Question 2

Wednesday, April 28, 2021 10:32 AM

"I pledge my honor I have abided by the Stevens Honor system."
- Alex Gaskins

A new, hydroelectric power station is to be built on the Hudson River. There are two possible sites being explored for this facility. At location (A) the river flows at 5 m/s with a volume flow rate of 150 m^3/s and at location (B) the river flows at 3 m/s with a volume flow rate of 400 m^3/s. You may take the density of water to be 1000 kg/m^3 at both locations.

Open System

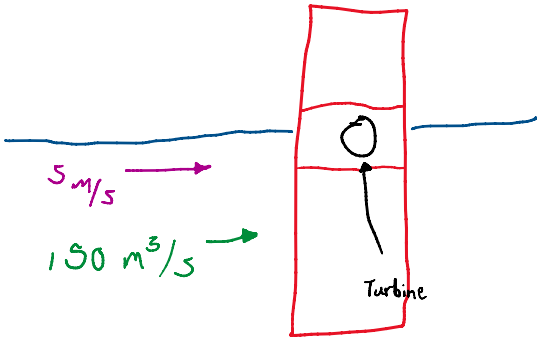
a) Draw a diagram of this system, show your governing equation(s) and show which terms can be removed.

b) Determine the maximum power that could be generated at each location.

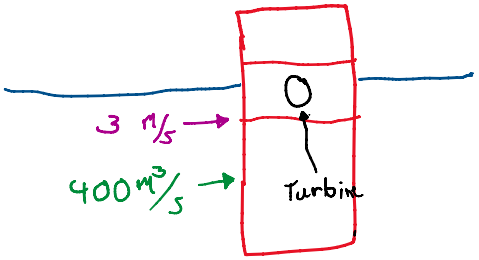
c) Do you think the values you calculated in part (a) are reasonable? Briefly explain.

A.)

Location A



Location B



$$\dot{E}_{in} - \dot{E}_{out} = \Delta \dot{E}_{sys} \quad \text{steady} = 0$$

$$\dot{m}_1\left(h_1 + \frac{V^2}{2} + gz_1\right) - \dot{m}_2\left(h_2 + \frac{V^2}{2} + gz_2\right) + W_{in} - W_{out} = 0$$

$$W_{out} = \dot{m}_1\left(\frac{V^2}{2}\right) - \dot{m}_2\left(\frac{V^2}{2}\right)$$

Relative to mechanical energy

$$P = \dot{m}\,\Delta E \quad \leftarrow \text{mechanical energy}$$

$P_2 = P_1$

$$\Delta E = \frac{P_2 - P_1}{\rho} + \frac{V_2^2 - V_1^2}{2} + g(z_2 - z_1)$$

horizontal

$$\Delta E = \frac{V_1^2}{2}$$

B.) $$P = \rho \dot{V} \left(\frac{V^2}{2} \right)$$

Location 1:

$$P = \rho \dot{V} \left(\frac{V^2}{2} \right) = 1000 (150) \left(\frac{5^2}{2} \right) = 1825000 \text{ W}$$

$$P = 1825 \text{ kW}$$

Location 2:

$$P = \rho \dot{V} \left(\frac{V^2}{2} \right) = 1000 (400) \left(\frac{3^2}{2} \right) = 1800000 \text{ W}$$

$$P = 1800 \text{ kW}$$

c.) It is unreasonable due to the fact that what we calculated is ideal. In reality more energy would be required to account for friction, electrical resistance, etc.