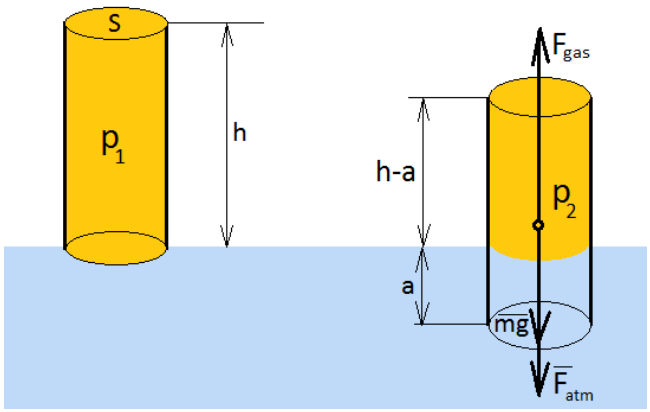
A thin walled cylinder of mass m height h and cross section area S is filled with gas and floats on the surface of water. As a result to leakage from lower part of cylinder the depth of its submergence has increased by a. Determine the initial pressure x in cylinder if initial atm pressure is p atm.

Solution:

Connection between the pressures p1 and p2 ($p_1 = p_{initial}$ - pressure before entering water, p_2 - pressure after entering water).



Mendeleev-Clapeyron equation for gas in the first and in the second case:

$$p_1V = vRT; V = h * S\ (1)$$

$$p_2V = vRT; V = (h-a) * S\ (2)$$

$$(1) = (2):\ p_1h = p_2(h-a)$$

$$p_2 = p_1\left(\frac{h}{h-a}\right)\ (2')$$

Newton's second law for the cylinder:

$$F_{atm} + mg - F_{gas} = 0\ (3)$$

$$F_{atm} = p * S\ (4)$$

$$F_{gas} = p_2S\ (5)$$

$$(2')\ and\ (5) and\ (4)\ in\ (3): pS + mg - p_1\left(\frac{h}{h-a}\right)S = 0$$

$$p_1\left(\frac{h}{h-a}\right) = \frac{mg}{S} + p$$

$$p_1 = \frac{\frac{mg}{S} + p}{\frac{h}{h-a}} = (\frac{mg}{S} + p)(1 - \frac{a}{h})$$

Answer: initial pressure $p_1 = x = \left(\frac{mg}{S} + p\right)\left(1 - \frac{a}{h}\right)$.