Answer on Question #71022, Physics / Molecular Physics | Thermodynamics

A turbine operating under steady flow conditions receives steam at the following state. Pressure 13.8 bar, specific volume 0.143 m3/kg, i.e., 2590 kJ/kg, velocity 30 m/s. The state of the steam leaving the turbine is pressure 0.35 bar, specific volume 4.37 m3/kg, i.e., 2360 kJ/kg, velocity 90 m/s. Heat is lost to the surroundings at the rate of 0.25 kJ/s. If the rate of steam flow is 0.38 kg/s, what is the power developed by the turbine?

Answer:

In the above equation :
— the mass flow is in kg/s
— velocity in m/s
— internal energy in J/kg
— pressure in Pa
— specific volume m3/kg
— the value of Q is in J/s
Then the unit of W will be J/s or W.

$$m\left[u_1 + p_1 v_1 \frac{C_1^2}{2} + Z_1 g\right] \pm Q = m\left[u_2 + p_2 v_2 \frac{C_2^2}{2} + Z_2 g\right] + W$$

$$W = m\left[(u_1 - u_2) + (p_1 v_1 - p_2 v_2) \frac{C_1^2 - C_2^2}{2}\right] - Q$$

$Z_1 = Z_2 = 0$

$$W = 0.38\ kJ/kg\left[\left(2590\frac{kJ}{kg} - 2360\frac{kJ}{kg}\right) + \left(13.5 \cdot 10^5\ Pa \times 0.143\frac{m^3}{kg} - 0.35\ \cdot 10^5 Pa \times 4.37\ \frac{m^3}{kg}\right) + \left(\frac{30^2\frac{m}{s} - 90^2\frac{m}{s}}{2}\right)\right] - 0.25kJ/s = 1.029 \cdot 10^5 J/s\ or\ 102.9\ kW$$

Answer: 102.9 kW