APPLICATION ON BERNOULLI EQUATION

PITOT TUBE

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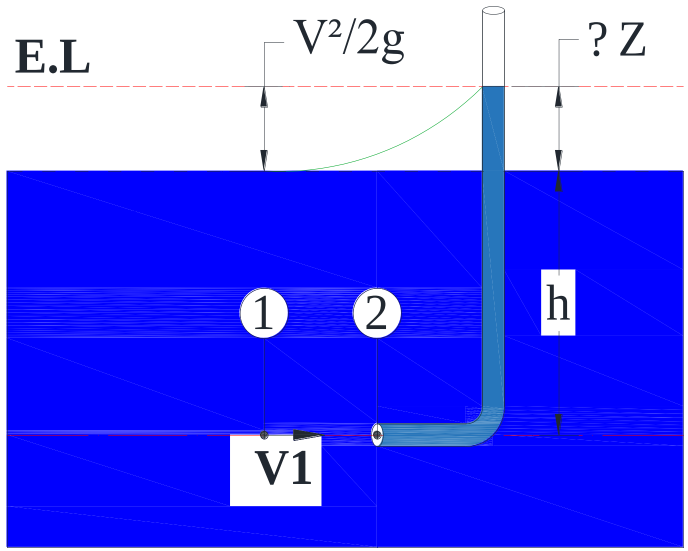
It is a tube with its lower end directed upstream and its other leg vertical and open to the atmosphere.

The impact of liquid against the opening 2, forces liquid to rise in the vertical leg to the height ΔZ above the free surface. Point 2 is a stagnation point, where the velocity of the flow is reduced to zero. This creates an impact pressure called the dynamic pressure, which forces the fluid in to the vertical leg. By writing the energy equation between point 1 and 2, neglecting losses, which are very small.



Pitot tube

Applying Bernoulli equation,

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

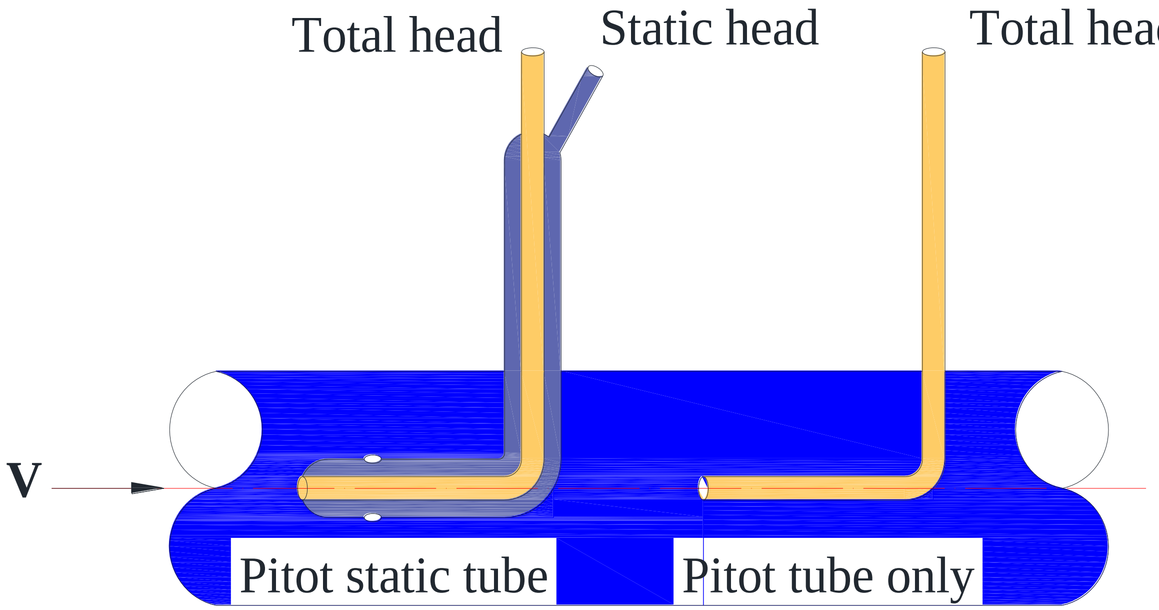
$$\frac{P_1}{\gamma_1} = h, is\ the\ height\ of\ fluid\ above\ point\ 1\ static\ pressure.$$

