inlet section is the maximum and on the throat is the min, and it’s refers to the increase of the velocity of the flowing fluid when the cross section area decreases, so since the inlet has the maximum cross section area and the velocity will be min, but the head pressure will be maximum, and for the throat the cross section area is min so the velocity will be max but the head pressure will be min.

 From figure 1 which represent the theoretical values versus the experimental values of the mass flow rate ,and it’s obvious that the values(theoretical, experimental) are close to each other and the relationship between the two values are linear, so when the experimental values of the mass flow rate increases the theoretical value will increase.

From figure 2 it’s obvious that there are no relationship between the Venturi-meter

coefficient C and the experimental value of the mass flow rate, and that’s because C is equals the experimental value over the theoretical value of the mass flow rate and its representing the energy losses in the venturi-meter.

The value of the Venturi-meter coefficient C was found to be almost equals to 1 and that’s proof that the values (theoretical, experimental) of the volume and the mass flow rate both areclose to each other due to accurate measurements we tried to take as possible as we can .

**Conclusion:**

 In this experiment the venturi-meter was based on observations throughout the experiment.

The venturi-meter was used to calculate the discharge of flow fluid and show the distribution pressure on different pipes by changing the cross section area for each pipe, then we conclude that this decrease in pressure difference causes the meter and discharge coefficient to fall as well. Graphical representations show that all variables in this experiment are directly correlated with one another. then calculated them theoretically by using continuity and Bernoulli’s equations by recording time needed to mass of the water through the venturi meters, after plotting the graphs and comparing it with discharge and the theoretical values we show the linear relationship with small differences between the values, so we note that the venturi is an accurate device to measure the flow rate.