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Paper: Thermodynamics-i

Department: Chemical Engineering.

3rd Semester.

Q No 1.

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①

① **System:-** In Thermodynamics, the system is defined as a definite space or area on which the study of energy transfer and energy conversion is made:

Example: Transport system, solar, Telelphone, e.t.c

(2) **Surroundings:-** Any thing out-side the system which effects the behaviour of the system is known as Surrounding

Example:- Radiator, Air, e.t.c.

(3) **Adiabatic Processes:-**
Adiabatic is a Thermodynamics processes where no heat energy is being supplied to the system.

(4) Isolated System:-

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⇒ System in which neither mass nor energy cross the boundries of the system.

Example: A Thermos flask.

(5) Extensive Property:-

⇒ Extensive properties are those that change as the size of an object changes. If the size of the system doubles, then value of an extensive property simply doubles as well.

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Q No 2 :

Given Data :

Pressure = P = 7 bar

Specific Enthalpy = $\hat{H}$ = 2600 KJ/kg

To Find =

Specific volume = ? $\hat{V}$

Specific internal Energy = $\hat{U}$ = ?

Solution :

(1) $\hat{h} = h_F + x h_{Fg}$

$2600 = 697.1 + x(2064.9)$

$2600 - 697.1 = x(2064.9)$

$x = \dfrac{1902.9}{2064.9}$

$\boxed{x = 0.921}$

(2) $\hat{V} = v_f + x v_{fg}$

$= 0.001108 + (0.921 - 0.001108)$

$= 0.001108 + (0.921)(0.273)$

$= 0.001108 + \cancel{0.273}\ 0.25041$

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

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

$= 696.3 + (0.921)(2571.1 - 696.3)$

$= 696.3 + 1726.69$

$\boxed{\hat{u} = 2420.02\ kJ/kg}$

Q NO 3 -

Data -

$m = 10.0\ kg$

$P_1 = 20\ bar$

$V_1 = 1.0\ m^3$

$P_2 = 100\ bar$

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

(a) $T = ?$

$$P_1 = \frac{20\ bar}{} \Big| \frac{100\ KPa}{1\ bar} = 2000\ KPa = 2\ MPa.$$

$$\hat{V}_1 = \frac{1.0\ m^3}{10\ kg} = 0.1\ m^3/kg$$

From steam tables at $P = 2\ MPa$

$\hat{V}_L = 0.0012$ $\hat{V}_2 = 0.0996$

(b) Since $\hat{V}_1 > \hat{V}_v$ ~~= 0.0996~~ at $P = 2\,MPa$

the steam is super heated.

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

$$= \frac{0.2838\,\cancel{MPa}\cdot\cancel{m^3}}{kg}\left|\frac{1000\,\cancel{kPa}}{1\,\cancel{MPa}}\right|\frac{1\,kN}{1\,\cancel{kPa}\cdot\cancel{m^2}}$$

$= 283.8\ kJ/kg$

(c) $q = ?$ $\Delta\hat{U} = \hat{q} + \hat{w}$

At state 1 $P_1 = 2\,MPa$ $T_1 = 213.6\,°C$

$U_1 = ?$

$U_1\ (kJ/kg)$	$T(°C)$
2600.3	212.4
U_1	213.6
2628.3	225

$\hat{u}_1 = 2602.97 \text{ KJ/Kg}$

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At state 2, $P_1 = 10 MPa$, $\hat{V}_2 = 0.0342 \frac{m^3}{Kg}$

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

$$\hat{U}_2 = 3095.15 \text{ KJ/Kg}$$

$$\hat{W} = -\int_{0.1}^{0.342} P_E \, d\hat{v} = -\int_{0.1}^{0.0342} P \, d\hat{v}$$

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

$$P = \frac{2 MPa \left| \left(\frac{0.1 \, m^3}{Kg}\right)^{1.5} \right|}{} \left| \left(\frac{Kg}{\hat{v} \cdot m^3}\right)^{1.5} \right.$$

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

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

=

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

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

$$= \frac{0.0632}{0.5} (5.4074 - 3.1028)$$

$$= \frac{-0.1419 \cancel{MPa} \cdot \cancel{m^3}}{-0.5 \quad kg} \left| \frac{1000 \cancel{kPa}}{\cancel{1MPa}} \right| \frac{1 kN}{1 \cancel{kPa} \cdot \cancel{m^2}}$$

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

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

$$\Delta\hat{U} = 492.18 \text{ kJ/kg}$$

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

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

$$\hat{q} = 208.38 \text{ kJ/kg}$$

(a) $T = ?$

$T_2\,(°C)$	$\hat{V}_2\ (m^3/kg)$
500	0.0328
T	0.0342
550	0.0356

$$T_2 = 525.0°C$$

$$y = \left[(y_2 - y_1)\left(\frac{x - x_1}{x_2 - x_1}\right)\right] + y_1$$

$$T = (225 - 212.4)\left(\frac{0.1 - 0.0996}{0.1038 - 0.0996}\right) + 212.4$$

$$T = 213.6\ °C$$

(b) $\hat{w} = ?$

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

$\hat{V}_2 = ?$

$$P_1 \hat{V}_1^{1.5} = P_2 \hat{V}_2^{1.5} \Rightarrow V_2^{1.5} = \frac{P_1 V_1^{1.5}}{P_2}$$

$$\hat{V}_2 = \left(\frac{(P_1 V_1^{1.5})}{P_2}\right)^{\frac{1}{1.5}}$$

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

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

$$= (0.2 \times 0.0316)^{\frac{1}{1.5}} = (0.2 \times 0.0316)^{0.667}$$

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