UCH305 (Chemical Engineering Thermodynamics I)

Tutorial Sheet No. 5 (FIRST LAW ANALYSIS OF FLOW PROCESSES)

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1. The velocity & enthalpy of fluid at the inlet of certain nozzle are 50 m/s & 2800 KJ/Kg respectively. The enthalpy at the exit of nozzle is 2600 kJ/kg. The nozzle is horizontal and insulated so that no heat transfer takes place. Find (1) Velocity if fluid at the exit (2) Mass flow rate, if inlet nozzle is 0.09 m^2 & specific volume is 0.185m^3/kg. (3) Exit area if specific volume at the exit of nozzle is 0.495m^3/kg.

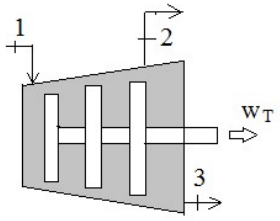
2. In a gas turbine, the gas flows at the rate of 5 Kg/s. The gas enters the turbine at a pressure of 7 bar with a velocity 120 m/s and leaves at a pressure 2 bar with a velocity 250 m/s. The turbine is insulated. If the enthalpy of gas at inlet is 900 KJ/Kg and at the outlet is 600 KJ/Kg, determine the capacity of the turbine.

3. The compressor of a large gas turbine receives air from the surrounding at 95 KPa, 20^0 C. At the compressor discharge, the pressure is 380 KPa, the temperature is 180^0 C & velocity is 120 m/s. The power input to the compressor is 3000 KW. Determine the mass flow rate of the air C_p = 1.0035 KJ/Kg K.

4. Air at 600 kPa and 500 K enters an adiabatic nozzle that has an inlet – to – exit area ratio of 2:1 with an velocity of 120 m/s and leaves with a velocity of 380 m/s. Determine (a) the exit temperature and (b) the exit pressure of the air. Assume $\gamma = 1.4$ and C_p = 1.005 kJ/kg K.

5. Steam enters an adiabatic turbine at 10 MPa and 500 °C and leaves at 10 kPa with a quality of 90 percent. Neglecting the changes in kinetic and potential energies, determine the mass flow rate required for the power output of 5 MW.

6. A steam turbine receives water at 15 MPa and 600°C at a rate of 100 kg/s, shown in figure. In the middle section 20 kg/s is withdrawn at 2 MPa and 350°C, and the rest exits the turbine at 75 kPa and 95% quality. Assuming no heat transfer and no changes in kinetic energy, find the total turbine power output?



7. Air expands in in a reversible adiabatic manner through a nozzle from 784 KPa & 220^0 C to an exit pressure of 98 KPa. Determine the exit velocity & the mass flow rate if the exit area is 6 cm^2. Neglect the inlet velocity. Assume γ = 1.4 and C_p = 1.005 KJ/Kg K.

8. A proposal is made to use a geothermal supply of hot water to operate a steam turbine.(as shown in fig. below) The high pressure water at 1.5 MPa, 1800 C, is throttled into a flash evaporator chamber, which forms liquid and vapor at a lower pressure of 400 KPa. The liquid is discarded while the saturated vapor feeds the turbine and exits at 10 KPa, 90 % quality. If the turbine should produce 1 MW, find the required mass flow rate of hot geothermal water in kilograms per hour.

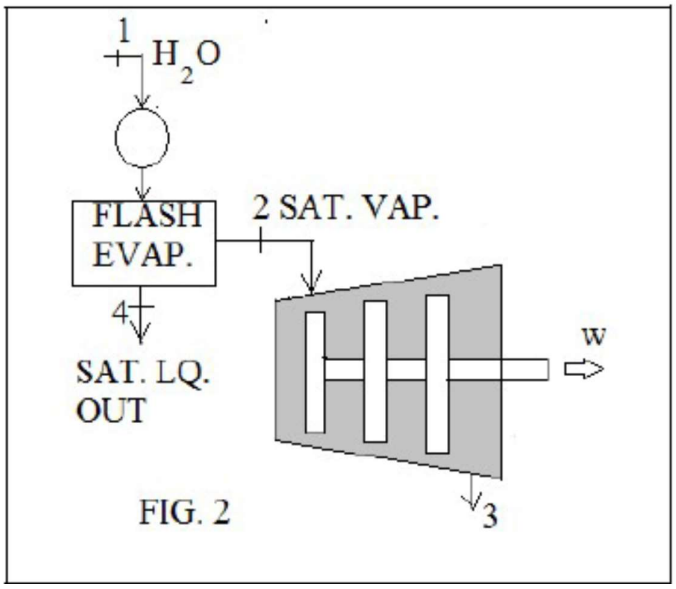


FIG. 2

9. An initially empty bottle is filled with water from a line at 0.8 MPa, 350^0 C. Assume no heat transfer and that the bottle is closed when the pressure reaches the pressure. If the final mass is 0.75 Kg . Find the final temperature and the volume of the bottle.