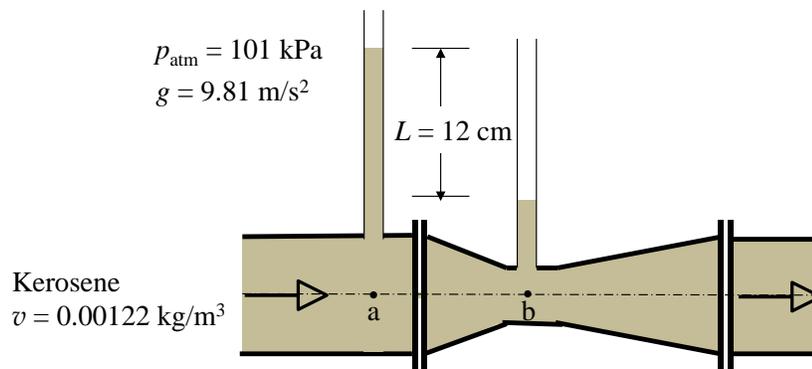


1.29 Liquid kerosene flows through a Venturi meter, as shown in Fig. P1.29. The pressure of the kerosene in the pipe supports columns of kerosene that differ in height by 12 cm. Determine the difference in pressure between points a and b, in kPa. Does the pressure increase or decrease as the kerosene flows from point a to point b as the pipe diameter decreases? The atmospheric pressure is 101 kPa, the specific volume of kerosene is $0.00122 \text{ m}^3/\text{kg}$, and the acceleration of gravity is $g = 9.81 \text{ m/s}^2$.

KNOWN: Kerosene flows through a Venturi meter.

FIND: The pressure difference between points a and b, in kPa and whether pressure increases or decreases as the kerosene flows from point a to point b as the pipe diameter decreases.

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL:

1. The kerosene is incompressible.
2. Atmospheric pressure is exerted at the open end of the fluid columns.

ANALYSIS:

Equation 1.11 applies to both columns of fluid (a and b). Let h_b be the height of the fluid above point b. Then $h_b + L$ is the height of the fluid above point a. Applying Eq. 1.11 to each column yields

$$p_a = p_{\text{atm}} + \rho g(h_b + L) = p_{\text{atm}} + \rho g h_b + \rho g L$$

and

$$p_b = p_{\text{atm}} + \rho g h_b$$

Thus, the difference in pressure between point a and point b is

$$\Delta p = p_b - p_a = (p_{\text{atm}} + \rho g h_b) - (p_{\text{atm}} + \rho g h_b + \rho g L)$$

$$\Delta p = -\rho g L$$

Density of kerosene is the reciprocal of its specific volume

$$\rho = 1/v = 1/0.00122 \text{ m}^3/\text{kg} = 820 \text{ kg/m}^3$$

Solving for the difference in pressure yields

$$\Delta p = -\left(820 \frac{\text{kg}}{\text{m}^3}\right)\left(9.81 \frac{\text{m}}{\text{s}^2}\right)(12 \text{ cm}) \left| \frac{1 \text{ N}}{1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}} \right| \left| \frac{1 \text{ m}}{100 \text{ cm}} \right| \left| \frac{1 \text{ kPa}}{1000 \frac{\text{N}}{\text{m}^2}} \right| = \underline{\underline{-0.965 \text{ kPa}}}$$

Since points a and b are at the same elevation in the flow, the difference in pressure is indicated by the difference in height between the two columns. **The negative sign indicates pressure decreases as the kerosene flows from point a to point b as the pipe diameter decreases.**