KHWAJA FAREED

UEIT

RAHIM YAR KHAN

Topic	:	Mid Term Exam Answer Sheet
Submitted by	:	Amjid Ali
Submitted to	:	Dr. Aamir Alaud Din
Roll No.	:	CHEN-19111046
Class	:	BS-CHEN-3
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Khwaja Fareed University of Engineering & Information Technology, Rahim Yar Khan.

(Question NO:1)

1) System:

System refers to the subject matter of analysis. Thermodynamic system or system refers to definite quantity of matter, enclosed by a boundary on which we focus our attention for thermodynamic analysis.

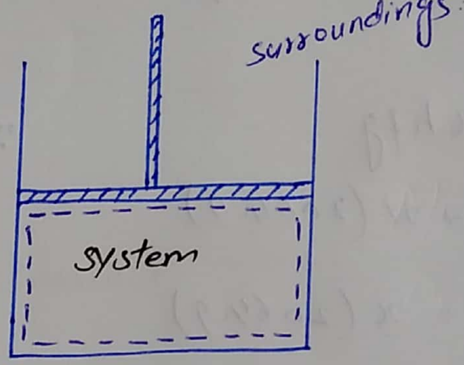

Fig:1

2) Surroundings:

The part of the Universe other than the system is called Surroundings. As shown in Fig:1

3) Adiabatic process:-

No heat transfer through boundries of the system.

4) Isolated process:-

No mass or heat energy trarfer with the environment.

5) Extensive property:

Depends ~~up~~on the mass of the system. e.g: mass, volume, internal energy, Enthalpy, Entropy.

(Question No: 2)

Solution:

Given:

$p = 7$ bar ; $\hat{H} = 2600$ kJ/kg

To find:

specific volume $= \hat{v} = ?$

specific internal energy $= \hat{u} = ?$

Solution:

(i) $\hat{h} = h_f + x h_{fg}$

$2600 = 697.1 + x(2064.9)$

$2600 - 697.1 = x(2064.9)$

$1902.9 = x(2064.9)$

$\frac{1902.9}{2064.9} = x$ $\boxed{x = 0.921}$

(ii) $\hat{v} = v_f + x v_{fg}$ $\boxed{\because v_{fg} = v_g - v_f}$

$= 0.001108 + (0.921)(0.273 - 0.001108)$

$= 0.001108 + (0.921)(0.271892)$

$= 0.001108 + 0.25041$

$\boxed{\hat{v} = 0.2515\ m^3/kg}$

$\hat{U} = ?$

$\hat{U} = u_f + x u_{fg}$

$= 696.3 + 0.921(2571.1 - 696.3)$

$\hat{U} = 699.3 + 0.921(1874.8)$

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$\hat{u} = 696.3 + 1726.6908$

$\boxed{\hat{u} = 2420\ kJ/kg}$

(Question No: 3)

Given:

$m = 10.0\ kg$

$P_1 = 20\ bar$

$V_1 = 1.0\ m^3$

$P_2 = 100\ bar$

PV relation $= PV^{1.5} =$ constant.

To find:

Workdone $= \hat{W} = ?$

heat transfer $= \hat{q} = ?$

(1) Workdone ($\hat{W}$) = ?

$$P_2 = \frac{100\,bar \,|\, 100\,kPa}{|\, 1\,bar} = 10{,}000\,kPa = 10\,MPa$$

$\hat{V}_2 = ?$

$$P_1 \hat{V}_1^{1.5} = P_2 \hat{V}_2^{1.5} \Rightarrow \hat{V}_2^{1.5} = \frac{P_1 \hat{V}_1^{1.5}}{P_2}$$

$$\hat{V}_2 = \left(\frac{P_1 \hat{V}_1^{1.5}}{P_2}\right)^{1/1.5}$$

$$= \left[\frac{2\,MPa \,\Big|\, \left(\frac{0.1\,m^3}{kg}\right)^{1.5} \,\Big|\, 1}{\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \Big|\, 10\,MPa}\right]^{1/1.5}$$

