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CHEN 19111024

Thermodynamics-I

Q. No. (2)

Given data:-

Pressure $= P = 7$ bar

Specific enthalpy $= \hat{H} = 2600$ KJ/Kg

Requirement:-

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) $\hat{v} = v_f + x v_{fg}$

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

$= 0.001108 + (0.92)(0.271892)$

$= 0.001108 + 0.25041$

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

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

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

$= 696.3 + (1726.69)$

$\boxed{\hat{u} = 2420 \ KJ/Kg}$

Q. No. (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.

e.g. Solar, Telephones etc.

Surroundings:-

Any thing outside the system which affects the behaviour of the system known as surroundings.

e.g. Radiator, air etc.

Adiabatic process:-

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

Isolated system:-

The system in which neither mass nor energy cross the boundaries of the system is called isolated system. e.g. Thermos flask.

Extensive property:-

Extensive properties are those properties 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.

Q.No. (3)

$m = 10.0\ Kg$

$P_1 = 20\ bar$

$V_1 = 1.0\ m^3$

$P_2 = 100\ bar$

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

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

$$P = \frac{100\ \cancel{bar} \mid 100\ KPa}{\mid 1\ \cancel{bar}}$$

$= 10\ MPa$

$\hat{V}_2 = ?$

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

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

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

$$\hat{V}_2 = (0.2 \times 10.1^{1.5})^{1.5}\ m^3/Kg$$

$$= (0.8 \times 0.0316)^{1/1.5}$$

$$= (0.2 \times 0.0316)^{0.663}$$

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

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

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

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

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

$$\hat{W} = -\int_{0.1}^{0.342} \frac{0.0632}{\hat{V}^{1.5}} \, d\hat{V}$$

$$= \frac{-0.0632}{-0.5} \left| \frac{1}{\hat{V}^{1.5}} \right|_{0.1}^{0.0342}$$

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

$$= \frac{0.2838\,MPa \cdot m^{\cancel{3}}}{Kg} \left| \frac{1000\,\cancel{KPa}}{1\,MPa} \right| \frac{1\,KN}{1\,\cancel{KPa} \cdot \cancel{m^2}}$$

$$= 283.8\,KJ/Kg$$

$$\boxed{\hat{W} = 283.8\,KJ/Kg}$$

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

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

At state 1,

$P_1 = 2 MPa$, $T_1 = 213.6°C$

$\hat{u}_1 = ?$

$\hat{u}_1$ (KJ/Kg)	T(°C)
2600.3	212.4
$\hat{u}_1$	213.6
2628.3	225

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

At state 2,

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

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

$$\hat{u}_2 = 3095.15 \; KJ/Kg$$

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

$$= (3095.15 - 2602.97) \; KJ/Kg$$

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$$\Delta\hat{U} = 492.18 \text{ KJ/Kg}$$

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

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

$$= (492.18 - 283.8) \text{ KJ/Kg}$$

$$\boxed{\hat{q} = 208.38 \text{ KJ/Kg}}$$