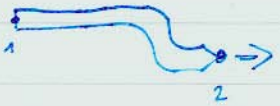
3-9

$d = 240\ mm$ $\quad \Delta p_1 = 20\ kPa$ $\quad d_2 = 80\ mm$, $\quad \Delta h = -60\ m$, $\quad \Delta p_2 = -9.81\ kPa$



$V_1 = V \qquad V_2 = V_1 \cdot \frac{A_1}{A_2} \qquad \frac{A_1}{A_2} = \frac{240^2}{80^2} = 3^2 = 9$

$p_1 = p_{atm} + 20\ kPa \qquad p_2 = p_{atm} - 9.81\ kPa \qquad \rho = 999.54\ kg/m^3$

$h_1 = 0 \qquad h_2 = -60\ m \qquad \eta = 1.234 \cdot 10^{-3}\ Pa \cdot s$

$$\frac{p_1}{\rho} + \frac{V_1^2}{2} + h_1 g + e_c = \frac{p_2}{\rho} + \frac{V_2^2}{2} + h_2 g + e_{dis}$$

$$\frac{29.81}{0.99954} + 60 \cdot 9.81 + \frac{v^2 - (v9)^2}{2} \text{ reais} = e_{dis}$$

a) $\quad 618{,}4237 + -40\,v^2 = 0$

$v = 3.93\ m/s \qquad V_2 = 35.39\ m/s$

b) $\quad e_{bis} = \left(\lambda \cdot \frac{L + L_{ek}}{d}\right) \frac{v^2}{2} \qquad L + L_{ek} = 600\ m$

ocel, nová $\quad \varepsilon_A = 0.2\ mm$

$$\lambda = 0.25 \Big/ \left\{ \log\left[\underbrace{(6.81/Re)^{0.9}}_{(A)} + \underbrace{\frac{\varepsilon_A/d}{3.7}}_{(B)} \right] \right\}^2$$

$$Re = \frac{v d \rho}{\eta} = 3.93 \cdot 240 \cdot 10^{-3} \cdot 999.54 \Big/ 1.234 \cdot 10^{-3} = 763992$$

(A) $= 0.000028513 \qquad \lambda = 0.01933$

(B) $= 0.000225225 \qquad e_{bis} = 48.343 \cdot \frac{v^2}{2}$

$$618.4237 + \underbrace{\frac{1 - 81 - 48.343}{2}}_{-64.171}\, v^2 = 0$$

$v = 3.104\ m/s \qquad V_2 = 27.94\ m/s$