# Answer on Question #39754, Engineering, Other

## Question

Olive oil with a density of 830 kg/$m^3$ ,in a food factory needs to be pumped in a 30 mm diameter pipe to a tank 10 m above the pump with a rate of 18 $m^3$/hr. The depth of fluid in the tank is 2.75 m, what pressure must be added to lift the oil to the upper tank.

Friction losses as 5kpa using this equation

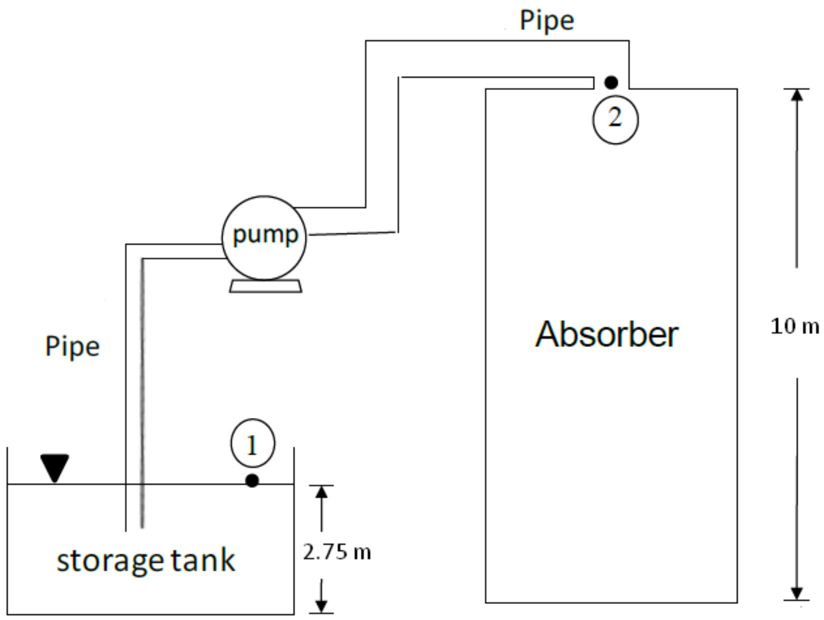
$$P_1 + \frac{\rho v_1^2}{2} + \rho g h_1 + \Delta P_e = P_2 + \frac{\rho v_2^2}{2} + \rho g h_2 + \Delta P_f$$

## Solution

The Bernoulli equation states that,

$$P \quad + \frac{\rho v^2}{2} + \rho g h \quad = constant$$

In the above equation, P is pressure, which can be either absolute or gage, but should be in the same basis on both sides, ρ represents the density of the fluid, assumed constant, v is the velocity of the fluid at the inlet/outlet, and h is the elevation about a datum that is specified.




We use location 1 for “in” and location 2 for “out.”

We have Bernoulli equation

$$P_1 + \frac{\rho v_1^2}{2} + \rho g h_1 + \Delta P_e = P_2 + \frac{\rho v_2^2}{2} + \rho g h_2 + \Delta P_f$$

Now list all the known information at the two locations.

$P_1$ = 0 gage (Open to atmosphere)

$v_1$ = 0 (Large cross-sectional area)

$h_1$ = 0 (By choice of datum)

From the given discharge rate Q = 18 $m^3$/hr = 18/3600 $m^3$/s and the diameter of the pipe d = 30 mm at the upper tank inlet, we can calculate $v_2$.

$$Q = v_2 A = v_2 \frac{\pi d^2}{4}$$

$$v_2 = \frac{4Q}{\pi d^2}$$

where A is cross sectional area of a pipe

$$v_2 = \frac{4Q}{\pi d^2} = \frac{4 \cdot 18}{3.14 \cdot (30 \cdot 10^{-3})^2 \cdot 3600} = 7.08 \text{ m/s}$$

p = 0 gage (Absorber is at atmospheric pressure)

$v_2$ =7.08 m/s (from specified data)

$h_2$ = 10 - 2.75 = 7.25 m (specified)

Substituting some of the known information into the above equation, we obtain

$$0 + \frac{\rho \cdot 0}{2} + \rho g \cdot 0 + \Delta P_e = 0 + \frac{\rho v_2^2}{2} + \rho g h_2 + \Delta P_f$$

$$\Delta P_e = \frac{\rho v_2^2}{2} + \rho g h_2 + \Delta P_f$$

$$\Delta P_e = \frac{830 \cdot 7.08^2}{2} + 830 \cdot 9.81 \cdot 7.25 + 5 \cdot 10^3 = 84834.1 \text{ Pa} = 84.8 \text{ kPa}$$

**Answer.** $\Delta P_e = 84.8 \text{ kPa}.$