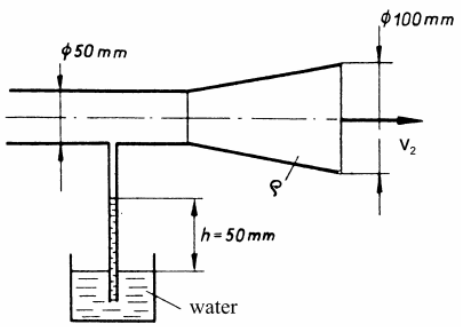
Air, having a density of ρ, flows through an air duct, shown in the image. The axis of the pipe is horizontal. The air duct has a diameter d_1, and there is a diffuser before the outlet. The outlet has a diameter d_2. On the first section, a small pipe is connected to a pressure tap, and the pipe is led to a vessel filled with water of density ρ_w. (This way, the pipe and the vessel function as a manometer.) In the pipe, the water column reaches a height of h.

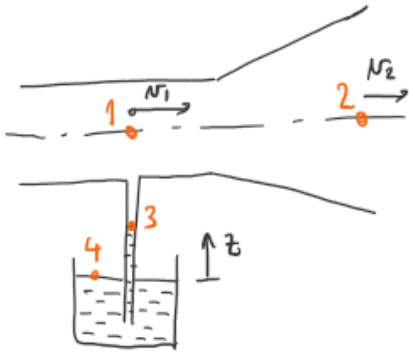


ASSIGNMENTS

What is the velocity at the outlet?

DATA

$\rho = 1.2\ kg/m^3$, $d_1 = 50\ mm$, $d_2 = 100\ mm$, $\rho_w = 1000\ kg/m^3$, $h = 50\ mm$



HE 4-3

$p_4 + \rho_w v_4 = p_3 + \rho_w v_3$

$p_4 = p_0$, $v_4 = g \cdot 0$, $v_3 = gh$

open surface

$p_3 = p_0 - \rho_w g h \approx p_1$

↑ the difference between the pressure at 1 and 3 is negligibly small!

BE 1-2

$v_1^2 = \left(\frac{A_2}{A_1} v_2\right)^2$ Cont.

$p_1 + \rho \frac{v_1^2}{2} + \rho v_1 = p_2 + \rho \frac{v_2^2}{2} + \rho v_2$

$v_1 = gz_1$, $p_2 = p_0$ free jet, $v_2 = gz_2$, $z_1 = z_2$

$\frac{\rho}{2}\left[\left(\frac{A_2}{A_1}\right)^2 - 1\right] v_2^2 = -p_1 + p_0 = -p_0 + \rho_w g h + p_0$

$\left(\frac{A_2}{A_1}\right)^2 = \left(\frac{d_2^2}{d_1^2}\right)^2$

$$v_2 = \sqrt{\frac{\frac{2}{\rho}\rho_w g h}{\left(\frac{d_2}{d_1}\right)^4 - 1}} = 7.45\ \frac{m}{s}$$