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)
Prof. Abrams – cfa22@drexel.edu
Midterm Exam – February 11, 2025

S O L U T I O N S

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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.

   SOLUTION

   Let stream 1 be the liquid water stream, which we assume is saturated liquid, stream 2 be the superheated steam inlet, and stream 3 be the saturated steam outlet. Hence, $\dot{m}_3 = 15$ kg s^{-1} as given. The mass and energy balance yield the two unknowns $\dot{m}_1$ and $\dot{m}_2$:

   $$\dot{m}_1 + \dot{m}_2 = \dot{m}_3$$
   $$\dot{m}_1\hat{H}_1 + \dot{m}_2\hat{H}_2 = \dot{m}_3\hat{H}_3$$

   Solving these two simultaneously yields

   $$\dot{m}_1 = \dot{m}_3\left(\frac{\hat{H}_2 - \hat{H}_3}{\hat{H}_2 - \hat{H}_1}\right)$$
   $$= (15)\left(\frac{3,099.15 - 2,803.60}{3,099.15 - 217.69}\right) = \boxed{1.33 \text{ kg s}^{-1}}.$$

2. (19 pts) True/False questions. Write "T" for "True" or "F" for "False" in the blank space.

  <u>F</u> The pope is Freewill Southern Baptist. No, the pope is Catholic.

  <u>T</u> A bear shits in the woods. Of course it does.

  <u>F</u> Entropy is delicious. You can't taste entropy.

  <u>T</u> The sky is blue. Of course it is.

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