Measurement of Pressure, Velocity, and Volume Flow Rate by Using Pressure Transmitter and Inclined Manometer

ME 316 MECHANICAL ENGINEERING LABORATORY

Mechanical Engineering
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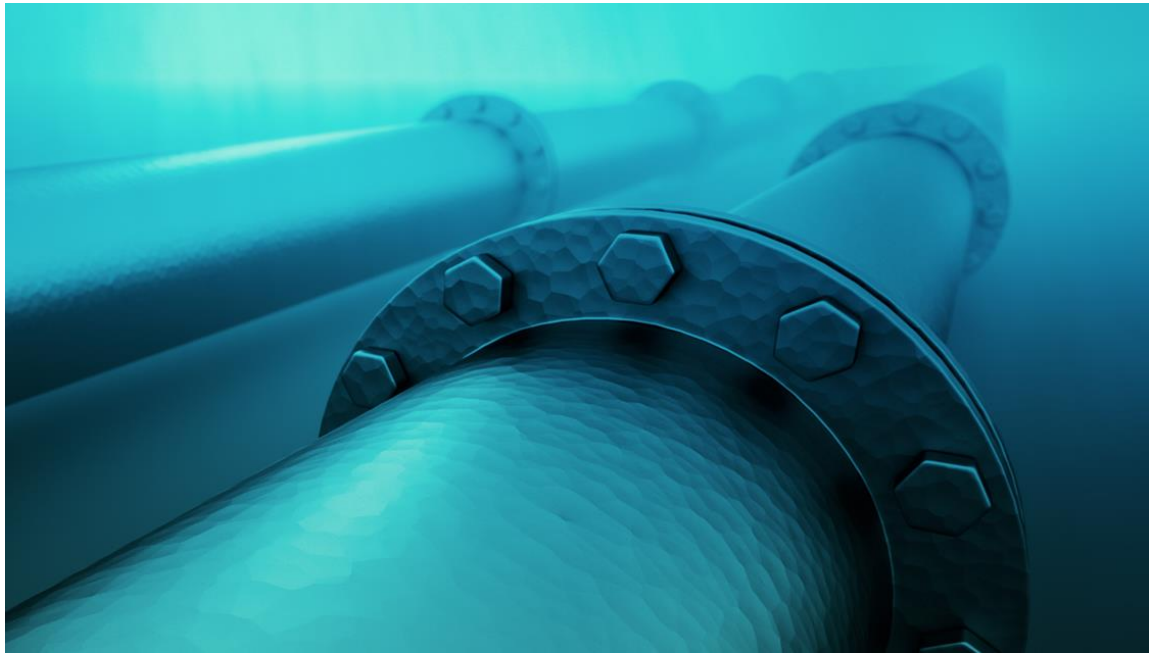
Importance of Measurement of Fluid Pressure



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Common Pressure Measurement Test Devices

