The Saylor Foundation's

ME 103 Assessment, Unit 5: Guide to Responding

Instructions: Please answer each of the following questions to the best of your ability.

Questions:

1. Determine the minimum of energy supplied by a heat pump to maintain a house at 22^oC, when the outside temperature is 10^0C. The house is losing heat to outside at the rate of 50,000 kJ per hour.

2. What is the maximum efficiency of a heat engine operating between a heat source at 500 K and a heat sink at 300 K?

3. Calculate the change in entropy when 10 kmol of an ideal gas at 335 K and 10 bar is expanded irreversibly to 300 K and 1 bar? Take $C_p$to be 50 kJ/kmol K.

4. Use the Mollier diagram to determine the specific enthalpy and specific entropy of wet steam of quality 0.85 at 2 bar pressure.

Solutions:

1. The work supplied by a heat pump is $W_{heat\text{-}pump}=Q_H/y$ where y is the coefficient of performance of the heat pump.

   According to Carnot law, y is less than or equal to the coefficient of performance y_{max} of a reversible heat pump cycle when each operates between the same two thermal reservoirs:

   Thus, the minimum energy supplied by a heat pump $W_{heat\text{-}pump,min} = (1-T_C/T_H)Q_H$. $=(1-283^oK/295^oK)\ (5x10^4 kJ/hour) = 2.03x10^3 kJ/hour$

2. The efficiency of a Carnot engine operating between two temperature levels T_1 and T_2 is $\mu = 1 - T_2/T_1 = 1- 300/500 = 0.4$.

3. The entropy change in this process is given by the following equation $\Delta S=C_p \ln(T_2/T_1)-R\ln(P_2/P_1)$ = 27.06 kJ/kmol K.

4. H = 2380 kJ/kg   s= 6.29 kJ/kg K