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

S O L U T I O N S

This is an example header named `example_head-12345678.tex`.

1. (15 pts)

   This is an example problem named `example_problem_template-12345678.tex`.

   Determine the product of 5 and 8.

   SOLUTION

$$5 \ \times \ 8 \ = \ 40$$

   The serial number is 12345678. This is labeled as question number 1.

2. (16 pts)

   This is an example problem named `example_problem2_template-12345678.tex`.

   Determine the quotient of 3.9 and 357.0.

   SOLUTION

$$3.9 \ \div 357.0 \ = \ 0.011$$

   The serial number is 12345678. This is labeled as question number 2.

3. (17 pts) Superheated steam at 3 MPa and 347.0°C is to be converted to saturated steam at 3 MPa in a desuperheater. This desuperheater is supplied with inlet liquid water at 47.0°C. The unit should produce saturated steam at a rate of 15.0 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 347.0°C and 3 MPa: $\hat{H} = 3{,}101.04$ kJ/kg;

   Saturated liquid water at 47.0°C: $\hat{H}^{\mathrm{L}} = 196.80$ kJ/kg; and

   Saturated water vapor at 3 MPa: $\hat{H}^{\mathrm{V}} = 2{,}803.76$ kJ/kg.

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

$$\dot{m}_1 = \dot{m}_3 \left(\frac{\hat{H}_2 - \hat{H}_3}{\hat{H}_2 - \hat{H}_1} \right)$$
$$= (15) \left(\frac{3,101.04 - 2,803.76}{3,101.04 - 196.80} \right) = \boxed{1.54 \text{ kg s}^{-1}}.$$

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Answers are compiled in solutions-12345678.yaml.