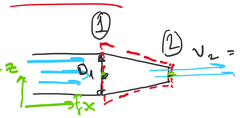
2019 Final

13 January 2020 Monday 12:33

Soru 1



$D_1 = 10$ cm

$v_1 = 7$ m/s

$\dot{V} = v_1 A_1 = v_2 A_2$

$\dot{m} = \rho \dot{V}$

$\dot{m} = 1000\ kg/m^3 \cdot 7\ \frac{m}{s} \cdot \frac{\pi (0.1)^2}{4}\ m^2$

$\dot{m} = 55\ kg/s$

$\Sigma F_x = \dot{m} (\beta_2 v_{2,x} - \beta_1 v_{1,x})$ — Assume $\beta = 1$

$F_{Rx} + P_1 A_1 = \dot{m} (v_2 - v_1)$

$F_{Rx} = 55 (30 - 7) - 400000 (0.0079)$

$\frac{kg}{s} \frac{m}{s} - \frac{N}{m^2} m^2$ → N

$F_{Rx} = 1265 - 3160$

$= -1895\ N$

$\approx -1.9\ kN$

$P_1 = 4\ bar = 400000\ Pa$

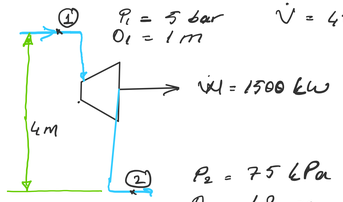
$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (0.1)^2}{4}$

$A_1 = 0.0079\ m^2$

$A_2 = \frac{A_1 v_1}{v_2} = \frac{7}{30} 0.0079$

$A_2 = 0.0018\ m^2$

Soru 2



$P_1 = 5$ bar $\quad \dot{V} = 4500$ litre/s

$D_1 = 1$ m

$v_1 = \frac{\dot{V}}{A_1} = \frac{4.5\ m^3/s}{(\pi\ 1^2)/4} = \frac{4.5}{0.785} = 5.73\ m/s$

$v_2 = \frac{\dot{V}}{A_2} = \frac{4.5\ m^3/s}{\pi (1.2)^2/4} = \frac{4.5}{1.131} = 3.98\ m/s$

$P_2 = 75$ kPa (mutlak)

$D_2 = 1.2$ m

Akış halindeki akışkanın mekanik enerjisi

$e_{mek} = \frac{P}{\rho} + \frac{v^2}{2} + gz$

iki nokta arasında mekanik enerji değişimi

$\Delta e_{mek} = \frac{P_2 - P_1}{\rho} + \frac{v_2^2 - v_1^2}{2} + g (z_2 - z_1)$

$\frac{P_1}{\rho_1} + \frac{v_1^2}{2} + g z_1 + w_{pompa} = \frac{P_2}{\rho_2} + \frac{v_2^2}{2} + g z_2 + w_{türbin} + e_{kayıp}$

$\Delta e_{mek} = \frac{-25 - 500}{1000} + \frac{3.98^2 - 5.73^2}{2 (1000)} + \frac{9.81 (-4)}{(1000)}$

$= -\frac{525}{1000} + \frac{15.84 - 32.83}{2 (1000)} + \frac{(-39.24)}{(1000)}$

$= -0.525 + (-0.0085) + (-0.039)$

$= -0.5725\ \frac{kJ}{kg}$

$\Delta \dot{E}_{mek} = \dot{m}\ \Delta e_{mek}$

$= 4500\ \frac{kg}{s} (-0.5725) = -2576.25\ kW$

1 ve 2 noktaları arasındaki güç potansiyeli 2576.25 kW

$\dot{W}_{kayıp} = \Delta \dot{E}_{mek} - \dot{W}_T$

$= 2576.25 - 1500 = 1076.25$ kW

$\eta_T = \frac{\dot{W}_T}{\Delta \dot{E}_{mek}} = \frac{1500}{2576.25} = 0.58$

Soru 3

Ticari çelik boru

$\varepsilon = 0.045$ mm $\quad \mu_{su} = 1.0 \times 10^{-3}\ \frac{kg}{ms}$

$L = 3$ m $\quad v = 5$ m/s

$D = 5$ cm $= 0.05$ m

Borudaki yük kaybı

$h_L = \left(f \frac{L}{D} + \sum K_L\right) \frac{V_{ort}^2}{2g}$

akışkan su

$h_L = \left(0.02 \frac{3}{0.05} + 1\right) \frac{5^2}{2 (9.81)}$

$h_L = 2.8$ m

$h_{piezo} = h_{havuz} + h_L$

$h_{piezo} = 4 + 2.8 = 6.80$ m

$Re = \frac{\rho V D}{\mu}$

$Re = \frac{1000 \cdot 5 (0.05)}{1 \times 10^{-3}}$

$Re = 250000$

$Re \gg 4000$ → Türbülan

$Re = 250000$ ⟩ → $f = 0.02$

$\frac{\varepsilon}{D} = \frac{0.045}{50} = 0.0009$

$K_L = 1$

Soru 4

Boeing 747

$m_1 = 250$ ton $= 250000$ kg (100 yolcu dahil) → $V_{min} = 230$ km/h

$V_{min} = 64$ m/s

$m_2 = 250000 + (400 - 100) \times 80 = 274000$ kg

$V_{min_2} = ?$

$\rho = 1.2$ kg (assume)

$F_L = W = \frac{1}{2} C_L \rho V_{min}^2 A$

$250000\ kg \cdot 9.8\ \frac{m}{s^2} = \frac{1}{2} C_L A\ 1.2\ \frac{kg}{m^3} (64\ m/s)^2$

$C_L A = \frac{250000\ kg \cdot 9.81\ m/s^2 \cdot (2)}{1.2\ kg/m^3 (64\ m/s)^2} = 1017\ m^2$

$C_L A = 508.5\ m^2$

$V_{min,2} = \sqrt{\frac{2W}{\rho C_L A}} = \sqrt{\frac{2 (274000) (9.81)}{(1.2)\ 1017}} = 66.27$ m/s

$= 240$ km/h

$\frac{V_{min,1}}{V_{min,2}} = \frac{\sqrt{\frac{2W_1}{\rho C_L A}}}{\sqrt{\frac{2W_2}{\rho C_L A}}} = \sqrt{\frac{W_1}{W_2}} = \sqrt{\frac{m_1 g}{m_2 g}} = \sqrt{\frac{m_1}{m_2}}$

$V_{min,2} = \frac{V_{min,1}}{\sqrt{m_1/m_2}} = \frac{64}{\sqrt{\frac{250000}{274000}}} = 66$ m/s