$$\frac{P_2}{\gamma_2} = h + \Delta Z, is\ the\ manometer\ readin = h + \Delta Z. pitot\ pressure.$$

$$0 + h + \frac{V_1^2}{2g} = 0 + (\Delta Z + h) + 0$$

$$\Delta Z = \frac{V_1^2}{2g} \Rightarrow \boldsymbol{V_1 = \sqrt{2g\ \Delta Z}}$$

Note: Pitot tube used to determine the velocity of liquid at point 1.



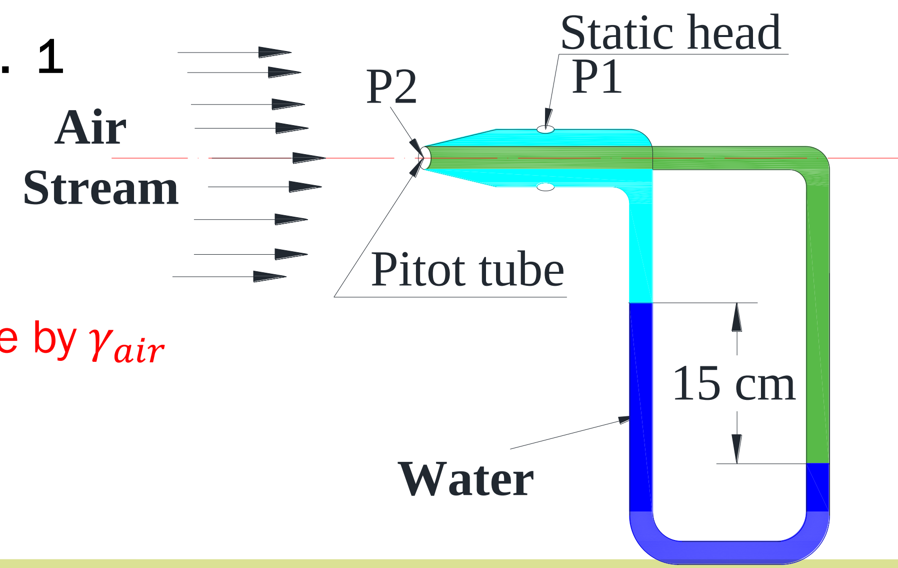
A Pitot-static tube is a device for measuring the velocity of moving fluids or of the velocity of bodies moving through fluids. It consists of one tube, called the Pitot tube, with an open end facing the direction of the fluid motion, shown in fig. above and a second tube, called the static tube, with the opening at 90° to the fluid flow, shown as T in fig. Pressure is recorded by a pressure gauge moving with the flow, static or stationary relative to the fluid. This is called static pressure and connecting a pressure gauge to a small hole in the wall of a pipe, is the easiest method of recording this pressure.

Example: This pitot static tube is carefully aliened with an air stream of density 1.23 kg/m3. If the attached differential manometer shows a reading of 15 cm of water, what is the velocity of the air stream ?

Solution:-

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

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} \quad \Rightarrow \quad \left[\frac{V_1^2}{2g} = \frac{P_2}{\gamma_{air}} - \frac{P_1}{\gamma_{air}}\right] \quad .... \; 1$$



From closed manometer:

$$P_2 + \gamma_{air} * 0.15 - \gamma_{water} * 0.15 = P_1$$

$$[P_2 - P_1 = \gamma_{water} * 0.15 - \gamma_{air} * 0.15]$$ divide by γ_{air}

$$\frac{P_2 - P_1}{\gamma_{air}} = \frac{9806}{1.23 \; * 9.806} * 0.15 - 0.15$$

$$\left[\frac{P_2 - P_1}{\gamma_{air}} = 121.9512 - 0.15\right] \quad ......2$$

V_2^2= 2*9.806 *121.8012 $\quad \Rightarrow \quad \boldsymbol{V_1 = 48.875 \, m/sec}$