VENTURI METER

Fluid Mechanics

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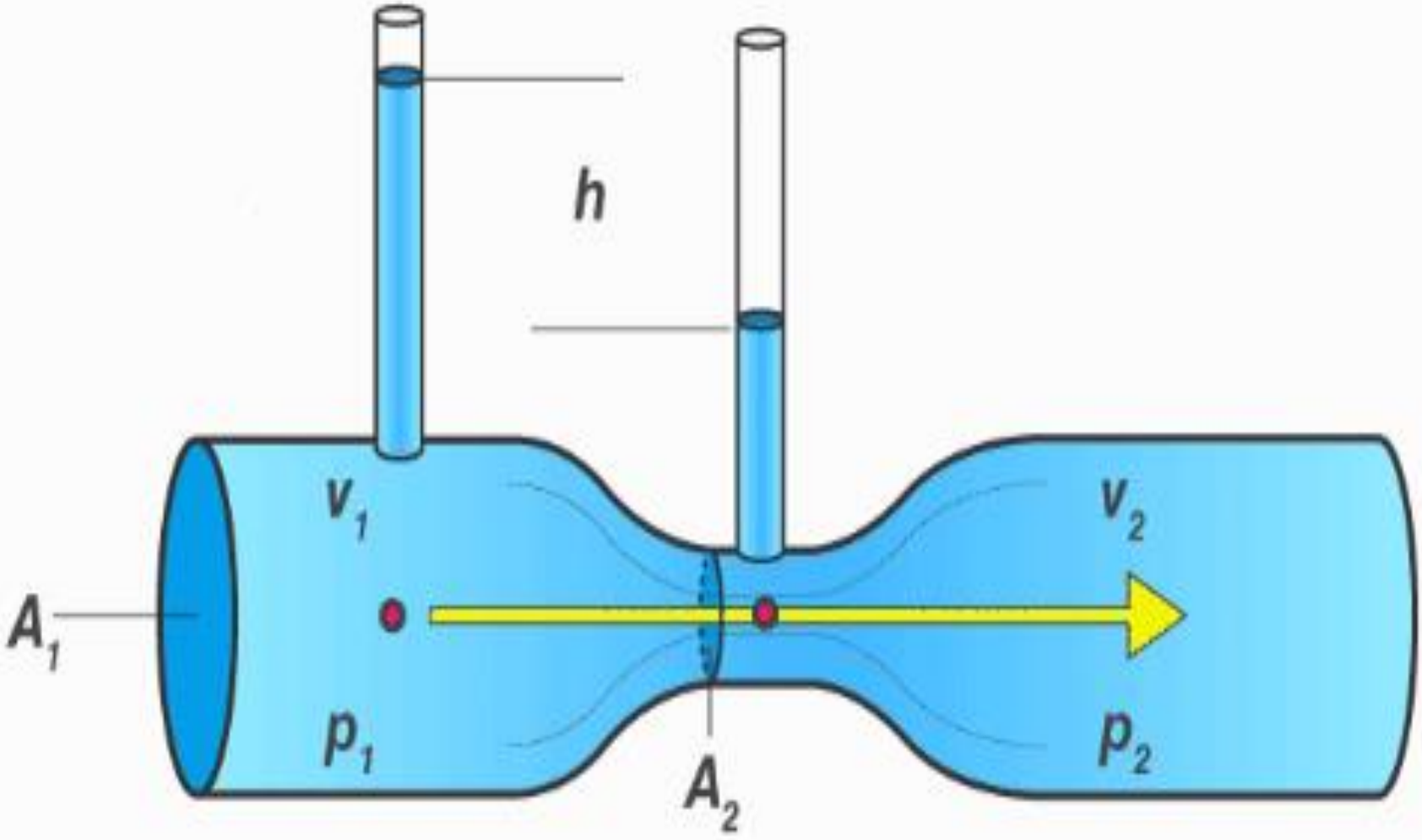
A venturi meter is a measuring or also considered as a meter device that is usually used to measure the flow of a fluid in the pipe. A Venturi meter may also be used to increase the velocity of any type fluid in a pipe at any particular point. It basically works on the principle of Bernoulli's Theorem.

VENTURIMETER



As per the Bernoulli's equation;

$$(P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1) = (P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2)$$

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

or

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g Z_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g Z_2$$

dividing both ρg

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 \quad \text{eqn (i)}$$

For Horizontal Pipe

$$Z_1 = Z_2$$

Therefore eqn (i) will be

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 \quad \text{eqn (i)}$$

For Horizontal Pipe

$$Z_1 = Z_2$$

Therefore eqn (i) will be

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

"or"

$$\frac{P_1}{\rho g} - \frac{P_2}{\rho g} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

$$\frac{P_1}{\rho g} - \frac{P_2}{\rho g} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} \longrightarrow \text{eq(iii)}$$

$\because$ $P_1 = \rho g h_1$ $\qquad$ $P_2 = \rho g h_2$

$\therefore$ $h_1 = \frac{P_1}{\rho g}$ $\qquad$ $h_2 = \frac{P_2}{\rho g}$

Now eq(ii) will be

$$h_1 - h_2 = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

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$$h = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

$$h = \frac{V_2^2 - V_1^2}{2g}$$

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$\because$ $Q_1 = A_1 V_1$ $\qquad$ $Q_2 = A_2 V_2$

$$V_1 = \frac{Q_1}{A_1} \qquad V_2 = \frac{Q_2}{A_2}$$

$$\therefore h = \frac{\left(\frac{Q_2}{A_2}\right)^2 - \left(\frac{Q_1}{A_1}\right)^2}{2g}$$

$$2gh = \frac{Q_2^2}{A_2^2} - \frac{Q_1^2}{A_1^2}$$

$$2gh = Q_2^2 \left[\frac{1}{A_2^2} - \frac{1}{A_1^2}\right]$$

A_1

$$\therefore \quad h = \frac{\left(\frac{Q_2}{A_2}\right)^2 - \left(\frac{Q_1}{A_1}\right)^2}{2g}$$

$$2gh = \frac{Q_2^2}{A_2^2} - \frac{Q_1^2}{A_1^2}$$

$$2gh = Q_2^2 \left[\frac{1}{A_2^2} - \frac{1}{A_1^2}\right]$$

$$2gh = Q^2 \left[\frac{A_1^2 - A_2^2}{A_1^2 A_2^2}\right]$$

$$Q^2 = 2gh \left[\frac{A_1 A_2^2}{A_1^2 - A_2^2}\right]$$

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$$Q = A_1 A_2 \frac{\sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$Q = A_1 A_2 \sqrt{\frac{2gh}{A_1^2 - A_2^2}}$$