- Barometer
- Piezometer
- Manometer
- Bourdon Gauge
- Pressure Gauge Diaphragm

- Hydrostatic Test System

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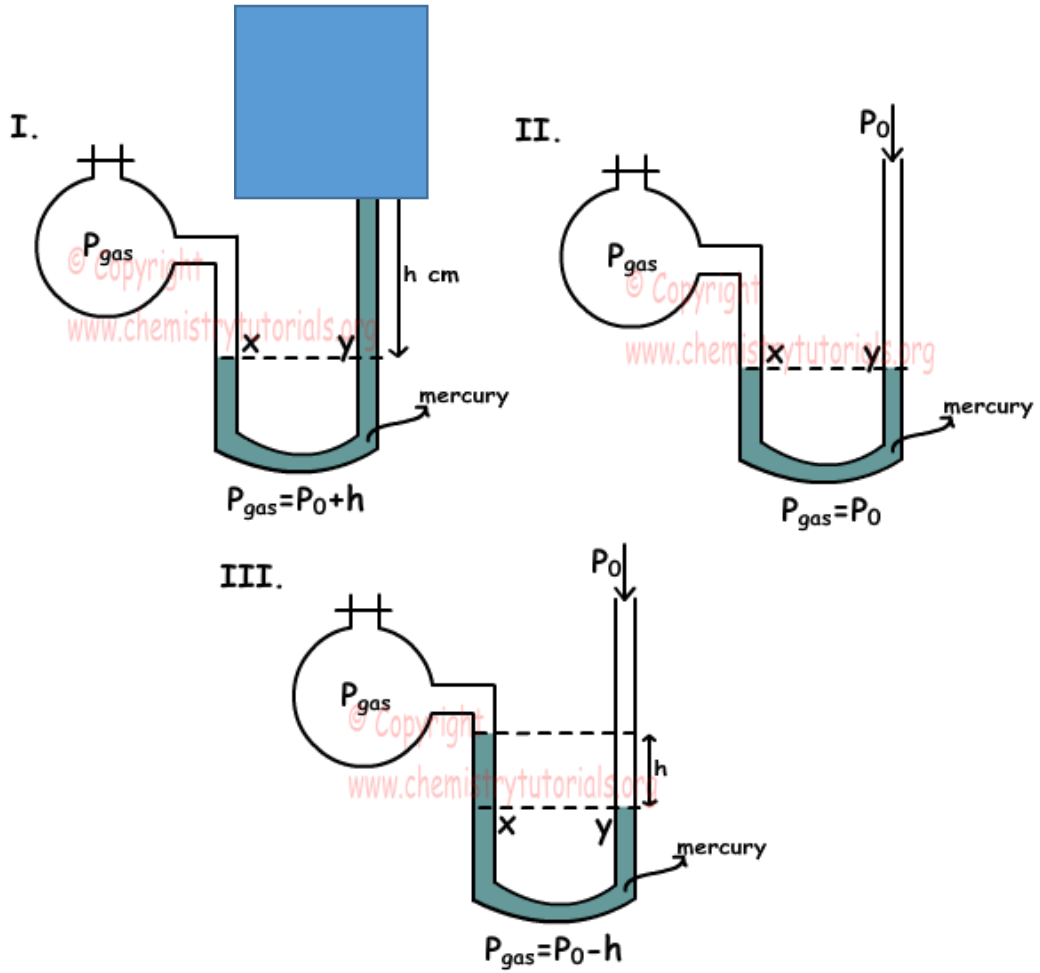
Manometers

- It is a widely used device for measurement of fluid pressure under steady state and laboratory conditions.
- This method involves balancing the unknown pressure against the pressure produced by a fluid column of known density.
- The manometer gives directly the gauge pressure.
- In order to improve the resolution on very low-pressure manometers, the indicating tube is inclined to cause a greater linear movement than a vertical tube.



