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Q no-01

1) System:-

Def: In thermodynamics, the system is defined as a definite ~~shape~~ space or area on which the study of energy transfer and energy conversions is made.

e.g: transport system, solar system, telephone system etc

2) Surroundings:-

Def: Anything outside the system which affects the behaviour of the system is known as surrounding.

e.g: Radiator, exhaust system, air

3) Adiabatic Process:-

Def: Adiabatic is a thermodynamic process where no heat energy is being supplied to the system.

4) Isolated system:-

The system in which neither mass nor energy cross the boundaries of the system e.g: A thermos flask

5) Extensive Property:-

Extensisive Properties are those that change as the size of an object changes. If the size of the system doubles, the value of an extensive property simply doubles as well.

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:-

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

$2600 = 697.1 + x(2064.9)$

$2600 - 697.1 = x(2064.9)$

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

$\boxed{x = 0.921}$

(ii) $\hat{V} = V_f + x V_{fg}$

$= 0.001108 + (0.92)(0.273) - 0.001108$

$= 0.001108 + 0.25041$

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

$\hat{u} = V_f + x V_{fg}$

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

$= 696.3 + 1726.69$

$\boxed{\hat{u} = 2420.02 \text{ KJ/Kg}}$

Q3:

$m = 10.0\,kg$

$P_1 = 20\,bar$

$V_1 = 1.0\,m^3$

$P_2 = 100\,bar$

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

(a) $T = ?$

$$P_1 = \frac{20\,bar \,|\, 100\,kPa}{\,|\, 1\,bar} = 2000\,kPa = 2\,MPa$$

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

From steam tables, at $P = 2\,MPa$

$\hat{V}_l = 0.0012$, $\hat{V}_v = 0.0996$

Since $\hat{V}_1 > \hat{V}_v$ at $P = 2\,MPa$

the steam is superheated

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

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

$= 283.8 \ KJ/kg$

$\hat{w} = 283.8 \ KJ/kg$

(c) $v = ?$

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

As state 1, $P_1 = 2MPa$, $T_1 = 213.6^\circ C$

$u_1 = ?$

u_1 (KJ/kg)	T(°C)
2600.3	212.4
u_1	213.6
2628.3	225

$u_1 = 2602.97 \ KJ/kg$

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

$\hat{u}_2$ (KJ/kg)	$\hat{v}_2$ (m^3/kg)
3045.8	0.0328
$\hat{u}_2$	0.0342
3144.4	0.0356

$\hat{u}_2 = 3095.15 \ \frac{KJ}{Kg}$

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

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

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

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

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

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

$$= -\frac{0.0632}{-0.5}\left[\frac{1}{0.0342^{0.5}} - \frac{1}{0.1^{1.5}}\right]$$

$$= -\frac{0.0632}{-0.5}(5.4074 - 3.1632)$$

$$= -\frac{0.1419\,\cancel{MPa}\cdot \cancel{m^3}}{-0.5\;kg} \cdot \frac{1000\,\cancel{kPa}}{1\,\cancel{MPa}} \cdot \frac{1\,kN}{1\,\cancel{kPa}\cdot\cancel{m^3}}$$

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

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

$$\Delta u = 492.18\,kJ/kg$$

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

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

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

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

(d) $T = ?$

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

$T_2 = 525.0°C$

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

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

$T = 213.6°C$

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

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

$\hat{V}_2 = ?$

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

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

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

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

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

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