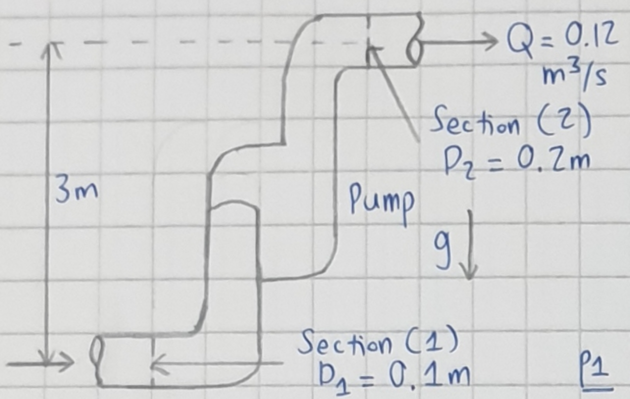
Nguyen Xuan Binh 887799 Round 4 Problem 3



Gasoline ($680\ kg/m^3$) flows through a pump at $0.12\ m^3/s$ as in the figure. The loss between sections (1) and (2) is $0.3\ v_1^2/2$. What is the difference in pressures between sections (1) and (2) if 20 kW is delivered by the pump to the fluid?

Extended Bernoulli equation:

$$\frac{p_1}{\rho} + \frac{v_1^2}{2} + gz_1 + gh_p = \frac{p_2}{\rho} + \frac{v_2^2}{2} + gz_2 + gh_\ell$$

We have: $Q = v_2 A_2 \Rightarrow v_2 = \frac{0.12}{0.1^2\pi} \approx 3.819\ (m/s)$

$Q = v_1 A_1 = v_2 A_2$ (mass conservation) $\Rightarrow v_1 = \frac{0.12}{0.05^2\pi} = 15.278\ (m/s)$

Let $z_1 = 0 \Rightarrow z_2 = 100m$

$gh_\ell = 0.3\frac{v_1^2}{2} = 0.3\frac{15.278^2}{2} \approx 35.012\ m$ = loss between sections (1) and (2)

Power of the turbine is 20000 W $\Rightarrow gh_p = \frac{W}{\dot{m}} = \frac{W}{\rho Q} = \frac{20000}{680 \times 0{,}12} = 245.098\ Nm/s$

$\Rightarrow$ The equation: $\frac{p_1}{\rho} + \frac{15.278^2}{2} + 9.81 \cdot 0 + 245.098 = \frac{p_2}{\rho} + \frac{3.819^2}{2} + 9.81 \cdot 3 + 35.012$

$\Rightarrow \frac{p_1}{\rho} + 361.8 = \frac{p_2}{\rho} + 71.73 \Rightarrow p_2 - p_1 = \rho(361.8 - 71.73)$

$\Rightarrow p_2 - p_1 = 680 \times 290.07 = 197247\ Pa$

Pressure of section (2) is more than section (1) 197247 Pa (answer)