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D R E X E L   U N I V E R S I T Y  
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 3 MPa and 348.0°C is to be converted to saturated steam at 3 MPa in a desuperheater. This desuperheater is supplied with inlet liquid water at 53.0°C. The unit should produce saturated steam at a rate of 42.0 kg s<sup>-1</sup>. 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 348.0°C and 3 MPa:  $\hat{H} = 3,110.43$  kJ/kg;

Saturated liquid water at 53.0°C:  $\hat{H}^L = 221.87$  kJ/kg; and

Saturated water vapor at 3 MPa:  $\hat{H}^V = 2,803.80$  kJ/kg.

2. (21 pts)

A stream of air at 14.14 bar and 1000 K (labeled “stream 1”) is to be cooled to 600 K by mixing with another stream of air at 10.08 bar and 450 K (labeled “stream 2”). Let  $\alpha$  be the ratio of the molar flow rate of the hotter stream to that of the cooler stream. Compute (1)  $\alpha$ , 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  $C_P = \frac{15}{2}R$ .

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:

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

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

- \_\_\_ A bear shits in the woods.
- \_\_\_ Entropy is delicious.
- \_\_\_ The sky is blue.
- \_\_\_ The pope is Freewill Southern Baptist.

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