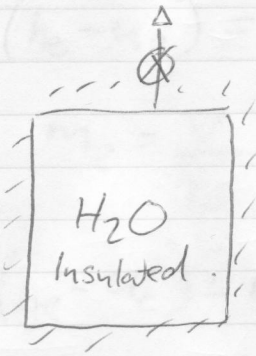
QUIZ 4 (DGD #1)

6.126/ Given:



State 1	State 2	State e
$x_1 = 1$		$x_e = 1$
$P_1 = 4\,MPa$	$P_2 = 1\,MPa$	
$V_1 = 2\,m^3$		

Assumptions: 1. Rigid tank
2. Neglect KE + PE.

Solving:

Mass conservation $\frac{dm}{dt} = -\dot{m}_e \Rightarrow \int_1^2 dm = -\int_1^2 \dot{m}_e\,dt$

$m_2 - m_1 = -m_e$

or $m_e = m_1 - m_2$

energy $\frac{dE}{dt} = \frac{dU}{dt} = \dot{Q} - \dot{W} - \dot{m}_e h_e$ (Q and W = 0)

$\int_1^2 dU = -\int_1^2 \dot{m}_e h_e \Rightarrow m_2 u_2 - m_1 u_1 = -m_e h_e$

from table B.1.2 $\Rightarrow$ State 1

$v_1 = 0.04978\,m^3/kg$

$u_1 = 2602.27\,kJ/kg$

$h_1 = 2801.38\,kJ/kg$

$\therefore m_1 = \frac{V_1}{v_1} = \frac{2}{0.04978} = 40.177\,kg$

State e $h_e = h_{AVG(1\to2)} = \frac{h_{g@4MPa} + h_{g@1MPa}}{2} = 2789.73\,kJ/kg$

substituting mass equation into energy yields:

$$m_2(h_e - u_2) = m_1(h_e - u_1)$$

also, $m_2 = \frac{V}{v_2}$.

$$\therefore \frac{V}{v_2}(h_e - u_e) = m_1(h_e - u_1)$$

(1) $$\frac{2\,m^3}{v_2}(2789.73 - u_2) = (40.177)(2789.73 - 2602.27)$$

Still have 2 unknowns....

But $\longrightarrow$ $v_2 = v_f + v_{fg} x_2$

$u_2 = u_f + u_{fg} x_2$

$\Downarrow$ at $P = 1\,MPa$ $\Rightarrow$

$v_f = 0.001127\ m^3/kg$

$v_{fg} = 0.19332\ m^3/kg$

$u_f = 761.67\ kJ/kg$

$u_{fg} = 1821.97\ kJ/kg$

v_f = ~~0.001252~~ m^3/kg

v_{fg} = ~~0.1694~~ m^3/kg

u_f = ~~1082.28~~ kJ/kg

u_{fg} = ~~1510.99~~ kJ/kg

$\therefore X_2$ is the only unknown. Substitute for v_2 + u_2 in eqn (1) + solve for X_2.

$$X_2 = 0.7936$$

$$\therefore v_2 = v_f + X_2 v_{fg} = \text{~~0.1073959~~}\ 0.1545\ m^3/kg$$

$$\therefore m_2 = \frac{V}{v_2} = \frac{2}{\text{~~0.10739~~}\ 0.1545} = 12.94\ kg$$

$$\therefore m_e = m_1 - m_2 = 40.177 - 12.94 = \underline{27.24\ kg}$$