Review of Chapter 8
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ME312

Exergy Study Problems

1. A mass of 5 kg of saturated water vapor at 300 kPa is heated at constant pressure until the temperature reaches 200°C. The work is determined to be 166 kJ with a First Law analysis. The exergy content of the water vapor at state 1 and state 2 are 205 kJ and 389 kJ. Determine the exergy change, the lost work (if any), and the second law efficiency of this process (4-8*).

2. A rigid tank contains 10 Ibm of air at 30 psia and 65°F. The air is now heated until its pressure doubles. The amount of heat transfer is determined to be 920 Btu from a First Law analysis. The exergy of the air at state 1 and state 2 are 250 kJ and 124 Determine the exergy change, the lost work (if any), and the second law efficiency of this process (4-60E*).

3. Argon is compressed in a polytropic process with n = 1.2 from 120 kPa and 10°C to 800 kPa in a piston-cylinder device. The work produced and heat transferred during this compression process is determined to be 109.5 kJ/kg and 76.6 kJ/kg, with a First Law Energy analysis. The exergy of the argon at state 1 and 2 are 230 kJ/kg and 560 kJ/kg respectively. Determine the exergy change, the lost work (if any), and the second law efficiency of this process (4-66*).

4. Air is compressed isothermally from 13 psia and 90°F to 80 psia in a reversible steady-flow device. The work required, in Btu/lbm, for this compression process is determined to be . 68.5 Btu/lbm. The exergy of the air at the entrance and exit of this device are 350 Btu/lbm and 560 Btu/lbm. Determine the exergy change, the lost work (if any), and the second law efficiency of this process (7-102E*)

5. Water enters the pump of a steam power plant as saturated liquid at 20 kPa at a rate of 45 kg/s and exits at 6 MPa. Neglecting the changes in kinetic and potential energies and assuming the process to be reversible, determine the power input to the pump, the exergy of the water at the pump entrance, the exergy of the water at the pump exit, the exergy change of the water, the lost work (if any), and the second law efficiency of this device (7-105*).

6. Steam enters an adiabatic turbine at 8 MPa and 500°C with a mass flow rate of 3 kg/s and leaves at 30 kPa. The isentropic efficiency of the turbine is 0.90. Neglecting the kinetic energy change of the steam the temperature at the turbine exit is 69.1 °C and the power output of the turbine is 3054 kW. The exergy of the steam at the inlet is 4578 kJ/kg and the exergy at the outlet is 2468 kJ/kg. Determine the exergy change of the steam in kW, the lost work in kW, and the second law efficiency (7-120*).

*problems from Cengel and Boles, 8th Edition