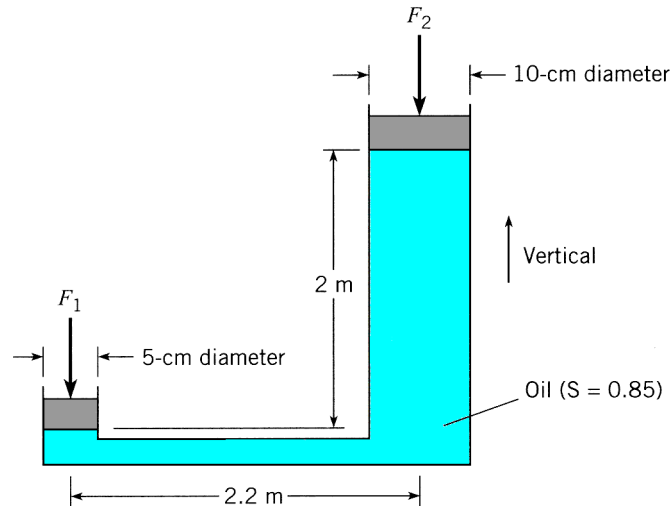


HYDROSTATICS

Example Problem: Pascal's Law

Find the magnitude of the force F_2 that can be resisted by the large piston in this hydraulic-lift device, if a 100 N force (F_1) is applied on the small piston.



Assumptions

The weight of the pistons will be neglected.

Solution

This problem illustrates Pascal's principle. A force applied on the first piston translates into a pressure increase in the fluid underneath this piston. This pressure increase, according to Pascal's law, is felt equally at every point in the fluid, including the points underneath the second piston (adjusted, of course, for the fact that the second piston is higher in the fluid than the first piston). Since the area of the second piston is larger, this pressure will translate into a larger force on that piston (force = pressure x area).

Starting with the hydrostatic equation:

$$\frac{dp}{dz} = -g \Rightarrow \frac{p_2 - p_1}{\Delta z_{12}} = -g_{oil} \Rightarrow p_2 = p_1 - g_{oil} \Delta z_{12} \quad (1)$$

where p_1 and p_2 are the pressures underneath pistons 1 and 2 respectively.
Now,

$$p_1 = \frac{F_1}{A_1} = \frac{100}{\frac{\pi}{4} (0.05)^2} = 50.929 \text{ kPa} \quad (2)$$

and $\mathbf{g}_{OIL} = S_{OIL}\mathbf{g}_{H_2O} = 0.85 \times 9,810 = 8,338.5 \text{ N} / \text{m}^3$ (3)

Solving eq.(1) for p_2 we get $p_2 = 34.25 \text{ kPa}$

So,

$$F_2 = p_2 A_2 = 34,250 \times \frac{\mathbf{p}(0.1)^2}{4} = 269 \text{ N}$$