2.56 $\Delta P = 5\ kPa$

Energy Balance $\dot{V}\Delta P = \dot{W}$

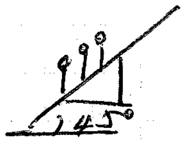
$\cancel{\Delta P} = \dot{W} = 5.2\ kW$

$\therefore\ \dot{V} = \frac{5.2}{5.0} = 1.04\ m^3/sec$

2.57 $M = 30 \times 75 = 2250\ kg.$

$\frac{\Delta PE}{\Delta t} = Mg\frac{\Delta z}{\Delta t}$

$= Mg \cdot \dot{V}\sin 45^\circ$



$= \frac{(2250)(0.8)(9.81)}{\sqrt{2}} = \underline{\underline{12.5\ kW}}$

Note: Power consumption results in people realizing potential energy

2.71 $\dot{W}_{shaft} = \frac{\dot{m}(\Delta PE)}{1000}\ kJ$

$\frac{(1500)(9.81)(70)}{1000} = \underline{\underline{1031}}\ kW$

If "generator" is efficient as well as the shaft assembly, then the power generated should be closer to this. This leads to

$\eta_{overall} = \frac{\text{Desired output}}{\text{required input}} = \frac{750\ kW}{1031}$

$= \underline{0.7274} \simeq \underline{0.73}$

Looking at generator, $\eta_{gen} = \frac{750}{800} = 0.94$

$\eta_{turbine} = \frac{800}{1031} = 0.78$ $\boxed{\eta_{overall} = \eta_{turb} \cdot \eta_{gen}}$

2.80

$$\Delta \dot{E}_{mech} = \dot{m}\left[\left(P_2 v_2 + \frac{V_2^2}{2}\right) - \left(P_1 v_1 + V_1^2/2\right)\right]$$

$$= \frac{\dot{m}}{\rho}\left[\left(P_2 + \frac{\rho V_2^2}{2}\right) - \left(P_1 + \frac{\rho V_1^2}{2}\right)\right]$$

$\cancel{\dot{m} = \rho A \vec{V}}$ $\quad \dot{m} = \rho \dot{V} = \frac{\dot{V}}{v}$ ($\dot{V}$ = vol. flowrate)

ρ = Density constant (Incompressible)

$$= \dot{V}\left[(P_2 - P_1) + \frac{\rho(V_2^2 - V_1^2)}{2000}\right] \text{ kW}$$

$$= (\dot{V})\left[(400) + \frac{860\,(V_2^2 - V_1^2)}{2000}\right] \text{kW}$$

$$V_1 = \frac{\dot{V}}{A_1} = \frac{0.1 \text{ m}^3/\text{s}}{\frac{\pi (0.08)^2}{4}} = 19.9 \text{ m/s}$$

$$V_2 = \frac{\dot{V}}{A_2} = \frac{0.1 \text{ m}^3/\text{s}}{\frac{\pi (0.12)^2}{4}} = 8.84 \text{ m/s}$$

From First law

$$\dot{W}_{pump} = \Delta \dot{E}_{mech}$$

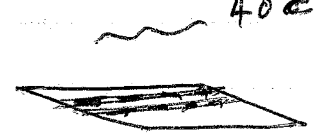
$$= (0.1)\left(400 + \frac{860\,(8.84^2 - 19.9^2)}{2000}\right) \text{ kW}$$

$$= \underline{26.3 \text{ kW}}$$

$$\dot{W}_{pump,\,shaft} = \eta_{motor}\,\dot{W}_{electric} = 35 \times 0.9 = 31.5 \text{ kW}$$

$$\eta_{pump} = \frac{26.3 \text{ (output)}}{31.5 \text{ (input)}} = 0.836\,\%$$

Note: Here efficiency defined as what is ideally required & what is provided



2.142

$\dot{Q} = 100 \times 0.08$

$= 8W$

$A = 0.02\ m^2$

$h = 10\ W/m^2\,°c$

$\dot{Q} = hA\,(T - T_{amb})$

$\frac{\dot{Q}}{hA} + T_{amb} = T \Rightarrow \frac{0.08}{(10)(0.02)} + 40°C$

$= 40°c + 40°c = \underline{\underline{80°c}}$

2.78

$\Delta \dot{E}_{mech} = \dot{m}\,\Delta e_{mech} = \dot{m}\,\Delta(pe)$

$= \dot{m}\,g\,(\Delta z)$

$(1000)(0.03)(9.81)(45) = \underline{13.2\ kW}$

$\dot{W}_{friction} = \dot{W}_{pump,\,actual} - \Delta\dot{E}_{mech}$

$= 20 - 13.2 = 6.8\ kW$

$\eta_{pump} = \frac{13.2}{20.0} \simeq \underline{\underline{0.66}}$ or 66%

2.72

Sweeping Area $= \frac{\pi D^2}{4} = \frac{\pi (50)^2}{4}$

$\dot{m}_{air} = \rho A V = (1.25)\left(\frac{\pi\,50^2}{4}\right)(12)$

$= 29,450\ kg/s$

$\dot{W}_{max} = \dot{E}_{mech} = \dot{m}\,e_{mech} \Rightarrow$

$e_{mech} = ke = \frac{V^2}{2} = \frac{12^2}{2000} = 0.072\ \frac{kJ}{kg}$

$\dot{W}_{max} = (29450)(.072) = 2121\ kW.$ $\quad \dot{W}_{el} = \eta\,\dot{W}_{max}$