UCH305 (Chemical Engineering Thermodynamics I)

Tutorial Sheet No. 7 (Entropy and Availability)

1. From a saturated liquid state at 200 kPa, 3 kg of water is heated to a temperature of 250°C at constant pressure. Determine the entropy change for the process.
Ans: 18.54 kJ/K

2. 0.5 kg of perfect gas is heated from 100^0 C to 300^0 C at constant pressure of 2.8 bars. It is then cooled to 100^0 C at constant volume. Find the overall change in entropy. Take C_p = 1000 J/kg-K and C_v = 720J/kg-K. **Ans: 60.15 J/K**

3. Air is compressed reversibly in a polytropic process from 1 bar and 40^0 C to 3 bars. The polytropic index is 1.3. Determine the change in entropy per unit mass of the air. Take C_p = 1.0045 kJ/kg-K, R = 0.287kJ/kg-K. **Ans: -0.0607 kJ/kg-K**

4. Air is throttled through a throttling valve from 2 bars and 30^0 C to 1 bar adiabatically. Assuming the kinetic energy change to be negligible. Calculate the molar change in entropy of air. Take C_p = 1007 J/kg-K, R = 8.314 kJ/kg mol-K and Molar mass of air (M_{air})= 28.97 kg/kg-mol. **Ans: 167 kJ/kmol-K**

5. A certain gas has a specific heat at constant volume of 1.25 kJ/kg.K. When it is expanded reversibly and adiabatically from a specific volume of 0.0624 m^3/kg and a temperature of 530 K to a specific volume of 0.186 m^3/kg its temperature falls by 165 K. When it is expanded into an evacuated space from the same initial condition to the same final specific volume its temperature falls only by 25 K. Find the change in entropy in each of the processes. **Ans: 0.4058 kJ/kg-K**

6. A heat engine receives heat from a source at 1000 K at the rate of 500 kJ/s and rejects waste heat to a sink at 350 K. The surrounding environment is at 300 K. If the measured power output of the engine is 200 KW. Determine: (a) Availability (b) The rate of irreversibility and (c) The second law efficiency of the heat engine. **Ans: 350 kW, 150 kW, 0.5415**