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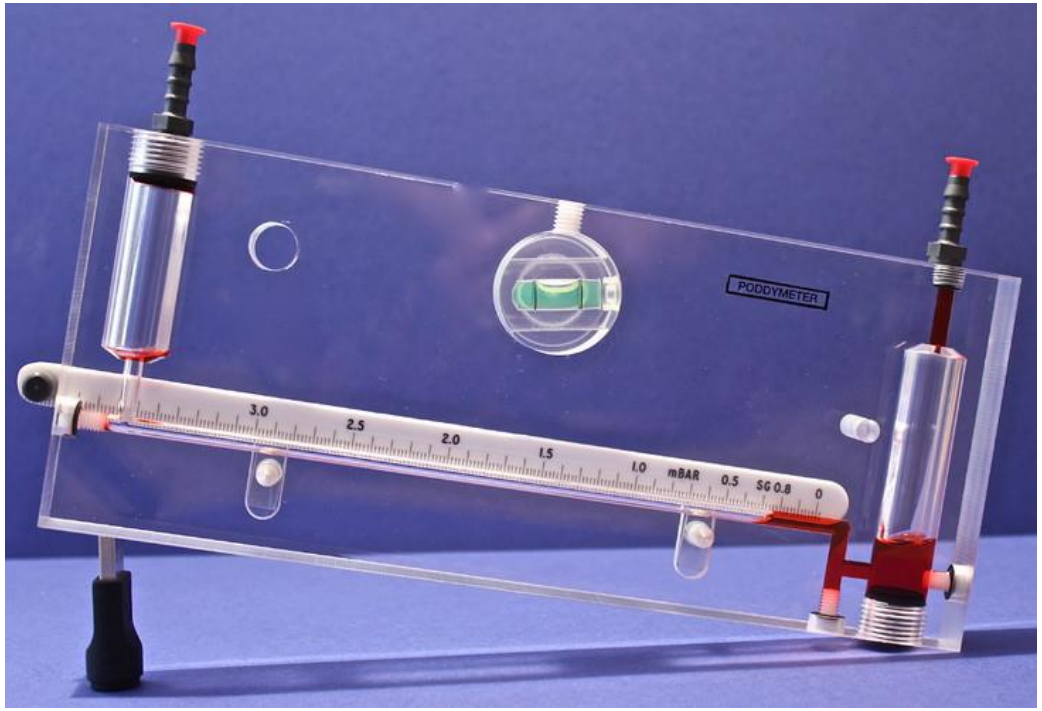
Inclined Manometers

- Many applications require accurate measurement of low pressure such as drafts and very low differentials.
- The inclined manometer is essential for retaining the most accurate pressure levels for industrial gas applications.
- A low-pressure industrial gas system may be used to heat or cool manufacturing processes. A small blockage within the gas system can be detected with an inclined manometer and corrected.



