Aalto University

Thermodynamics and Heat Transfer

LE4: Part 2- Refrigeration Cycles (50 points)

Problem 1: A refrigerator with R-134a as the working fluid has a minimum temperature of −10℃ and a maximum pressure of 1 MPa. Assume an ideal refrigeration cycle, as in Fig. 1. Find the specific heat transfer from the cold space and that to the hot space, and the COP. Compare the results with R410a (15 points).

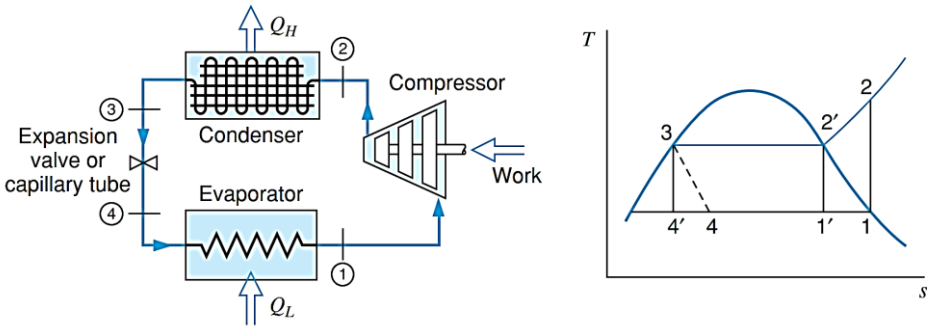

Figure 1

Problem 2: Consider an ideal refrigeration cycle that has a condenser temperature of 45℃ and an evaporator temperature of −15℃. Determine the COP of this refrigerator for the working fluids R-134a and R-410a (10 points).

Problem 3: A heat pump uses R410a with a high pressure of 3000 kPa and an evaporator operating at −10℃, so it can absorb energy from underground water layers at 4℃. Find the COP and the temperature at which it can deliver energy (10 points).

Problem 4: A refrigerator using R-134a is located in a 20℃ room. Consider the cycle to be ideal, except that the compressor is neither adiabatic nor reversible. Saturated vapor at −20℃ enters the compressor, and the R-134a exits the compressor at 50℃. The condenser temperature is 40℃. The mass flow rate of refrigerant around the cycle is 0.2 kg/s, and the COP is measured and found to be 2.3. Find the power input to the compressor and the rate of entropy generation in the compressor process (15 points).