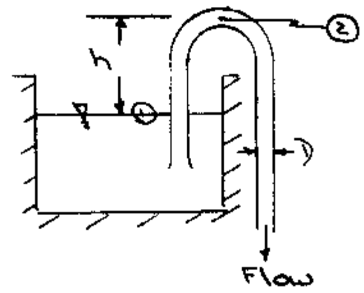
Given: Water flow through siphon as shown

$Q = 0.03\ m^3/sec$, $T = 20°C$, $D = 75\ mm$



Find: Maximum allowable height, h, such that P_2 is above the vapor pressure of the water

Solution: Apply the Bernoulli equation along the streamline between locations 1 and 2 to determine h after employing the definition of volume flowrate to determine the flow speed in the tube

Basic equations: $Q = \int \vec{V} \cdot d\vec{A}$ (Q is volume flow rate)

$$\frac{P_1}{\rho} + \cancel{\frac{V_1^2}{2}}^{\approx 0(6)} + \cancel{g z_1}^{0(5)} = \frac{P_2}{\rho} + \frac{V_2^2}{2} + g z_2$$

Assumptions:
(1) steady flow
(2) incompressible flow
(3) frictionless flow
(4) flow along a streamline
(5) $z_1 = 0$
(6) $V_1 \approx 0$
(7) uniform flow in the tube

From the definition of Q and assumption 7, $Q = V_2 A_2$, and

$$V_2 = \frac{Q}{A_2} = \frac{4Q}{\pi D_2^2} = \frac{4}{\pi} \times 0.03\,\frac{m^3}{s} \times \frac{1}{(75 \times 10^{-3})^2\, m^2} = 6.79\ m/s$$

From the Bernoulli equation,

$$h = z_2 = \frac{1}{g}\left[\frac{P_1 - P_2}{\rho} - \frac{V_2^2}{2}\right]$$

For water at 20°C, $P_{vapor} = P_2 = 2.33\ kPa$. Then

$$h = \frac{1}{g}\left[\frac{P_1 - P_2}{\rho} - \frac{V_2^2}{2}\right] = \frac{s^2}{9.81\,m}\left[(101 - 2.33) \times 10^3\,\frac{N}{m^2} \times \frac{m^3}{999\,kg} \times \frac{kg \cdot m}{N \cdot s^2} - \frac{1}{2} \times (6.79)^2\,\frac{m^2}{s^2}\right]$$

$h = 7.72\ m$ — h