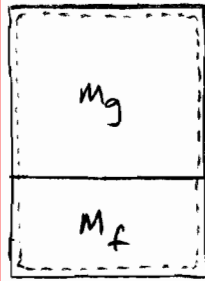


Given: An equilibrium mixture of water in a closed, rigid container

ALL EES solutions must include a hand-written preface that contains the GIVEN information, what you are trying to FIND and your SOLUTION including a SOLUTION STRATEGY for implementation in EES.



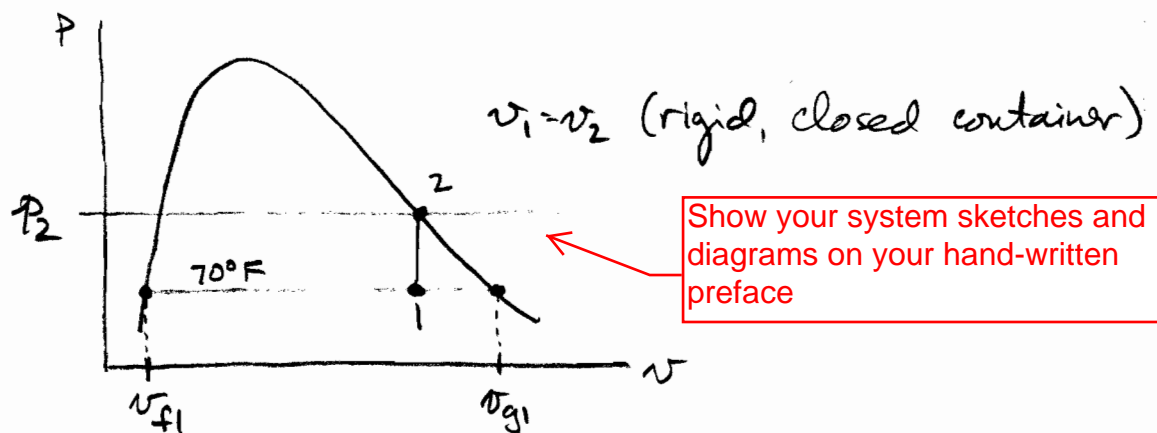
$$T_1 = 70^\circ\text{F}$$

$$m_{f1} = 10.236 m_{g1}$$

The container is heated until all the liquid becomes vapor

Find: a) The initial quality
b) The final pressure
c) The p - v diagram

Solution: The p - v diagram is helpful to begin this problem,



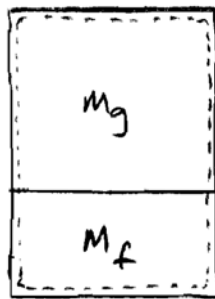
Solution Strategy ← Write out your strategy for solving the problem using EES

$$a) \quad x_1 = \frac{m_{g1}}{m_{f1} + m_{g1}} = \frac{m_{g1}}{10.236 m_{g1} + m_{g1}} = \frac{1}{10.236 + 1} \leftarrow$$