$$= \left(0.2 \times (0.1)^{1.5}\right)^{1/1.5} \; m^3/kg$$

$$= \left(0.2 \times 0.0316\right)^{1/1.5}$$

$$= \left(0.2 \times 0.0316\right)^{0.667}$$

$$\hat{V}_2 = 0.0342 \; m^3/kg$$

$$\hat{W} = -\int_{0.1}^{0.0342} P_E \, d\hat{V} = -\int_{0.1}^{0.0342} p \, d\hat{V}$$

$$P\hat{V}^{1.5} = P_1 \hat{V}^{1.5} \Rightarrow P = \frac{P_1 \hat{V}_1^{1.5}}{\hat{V}^{1.5}}$$

$$P = \frac{2\,mpa \left| \left(\frac{0.1 m^3}{kg}\right)^{1.5} \right| \left(\frac{1 kg}{\hat{V} \; m^3}\right)^{1.5}}{}$$

$$P = \frac{0.0632}{\hat{V}^{1.5}} \; mpa$$

$$\hat{W} = -\int_{0.1}^{0.0342} \frac{0.0632}{\hat{V}^{1.5}} \, d\hat{V}$$

$$= \frac{-0.0632}{-0.5} \left| \frac{1}{\hat{V}^{0.5}} \right|_{0.1}^{0.0342}$$

$$= \frac{-0.0632}{-0.5} \left[\frac{1}{(0.0342)^{0.5}} - \frac{1}{(0.1)^{0.5}} \right]$$

$$= \frac{0.2838 \, mpa \cdot m^3}{kg} \left| \frac{1000 \, KPa}{1 \, mpa} \right| \frac{1 \, KN}{1 \, KPa \cdot m^2} = 283.8 \frac{KJ}{kg}$$

So

$$\boxed{\hat{W} = 283.8 \; \frac{KJ}{kg}}$$

heat transfer = $\hat{q}$ = ?

$$\Delta \hat{u} = \hat{q} + \hat{w}$$

At state : 1 :

$P_1 = 2\,\text{Mpa}$; $T_1 = 213.6\,°c$

$U_1 = ?$

	$U_1 \left(\frac{kJ}{kg}\right)$	T (°c)	
x_1	2600.3	212.4	y_1
x_2	U_1	213.6	y_2
x_3	2628.3	225	y_3

Interpolating:

$$\frac{Y_2 - Y_1}{X_2 - X_1} = \frac{Y_3 - Y_1}{X_3 - X_1}$$

$$\frac{213.6 - 212.4}{U_1 - 2600.3} = \frac{225 - 212.4}{2628.3 - 2600.3}$$

$$\frac{1.2}{U_1 - 2600.3} = \frac{12.6}{8}$$

$$8(1.2) = 12.6(U_1 - 2600.3)$$

$$9.6 = 12.6\,U_1 - 32,763.78$$

$$9.6 + 32763.78 = 12.6\,U_1$$

$$\frac{32773.38}{12.6} = U_1$$

$$U_1 = 2602.97 \frac{kJ}{kg}$$

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At state 2:

$P_2 = 10\,MPa \; ; \; \hat{V}_2 = 0.0342\, m^3/kg$

	U_2 KJ/kg	$\hat{V}_2$ m³/kg	
x_1	3045.8	0.0328	Y_1
x_2	$\hat{U}_2$	0.0342	Y_2
x_3	3144.5	0.0356	Y_3

After interpolating, we get

$$\hat{U}_2 = 3095.15\, KJ/kg$$

$$\Delta\hat{U} = \hat{U}_2 - \hat{U}_1$$

$$= (3095.15 - 2602.97)\, KJ/kg$$

$$= 492.18\, KJ/kg$$

$$\Delta\hat{U} = \hat{q} + \hat{W}$$

$$\hat{q} = \Delta\hat{U} - \hat{W}$$

$$= (492.18 - 283.8)\, \frac{KJ}{kg}$$

$$\hat{q} = 208.38\, KJ/kg$$

So

$$\hat{q} = 208.38\, \frac{KJ}{kg}$$

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