CHAPTER FIVE – THE SECOND LAW OF THERMODYNAMICS

LECTURE NO. 2

HOME WORK

4.6 1 kg of steam undergoes a reversible isothermal process from 20 bar and 250 °C to a pressure of 30 bar. Calculate the heat flow, stating whether it is supplied or rejected, and sketch the process on a T–s diagram.

(−135 kJ/kg)

4.7 1 kg of air is allowed to expand reversibly in a cylinder behind a piston in such a way that the temperature remains constant at 260 °C while the volume is doubled. The piston is then moved in, and heat is rejected by the air reversibly at constant pressure until the volume is the same as it was initially. Calculate the net heat flow and the overall change of entropy. Sketch the process on a T–s diagram.

(−161.9 kJ/kg; −0.497 kJ/kg K)

4.8 Steam at 5 bar, 25 °C, expands isentropically to a pressure of 0.7 bar. Calculate the final condition of the steam.

(0.967)

4.9 Steam expands reversibly in a cylinder behind a piston from 6 bar dry saturated, to a pressure of 0.65 bar. Assuming that the cylinder is perfectly thermally insulated, calculate the work done during the expansion per kilogram of steam. Sketch the process on a T–s diagram.

(323.8 kJ/kg)

4.10 1 kg of a fluid at 30 bar, 300 °C, expands reversibly and isothermally to a pressure of 0.75 bar. Calculate the heat flow and the work done (i) when the fluid is air, (ii) when the fluid is steam. Sketch each process on a T–s diagram.

(607 kJ/kg; − 607 kJ/kg; 1035 kJ/kg; − 975 kJ/kg)

4.12 1 kg of air at 1.013 bar, 17 °C, is compressed according to a law $pv^{1.3}$ = constant, until the pressure is 5 bar. Calculate the change of entropy and sketch the process on a T–s diagram, indicating the area which represents the heat flow.

(−0.0885 kJ/kg)

4.13 0.06 m^3 of ethane (molar mass 30 kg/kmol), at 6.9 bar and 260 °C, is allowed to expand isentropically in a cylinder behind a piston to a pressure of 1.05 bar and a temperature of 107 °C. Calculate γ, R, c_p, c_v, for ethane, and calculate the work done during the expansion. Assume ethane to be a perfect gas.

The same mass of ethane at 1.05 bar, 107 °C, is compressed to 6.9 bar according to a law $pv^{1.4}$ = constant. Calculate the final temperature of the ethane and the heat flow to or from the cylinder walls during the compression. Calculate also the change of entropy during the compression, and sketch both processes on a p–v and a T–s diagram.

(1.219; 0.277 kJ/kg K; 1.542 kJ/kg K; 1.265 kJ/kg K; 54.2 kJ; 377.7 °C; 43.4 kJ; 0.0862 kJ/K)