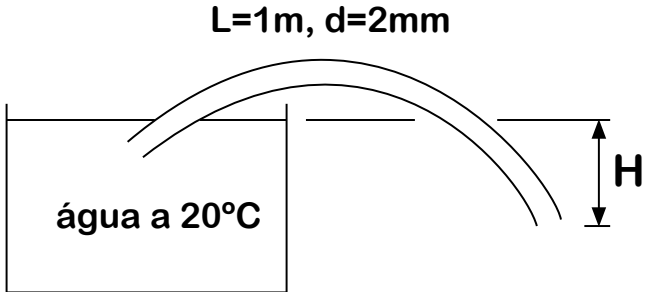
Exercício para a entrega referente à aula de Escoamento Interno - I

Água a 20ºC será sifonada por um tubo com 1 m de comprimento e 2 mm de diâmetro, conforme figura. Qual a altura H máxima possível para que o escoamento seja laminar. Calcule a vazão para H = 50 cm. Despreze o efeito da curvatura do tubo.



SOLUÇÃO

Solution: For water at 20°C, take $\rho = 998$ kg/m^3 and $\mu = 0.001$ kg/m•s. Write the steady flow energy equation between points 1 and 2 above:

$$\frac{p_{atm}}{\rho g} + \frac{0^2}{2g} + z_1 = \frac{p_{atm}}{\rho g} + \frac{V_{tube}^2}{2g} + z_2 + h_f \text{ , or: } H - \frac{V^2}{2g} = h_f = \frac{32\mu L}{\rho g d^2} V \quad (1)$$

$$\text{Enter data in Eq. (1): } 0.5 - \frac{V^2}{2(9.81)} = \frac{32(0.001)(1.0)\ V}{(998)(9.81)(0.002)^2} \text{ , solve } V \approx 0.590 \frac{m}{s}$$

Equation (1) is quadratic in V and has only one positive root. The siphon flow rate is

$$Q_{H=50\,cm} = \frac{\pi}{4}(0.002)^2(0.590) = 1.85E\text{-}6 \frac{m^3}{s} \approx \mathbf{0.00667} \frac{\mathbf{m^3}}{\mathbf{hr}} \quad \textit{Ans.}$$

Check Re = (998)(0.590)(0.002)/(0.001) ≈ 1180 (OK, laminar flow)

It is possible to approach Re ≈ 2000 (possible transition to turbulent flow) for H < 1 m, for the case of the siphon bent over nearly vertical. We obtain Re = 2000 at **H ≈ 0.87 m**.