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Inclined Manometers

$$A_1.x = A_2.d$$

$$x = \frac{A_2}{A_1}.\mathrm{d} \quad (1)$$

$$\sin\Theta = \frac{y}{d}$$

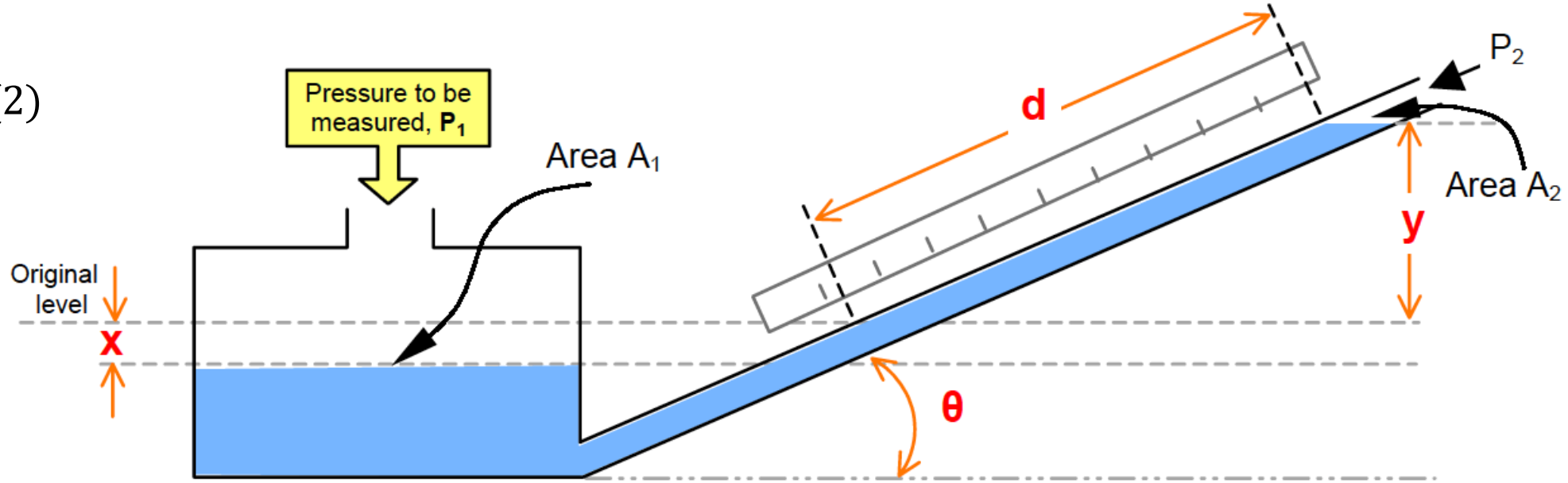
$$y = d.sin\Theta \quad (2)$$

$$P_1 - P_2 = \rho.g.(x+y)$$

$$\text{By using (1)} = \rho.g.(\frac{A_2.d}{A_1} + y)$$

$$\text{By using (2)} = \rho.g.(\frac{A_2.d}{A_1} + \mathrm{d}.\sin\Theta)$$

$$= \rho.g.d(\frac{A_2}{A_1} + sin\Theta)$$



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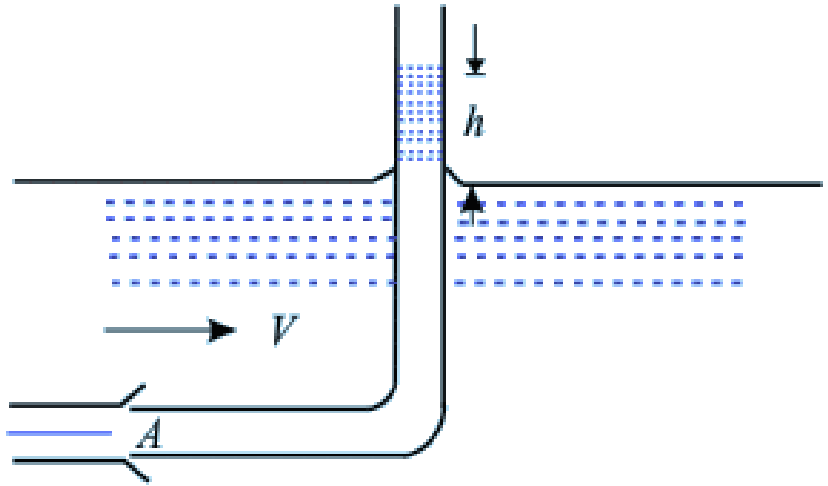
Pitot Tube

- A right angled glass tube, large enough for capillary effects to be negligible, is used for the purpose.



- One end of the tube faces the flow while the other end is open to the atmosphere as shown in Figure.

- The liquid flows up the tube and when equilibrium is attained, the liquid reaches a height above the free surface of the water stream.

- Since the static pressure, under this situation, is equal to the hydrostatic pressure due to its depth below the free surface, the difference in level between the liquid in the glass tube and the free surface becomes the measure of dynamic pressure.

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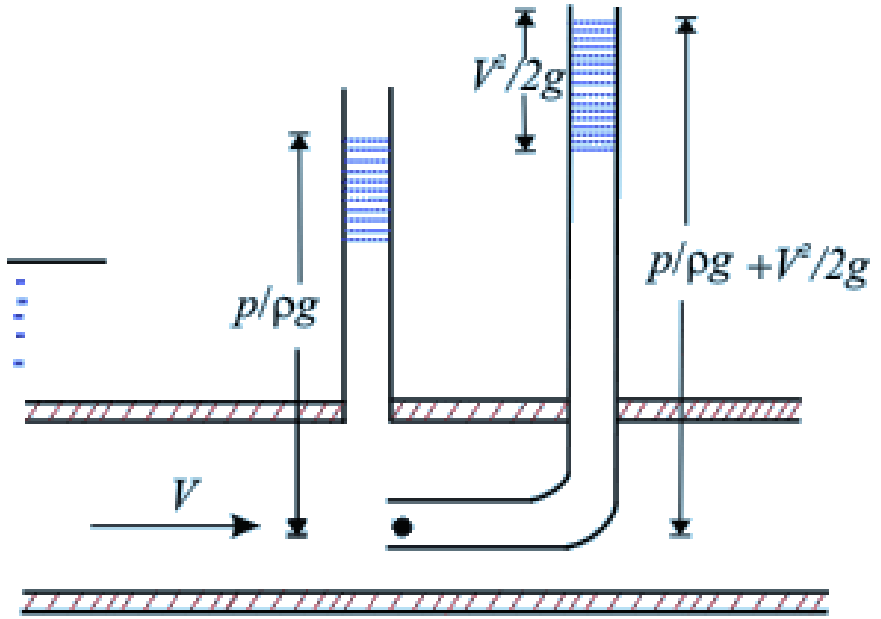
Pitot Tube

