M E 345

Today, we will:

- Finish the pdf module: Linear Velocity Measurement and do some example problems
- Additional notes: hydraulic jacks, tire gages, strain gage pressure cells

Pressure Measurement in Moving Fluids

We define three types of pressure used in moving fluids:

- Stagnation pressure P_{stag} = pressure at a stagnation point where the velocity is slowed down to zero nearly isentropically. This is the pressure at the *nose* (*stagnation point*) of a probe in the flow.
- Static pressure P = pressure that would be measured by an infinitesimal pressure sensor moving with the flow. This is the pressure upstream of a probe in the flow.

It turns out that the pressure at point 2 in the sketch below is approximately equal to the static pressure, since the velocity at point 2 is approximately equal to V and the streamlines are straight (not curved, which leads to pressure changes) at point 2.

• **Dynamic pressure** $\rho V^2/2$ = difference between stagnation and static pressure = $P_{\text{stag}} - P$. This is the "extra" pressure that is felt at the stagnation point at the nose of a probe in the flow.



We combine these definitions in a practical application – measurement of velocity.

Example: Velocity measurement

Given: A Pitot-static probe is placed in an air jet to measure the air speed. The differential pressure is measured with a U-tube manometer that uses mercury ($\rho = 13,600 \text{ kg/m}^3$) as the manometer fluid. The difference in column height between the two legs of the manometer is h = 1.20 cm. The air density is 1.204 kg/m³.

To do: Calculate the air speed at the location of the Pitot-static probe.

Solution:



Additional Notes: Hydraulic Jack (how does it work?)



Example: Pressure measurement and hydrostatics

Given: A hydraulic jack is constructed with the large piston diameter equal to 25.4 cm (10 inch) and the small piston diameter equal to 0.635 cm (1/4 inch).

To do: How much weight (in lbf) can a person lift with the jack if he exerts a force of 20.0 lbf on the small piston? *Give your answer to three significant digits*.

Solution:



