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Bs-Chem- 3
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Thermodynamics-1

Question no# 1

system:

Everything under consideration or under interest is called a system. For example a piston cylinder assembly is a system. Everything inside is a system. We determine its T, P, V, h, u, s so it is under interest.

surroundings:

The rest of universe except system is called surroundings. The surrounding is separated from the system by system boundary. So all the universe except system is surroundings.

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Adibatic system:

Adibatic system is a system in which no heat transfer b/w the system and surrounding. It does not mean that temprature of the system remains constant it mean that only heat transfer not accur or there is no driving force.

Isolated system:

An isolated system is a system in which no transfer of energy and mass b/w the system and surroundings. So it is closed by some insolated matter.

Extensive Property:

It is a property of the system which is proportional or which is depend upon the quantity of the material.

m, n, V are some examples of extensive properties.

E_K, E_P, U are also extensive properties.

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Question no #2

Given Data:

pressure $= 7$ bar
$\hat{h}$ = specific ethalapy = 2600 kJ/kg.

To Find:

$\hat{v}$ = specific volume = ?
$\hat{u}$ = specific internal energy = ?
~~$\hat{h}$ = specific ethalapy = ?~~

Solution:

First of all we have to find the dryness fraction.

From saturate steam table at 7 bar.

$\hat{h}_l = 697$ kJ/kg , $\hat{h}_v = 2764$ kJ/kg.

$\hat{h} = 2600$ kJ/kg

$$x = \frac{h - h_l}{h_v - h_l}$$

$$= \frac{2600 - 697}{2764 - 697} = \frac{1903}{2067}$$

$$\boxed{x = 0.9207}$$

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Now by using dryness fraction we can calculate the internal energy and specific volume.

$v'' = x\, v_g$

$= 0.9207 \times 0.228\, m^3/kg$ $\quad (v_g = 0.228\, m^3/kg)$

$\boxed{v'' = 0.2151\, m^3/kg}$

Internal Energy

$u'' = (1-x)u_l + x u_v$

$= (1-0.921)696 + 0.921 \times 2573$

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

Hence the value of specific volume is $0.2151\, m^3/kg$ and the value of specific internal energy is $2420\, kJ/kg$.

Q-NO#3

Given Data:

Mass of water $= m = 10\, kg$
Initial Pressure $= P_1 = 20\, bar$
Initial volume $= V_1 = 1\, m^3$

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The prosess accur in a given system is reversible in which work of compression accur.

Final pressure $= P_2 = 100\ bar$

Pressure - volume relationship $= PV^{1.5} = constant.$

To Find:

W = work done = ?

q = heat transfer = ?

Solution:

We first calculate the work of compression.

For this we convert the units of pressure.

$$P_1 = \frac{2\,bar \mid 10^5\,Pa}{\mid 1\,bar} = 2\,MPa$$

$$P_2 = \frac{100\,bar \mid 10^5\,Pa}{\mid 1\,bar} = 10\,MPa.$$

As $V = 1\,m^3$

$$\hat{V}_1 = \frac{V}{m} = \frac{1\,m^3}{10\,kg} = 0.1\,m^3/kg.$$

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As we know that

$$\hat{W} = -\int_{V_1}^{V_2} P_E \, d\hat{V}$$

$$P = P_E$$

$$\hat{W} = -\int_{\hat{V}_1}^{\hat{V}_2} P \, dV$$

$$\hat{W} = -\int_{\hat{V}_1}^{\hat{V}_2} \frac{P_1 \hat{V}_1^{1.5}}{\hat{V}^{1.5}} \, d\hat{V} \quad \text{——— (1)}$$

so

As we know that

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

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

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

$$\hat{V}_2 = \left(\frac{2\,MPa \left(\frac{0.1\,m^3}{kg} \right)^{1.5}}{\cancel{10}\,5\,MPa} \right)^{1/1.5}$$

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

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$$\hat{v}_2 = (0.2 \times 0.0316)^{0.666}$$

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

Now from ①

$$\hat{W} = -\int_{0.1}^{0.0342} \frac{P_1 \hat{V}_1^{1.5}}{\hat{v}^{1.5}}\, dV \quad \text{———} \quad ②$$

$$\frac{P_1 \hat{V}_1^{1.5}}{\hat{v}^{1.5}} = \frac{2\,Mpa}{} \left| \left(\frac{0.1\,m^3}{kg}\right)^{1.5} \right| \left(\frac{kg}{\hat{v}^{1.5}\,m^3}\right)^{1.5}$$

$$\frac{P_1 \hat{v}_1^{1.5}}{\hat{v}^{1.5}} = \frac{0.0632}{\hat{v}^{1.5}}\, Mpa$$

from ②

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

$$= -\frac{0.0632\,Mpa}{0.5}\left[\frac{1}{0.0432^{0.5}} - \frac{1}{0.1^{0.5}}\right]$$

$$= \frac{0.2038\,Mpa}{} \left| \frac{m^3}{kg} \right| \frac{10^6\,Pa}{1\,Mpa} \left| \frac{1N}{1Pa \cdot m^2} \right| \frac{1J}{} \left| \frac{1kJ}{} \right.$$

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$$\boxed{\hat{W} = 283.84\, kJ/kg}$$

Now we calculate the value of q.

For this first we have to find the initial temprature.

From steam table at 2MPa.

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

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

$$y = \frac{y_h - y_l}{x_h - x_l}(x - x_l) + y_e$$

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

$$\boxed{T = y = 213.6^\circ C.}$$

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Now

$q^n = \Delta u^n - w^n$

$\Delta u = u_2 - u_1$

At state 1 $P = 2MP$, $T = 213.6°C$

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

$$y = \frac{y_h - y_l}{x_h - x_l}(x - x_l) + y_l$$

$$= \frac{2628.3 - 2600.3}{225 - 212.4}(213.6 - 212.4) + 2600.3$$

$u = 2602.96$ kJ/kg

At state 2 $P = 10$ MPa, $v_2^n = 0.0342 m^3/kg$

~~v_2 (m³/kg)~~
~~3045.8~~
~~y~~
~~3144.5~~

v_2^n (m³/kg)	u_2^n (kJ/kg)
0.0328	3045.8
0.0342	y
0.0356	3144.5

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$$y = \frac{y_h - y_l}{x_h - x_l}(x - x_l) + y_l$$

$$= \frac{3144.5 - 3045.8}{6.0356 - 6.0328}(6.0342 - 6.0328) + 3045.8$$

$u_2 = 3095.16$ KJ/kg

$\Delta\hat{u} = u_2 - u_1$

$\cancel{= 2602.9 \cdot 30}$

$= (3095.16 - 2602.96)$ KJ/kg.

$$\boxed{\Delta\hat{u} = 492.2 \text{ KJ/kg}}$$

Now

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

$= (492.2 - 283.84)$ KJ/kg

$$\boxed{\hat{q} = 208.36 \text{ KJ/kg}}$$