
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

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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⁻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 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.

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, $\dot{m}_3 = 42.0$ kg s⁻¹ as given. The mass and energy balance yield the two unknowns \dot{m}_1 and \dot{m}_2 :

$$\begin{aligned}\dot{m}_1 + \dot{m}_2 &= \dot{m}_3 \\ \dot{m}_1 \hat{H}_1 + \dot{m}_2 \hat{H}_2 &= \dot{m}_3 \hat{H}_3\end{aligned}$$

Solving these two simultaneously yields

$$\begin{aligned}\dot{m}_1 &= \dot{m}_3 \left(\frac{\hat{H}_2 - \hat{H}_3}{\hat{H}_2 - \hat{H}_1} \right) \\ &= (42.0) \left(\frac{3,110.43 - 2,803.80}{3,110.43 - 221.87} \right) = \boxed{4.46 \text{ kg s}^{-1}}.\end{aligned}$$

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

T A bear shits in the woods. Of course it does.

F Entropy is delicious. You can't taste entropy.

T The sky is blue. Of course it is.

F The pope is Freewill Southern Baptist. No, the pope is Catholic.

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