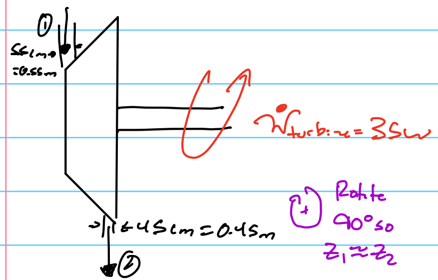
Trevor Swan **ECHE225: QUIZ #7 // 10.24.24**



$P_1 - P_2 = 125\ kPa$

$\dot{V}_1 = 2.5\ m^3/s$

Incompressible: $\dot{V}_1 = \dot{V}_2 = \dot{V}$

$\rho_w = 997\ kg/m^3,\ \alpha = 1$ ← Turbulent

2. Want to know: $h_{turbine}$

4. Want to know: efficiency η_t

$h_L = 3.25m$

$$\frac{P_1}{\rho g} + \alpha \frac{V_1^2}{2g} + \underbrace{\cancel{z_1}}_{z_1 \approx z_2} + \underbrace{\cancel{h_{pump,u}}}_{\text{no pump}} = \frac{P_2}{\rho g} + \alpha \frac{V_2^2}{2g} + \cancel{z_2} + h_{turbine} + h_L$$

$$h_{turbine} = \frac{P_1}{\rho g} - \frac{P_2}{\rho g} + \frac{V_1^2}{2g} - \frac{V_2^2}{2g} - h_L$$

$$= \frac{P_1 - P_2}{\rho g} + \frac{V_1^2 - V_2^2}{2g} - h_L$$

$\boxed{\text{velocities}}$ $\dot{V} = V_{Avg} A_c$

$$V_1 = \frac{\dot{V}_1}{\frac{\pi}{4}(D)^2} = \frac{2.5\ m^3/s}{\frac{\pi}{4}(0.55m)^2} = 10.52\ m/s$$

$$V_2 = \frac{\dot{V}_2}{\frac{\pi}{4}(D)^2} = \frac{2.5\ m^3/s}{\frac{\pi}{4}(0.45m)^2} = 15.72\ m/s$$

2. $$h_{turbine} = \frac{125{,}000 Pa}{997\ kg/m^3 (9.81 m/s^2)} + \frac{(10.52 m/s)^2 - (15.72 m/s)^2}{2(9.81 m/s^2)} - 3.25m = \boxed{2.58\ m}$$

4. $$\eta_t = \frac{\dot{W}_{turbine}}{\dot{W}_{turbine}},\quad h_{turbine} = \frac{\dot{W}_{turbine}}{\dot{m} g},\quad \dot{W}_{turbine} = 35kW$$

$$\dot{m} = \dot{V}\rho = 2.5\ m^3/s (997\ kg/m^3) = 2492.5\ kg/s$$

$\{W\}$

$$\dot{W}_{turbine} = \dot{m} g h_{turbine} = (2492.5\ kg/s)(9.81 m/s^2)(2.58 m) = 63084.68\ \frac{kg \cdot m^2}{s^3}$$

$$= 63.084\ kW$$

$$\eta_t = \frac{35kW}{63.084kW} = 0.5548$$

$$\boxed{\eta_t = 55.48\%}$$