DREXEL UNIVERSITY
Department of Chemical and Biological Engineering
CHE 230 – Chemical Engineering Thermodynamics I
Winter 2024-2025 (202425)
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Midterm Exam – February 11, 2025

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1. (17 pts) Superheated steam at 4 MPa and 349.0°C is to be converted to saturated steam at 3 MPa in a desuperheater. This desuperheater is supplied with inlet liquid water at 52.0°C. The unit should produce saturated steam at a rate of 13.0 kg s^{-1}. Assuming adiabatic operation, and assuming the liquid inlet is saturated, what is the mass flowrate of the inlet water?

   The following enthalpies will be useful:

   Superheated steam at 349.0°C and 4 MPa: $\hat{H} = 3{,}099.15$ kJ/kg;

   Saturated liquid water at 52.0°C: $\hat{H}^{\mathrm{L}} = 217.69$ kJ/kg; and

   Saturated water vapor at 3 MPa: $\hat{H}^{\mathrm{V}} = 2{,}803.60$ kJ/kg.

2. (21 pts)

   A stream of air at 13.12 bar and 950 K (labeled "stream 1") is to be cooled to 700 K by mixing with another stream of air at 10.26 bar and 350 K (labeled "stream 2"). Let α be the ratio of the molar flow rate of the hotter stream to that of the cooler stream. Compute (1) α, and (2) the pressure P of the mixed stream (labeled "stream 3"). You may assume this is carried out adiabatically and that air is an ideal gas for which $C_{\mathrm{P}} = 7R$.

   It may be helpful for you to remember, **for the ideal gas**, that a change of state from (T_A, P_A) to (T_B, P_B) results in the following enthalpy and entropy changes, respectively:

$$\Delta \underline{H} \equiv \underline{H}_B - \underline{H}_A = \int_{T_A}^{T_B} C_{\mathrm{P}} dT$$

$$\Delta \underline{S} \equiv \underline{S}_B - \underline{S}_A = \int_{T_A}^{T_B} \frac{C_{\mathrm{P}}}{T} dT - R \ln \frac{P_B}{P_A}.$$

3. (19 pts) True/False questions. Write "T" for "True" or "F" for "False" in the blank space.

   ___ The pope is Freewill Southern Baptist.

   ___ A bear shits in the woods.

   ___ Entropy is delicious.

   ___ The sky is blue.

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