b) v_1 can be found knowing T_1, x_1

$$v_1 = v_2$$

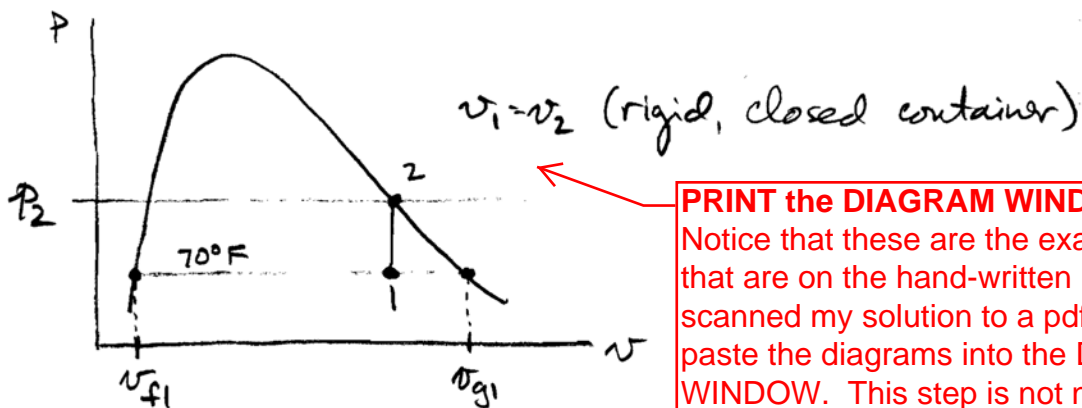
p_2 can be found knowing p_2, x_2



$$T_1 = 70^\circ\text{F}$$

$$m_{f1} = 10.236 m_{g1}$$

The container is heated until all the liquid becomes vapor



PRINT the DIAGRAM WINDOW if you use it. Notice that these are the exact same figures that are on the hand-written preface. I scanned my solution to a pdf file, then cut/paste the diagrams into the DIAGRAM WINDOW. This step is not necessary because you have the diagrams on your hand-written preface. However, it does make for a nice complete EES solution!

ME 322 - ME Thermodynamics
Homework 7

GIVEN: An equilibrium mixture of liquid and vapor water in a rigid container

fluid\$ = 'steam_iapws'

$T_1 = 70$ [F]

$m_{\text{ratio},1} = 10.236$ m_{f1}/m_{g1}

FIND: (a) The initial quality of the mixture

(b) The pressure in the container when the last bit of liquid disappears after heating

PRINT the FORMATTED EQUATIONS WINDOW. This window shows the equations in a nice formatted form which makes it easier to follow when you study for an exam. Notice that the equations are surrounded by MANY comments, including the GIVEN, FIND, and SOLUTION statements. USE COMMENTS generously. Lots of comments help you understand what you did to solve the problem. This is a great way to study for exams!

SOLUTION:

The initial quality of the mixture is given by,

$$x_1 = m_{g1}/(m_{g1} + m_{f1})$$

This is equivalent to (see written preface)

$$x_1 = \frac{1}{m_{\text{ratio},1} + 1}$$

Now that the quality is known at state 1, the initial specific volume can be found,

$$x_1 = \frac{v_1 - v_{f1}}{v_{g1} - v_{f1}}$$

$$v_{f1} = v [\text{fluid}\$, T = T_1, x = 0]$$

$$v_{g1} = v [\text{fluid}\$, T = T_1, x = 1]$$

Since the container is rigid and closed,

$$v_1 = v_2$$

The final state is saturated vapor. Therefore we know two independent, intensive properties!

$$p_2 = P [\text{fluid}\$, v = v_2, x = 1]$$

SOLUTION

Unit Settings: Eng F psia mass deg

fluid\$ = 'steam_iapws'

p2 = 4.747 [psia]

v1 = 77.19 [ft³/lbm]

v_{f1} = 0.01605 [ft³/lb_m]

x1 = 0.089

m_{ratio,1} = 10.24

T₁ = 70 [F]

v₂ = 77.19 [ft³/lbm]

v_{g1} = 867.2 [ft³/lb_m]

No unit problems were detected.

KEY VARIABLES

x1 = 0.089 (a) quality at the initial state

p2 = 4.747 [psia] (b) pressure at the final state



PRINT the SOLUTIONS WINDOW including all variables in the problem and the KEY VARIABLES. The Key Variables are the answer(s) requested in the problem statement. In the Solution Window, right-click or double-click on the variable and specify it as a Key Variable. It will show up as a Key Variable in your solution!

REFLECTION:

This problem is a good reminder of what thermodynamic quality is and where it is valid. We learn that $x = 1$ on the saturated vapor line! This also implies that $x = 0$ on the saturated liquid line.

$v_1 = v_2$ must be true for a closed, rigid container. Can you prove that this is true?

PRINT the REPORT WINDOW. The Report Window contains your Reflection to the problem. The Report Window is a mini word processor. It is the last thing to print, which makes it a nice way to present your Reflection.

Other things to PRINT (if required by the problem statement):

- If the problem statement requires a parametric study, PRINT the PLOT WINDOW(s) that show the result of your parametric study.
- DO NOT print the Parametric Table. Often times, the Parametric Table is very large and it is a waste of paper to print out all those numbers! The Plot Window is sufficient to see the result of the parametric study.
- If you work a problem using Array Variables, print out the ARRAYS TABLE. Using Arrays can be very helpful when we start looking at thermodynamic cycles that have many state points. The table is an easier way to keep track of the properties required for the solution.
- The EES Print window below shows the boxes to check when you are printing your solution to hand in.

