Al-Mustaqbal University
College of Engineering and Engineering Technologies
Department of Chemical Engineering and Petroleum Industries

EXPERIMENTS(1)

SECOND CLASS

1 ND SEMESTER

FLUID FLOW LABORATORY

By

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Experiment No. (1): *(Flow Through a Venturi Meter)*

Object of Experiment:

1. Determination of actual and theoretical volumetric flow rate of water.
2. Measurement the Coefficient of discharge

Theory of Experiment:

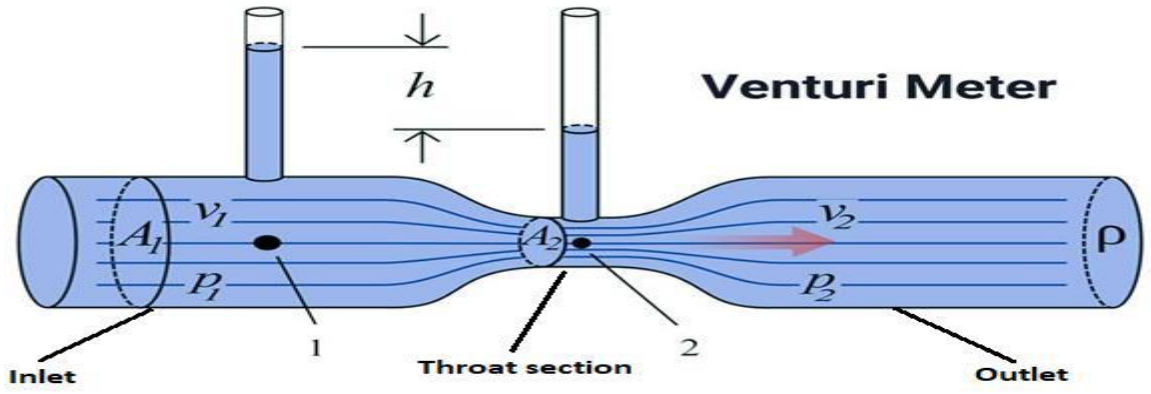
Measuring flow rates through pipes based on the principle of converting energy from one form to another .

Idea of the Experiment:

It relies on the change in cross-sectional area, which affects the values of pressure and velocity and the inverse relationship between them.

Venturi meter:

It is a device used to measure the flow of fluid through pipes. When the fluid passes through a (throat section), its velocity increases and its pressure decreases. This device operates on the principle of Bernoulli's theory and the continuity equation, and the Venturi meter is used in wastewater treatment plants."



من معادلة برنولي :

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

$$h_1 - h_2 = \Delta h = \frac{V_2^2 - V_1^2}{2g} \quad \text{.....Eq 1}$$

من معادلة الاستمرارية :

$$Q_1 = Q_2 \quad \rightleftarrows \quad A_1 V_1 = A_2 V_2$$

$$V_1 = \frac{A_2}{A_1} V_2 \quad \text{..... Eq 2}$$

نضع معادلة Eq 2 في Eq 1 ونحصل على :

$$\Delta h = \frac{1}{2g}\left(V_2^2 - \frac{A_2^2}{A_1^2}\right) \quad \rightleftarrows \quad \Delta h = \frac{V_2^2}{2g}\left(1 - \frac{A_2^2}{A_1^2}\right)$$

$$V_2^2 = \frac{2g\,\Delta h}{\left(1 - \frac{A_2^2}{A_1^2}\right)} \quad \rightleftarrows \quad V_2 = \sqrt{\frac{2g\,\Delta h}{\left(1 - \frac{A_2^2}{A_1^2}\right)}}$$

ومن ثم يمكن التعبير عن التدفق النظري (Q_{theo}) كالاتي:

$$Q_{theo} = A_2 V_2 = A_2 \sqrt{\frac{2g\,\Delta h}{\left(1 - \frac{A_2^2}{A_1^2}\right)}}$$

وبسبب الافتراضات المذكوره أعلاه، فإن معدل التدفق الفعلي(Q_{act}) يختلف عن (Q_{theo}) والنسبة بينهما تسمى معامل التفريغ (التصريف) ، C_d والتي يمكن كتابتها :

$$C_d = \frac{Q_{act}}{Q_{theo}}$$

وتتراوح قيمة معامل التدفق بين (0.96-0.99).

حيث :

C_d : discharge coefficient.

A_1 : Area of inlet.

A_2 : Area of throat.

V_1 : Velocity at point 1.

V_2 : Velocity at point 2.

Z_1: Level at point 1.

Z_2: Level at point 2.

P_1 : Pressure at point 1.

P_2 : Pressure at point 2.

Tools used:

1. Venturi meter.
2. water collection tank.
3. Manometer.

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Calculate :-

1. V
2. C_d

$$Q_{theo} = V = \sqrt{\frac{2\Delta p}{\rho\left[\left(\frac{A1}{A2}\right)-1\right]}}$$

D_1=4cm D_2=2cm

Q_{act} (L/min)	Q_{act} (m^3/s)	Δp (Kg/cm^2)	V (m/s)	Q_{theo} (m^3/s)
30		2.1		
15		1.3		
1		0.01		

Discussion:

1. What is the principle of operation of the Venturi device, and how does it contribute to measuring fluid flow?
2. What are the practical applications in which the Venturi device can be used?
3. What factors can affect the accuracy of the Venturi device's measurements?