KHWAJA FAREED
UEIT
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Faculty of Engineering

Subject : **Thermodynamics-I (CHEN-2102)**

TOPIC : **Mid exam**

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Q NO: 01

System:-

A system is the set of substance that being studied i.e Chemical reaction or physical reactions occur in a reactor. All things in the reactor is system.

Surroundings:-

Everything in the universe around the system is called surrounding

Adiabatic:-

Adiabatic is that process in which no heat and mass is release and enter between system and surrounding.

Isolated System:-

Isolated System is that which cut off the connection between system and surrounding. Isolation may be Physical or chemical. like a example of thermose.

Extensive:-

Extensive property depend on the size of the system as size change its properties Change and denoted by capital letter like volume is "V" im m^3.

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Q NO:- 02

Solution:- As pressure is give 07 bar
First of all find dryness fraction because at 2600 KJ/kg is not at 7 bar.
So from steam table:-

specific enthalpy of liquid $= \hat{h}_f = 697\ KJ/kg$
Change in specific enthalpy $= \Delta \hat{h}_{fg} = 2067\ KJ/kg$
Given specific enthalpy $= \hat{h} = 2600\ KJ/kg$

$\hat{V}_g = 0.2728$

$$\text{Dryness fraction} = x = \frac{\hat{h} - \hat{h}_f}{\hat{h}_{fg}} = \frac{2600 - 697}{2067}$$

$$x = 0.921$$

specific volume

$$\hat{V} = x\hat{V}_g$$
$$\hat{V} = (0.921)(0.2728)$$
$$\hat{V} = 0.2515\ m^3/kg$$

Internal energy $\hat{U}_f = 696\ KJ/kg$, $\hat{U}_g = 2573\ KJ/kg$

$$\hat{U} = (1-x)\hat{U}_f + x\hat{U}_g$$
$$= (1-0.921)696 + (0.921)(2573)$$
$$= (55 + 2365)\ KJ/kg$$

$$\hat{U} = 2420\ KJ/kg$$

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Q.NO:-03

Consider a piston cylinder assembly containing 10 kg of water. Initially the gas has a pressure of 20 bar and occupies volume of $1 m^3$. The system undergoes a reversible process in which it is compressed to 100 bar

The $PV^{1.5} = const$

calculate work done and heat transfer during process

Solution:-

mass of water = 10 kg = m

Pressure initially = P_1 = 20 bar = 2 MPa

$V_1 = 1.0 \, m^3$

P_2 = 100 bar. = 10 MPa

As $P\hat{V}^{1.5} = const.$

work = $\hat{W}$ = ?

Heat = $\hat{Q}$ = ?

For work

$$\hat{W} = -\int P_E \, d\hat{V}$$

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

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

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$$\hat{V}_2 = \left[\frac{2\,MPa \left(\frac{0.1\,m^3}{kg}\right)^{1.5}}{10\,MPa}\right]^{1/1.5}$$

$$\hat{V}_2 = \left(0.2 \times (0.1)^{1.5}\right)^{\frac{1}{1.5}} m^3/kg$$

$$= \left(0.2 \times 0.0516\right)^{0.667}$$

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

Now

$$\hat{W} = -\int_{0.1}^{0.0342} P_E\, d\hat{V} = -\int_{0.1}^{0.0342} P\, d\hat{V} \quad \text{— (1)}$$

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

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

$$= \frac{2\,MPa \left(\frac{0.1\,m^3}{kg}\right)^{1.5}\left(\frac{kg}{\hat{V}\,m^3}\right)^{1.5}}{}$$

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

Now put the value of P in eq (1)

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

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

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

$$= (0.1264)(2.245)\ MPa\ \frac{m^3}{kg} = 0.2830\ MPa\ \frac{m^3}{kg}$$

$$= \frac{0.2830\ MPa\ m^3}{kg}\left|\frac{1000\ KPa}{1\ MPa}\right|\frac{KN}{KPa \cdot m^2} \qquad \because N.m = J$$

$$\hat{W} = 284\ KJ/kg$$

Now Heat,

$$\hat{q} = ?$$

we know that $\Delta\hat{U} = \hat{q} + \hat{W}$

$$\hat{q} = \Delta\hat{U} - \hat{W} \quad — ②$$

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

At stat 1.

$$P_1 = 2MPa$$

Find Temperature at T_1 is by linear interpolation

At 2MPa $\hat{V}_f = 0.0012\ m^3/kg$, $\hat{V}_g = 0.0996\ m^3/kg$

$T\ °C$	$\hat{V}\ (m^3/kg)$
212.4	0.0996
T	0.1
225	0.1038

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By linear interpolation

$T = 213.6^{\circ}C$

Temp. Diff.
$225 - 212.4 = 12.6$

specific velocity diff.
$0.1038 - 0.0996 = 4.2 \times 10^{-3}$

Now at stat 1:- $P_1 = 2\,MPa$
$T_1 = 213.6^{\circ}C$
$\hat{U}_1 = ?$

U_1 (KJ/Kg)	$T^{\circ}C$
2600.3	212.4
U_1	213.6
2628.3	225

By linear Interpolation
$\hat{U}_1 = 2602.97\ KJ/Kg$

At state 2: $P_2 = 10\,MPa$, $\hat{V}_2 = 0.0342\ \frac{m^3}{Kg}$

$\hat{U}_2$ KJ/Kg	$\hat{V}_2$ m^3/Kg
3045.8	0.0328
$\hat{U}_2$	0.0342
3144.5	0.0356

By linear interpolation b/w $\hat{U}$ & $\hat{V}$ we get
$\hat{U}_2 = 3095.15\ KJ/Kg$

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

$$= (3095.15 - 2602.97) \frac{KJ}{kg}$$

$$\Delta\hat{u} = 429.18 \ KJ/kg$$

Put the values of $\Delta\hat{u}$ & $\hat{w}$ in eq (2)

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

$$\hat{q} = (492.18 - 283.8) \ KJ/kg$$

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