CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering

ECHE 225: Fall 2024

Homework #5: Entropy change, and isentropic efficiency

Due October 3

1. [Chapter 8] Air is compressed by a 20 kW compressor from P1 to P2. The air temperature is maintained constant at 30°C. Determine the rate of entropy change in the air. State the assumptions made in solving this problem.

2. [Chapter 8] A rigid tank is divided into two equal parts by a partition. One part of the tank contains 2 kg of compressed liquid water at 500 kPa and 60°C while the other part is evacuated. The partition is now removed and the water expands to fill the entire tank. Determine the entropy change of water during the process if the final pressure in the tank is 50 kPa.

3. [Chapter 8] R134a enters an adiabatic compressor as saturated vapor ato 100 kPa at a rate of 0.7 m^3/min and exits at 1 MPa. If the isentropic efficiency of the compressor is 87 percent, determine (a) the temperature of the refrigerant at the exit of the compresssor and (b) the power input, in kW.

4. [Chapter 8] Air enters a compressor steadily at ambient conditions of 100 kPa and 30°C and leaves at 600 kPa. Heat is lost from the compressor in the amount of 95 kJ/kg and the air experiences an entropy decrease of 0.30 kJ/kgK. Using constant specific heats, determine:

   (a) the exit temperature of the air

   (b) the work input to the compressor (in kJ/kg)

   (c) the total entropy change during the process (in kJ/kgK)

5. An inventor claims to have invented an adiabatic steady-flow device with a single inlet and single outlet that produces 230 kW when expanding 1 kg/s of air from 1200 kPa and $300°$C to 100 kPa. Is the claim valid?

Answers

1. -0.066 kW/K
2. 0.524 kJ/K
3. (a) 56.5°C, (b) 3.35 kW
4. (a) 101°C, (b) 166.8 kJ/kg (c) 0.0134 kJ/kgK
5. Possible, but why?