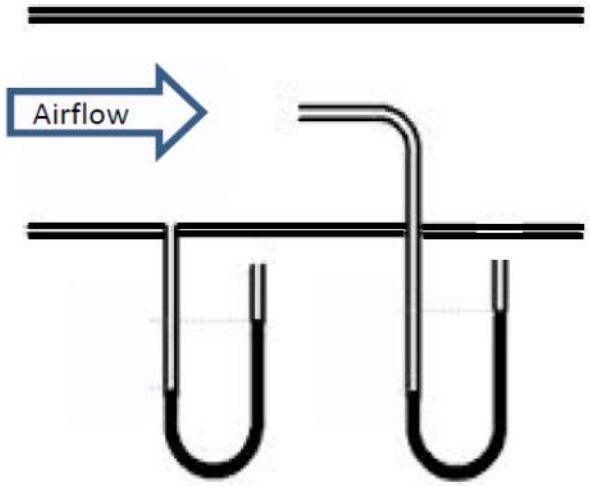
The static pressure head in an air pipe is measured with piezometer as 12 mm of water ($\rho_W = 1{,}000\ \text{kg/m}^3$). A Pitot-probe indicates 20 mm of water. Calculate the velocity of the 20°C air ($R = 287\ \text{J/kgK}$, $k = 1.4$). Also calculate the Mach number and comment as to the compressibility of the flow.



$$p_1 = \gamma_W h_1 = 9{,}810 \times 0.012 = 118\ \text{Pa}$$

$$p_2 = \gamma_W h_2 = 9{,}810 \times 0.02 = 196\ \text{Pa}$$

$$\rho_A = \frac{p_1}{RT} = \frac{118}{287 \times (20 + 273)} = 1.2\ \text{kg/m}^3$$

$$v_1 = \sqrt{\frac{2}{\rho}(p_2 - p_1)} = \sqrt{\frac{2}{1.2} \times (196 - 118)} = 11.5\ \frac{\text{m}}{\text{s}}$$

$$c = \sqrt{kRT} = \sqrt{1.4 \times 287 \times 293} = 343\ \frac{\text{m}}{\text{s}}$$

$$M = \frac{v_1}{c} = \frac{11.5}{343} = 0.033$$

If $M < 0.3$, density variations are at most 3% and the flow is assumed to be incompressible; for standard air this corresponds to a velocity below about 100 m/s. If $M > 0.3$, the density variations influence the flow and compressibility effects should be accounted for.