- For an open stream of liquid with a free surface, this single tube is sufficient to determine the velocity.

- But for a fluid flowing through a closed duct, the Pitot tube measures only the stagnation pressure and so the static pressure must be measured separately.

- Measurement of static pressure in this case is made at the boundary of the Wall.



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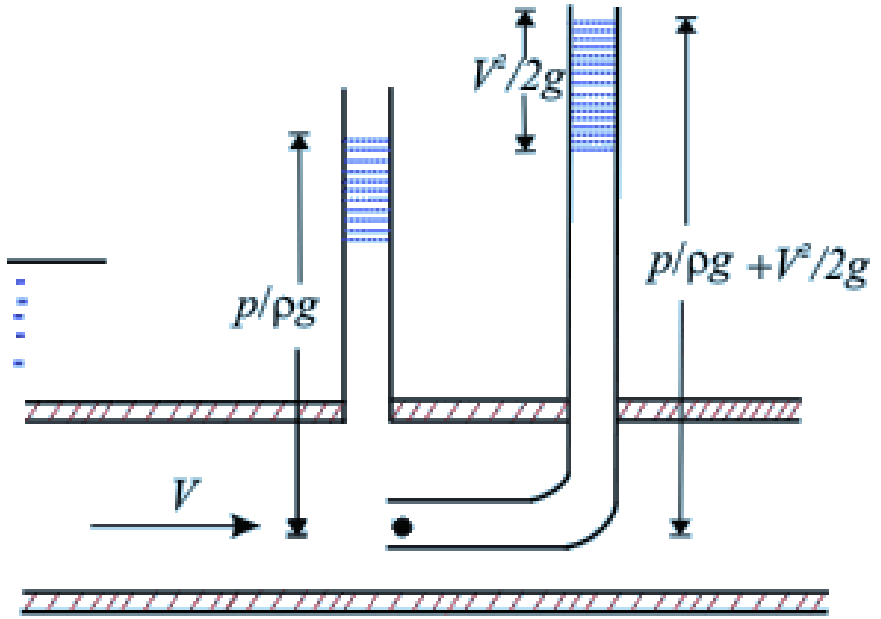
Pitot Tube

- The axis of the tube measuring the static pressure must be perpendicular to the boundary and free from burrs, so that the boundary is smooth and hence the streamlines adjacent to it are not curved.
- This is done to sense the static pressure only without any part of the dynamic pressure.
- A Pitot tube is also inserted as shown in Figure on the right side to sense the stagnation pressure.
- The ends of the Pitot tube, measuring the stagnation pressure, and the piezometric tube, measuring the static pressure, may be connected to a suitable differential manometer for the determination of flow velocity and hence the flow rate.



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Aim of The Experimentation

- The object of this experiment is to measure the static pressure loss by using the static pressure tappings and the flow rate by using the pitot tube and static pressure tapping combination in a circular pipe in which air flows.
- In order to determine the flow rate the local air velocities are measured by traversing the pitot tube across the cross-scection of the pipe.
- Also, the inclined well type alcohol manometers will be used to read sensed pressure magnitudes by the static pressure tappings and pitot tube.

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