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Mid Term paper

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Submitted to

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for

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Q# 2

Compute specific volume and specific Internal Energy of steam at 7 bar and specific Enthalphy $2600 \frac{kJ}{kg}$?

Sol:

Given

Pressure $= P = 7$ bar

Specific Enthalphy $= \hat{h} = 2600 \frac{kJ}{kg}$

Need to Find

Specific Volume $= \hat{v} = ?$

Specific Internal Energy $= \hat{u} = ?$

To Find specific volume we have to find First dryness fraction "x"

Dryness fraction $= x = ?$

From saturated steam table @ 7bar and $2600 \frac{kJ}{kg}$ specific Enthalpy, we have

Specific Enthalpy of Liquid $= \hat{h}_f = 697 \frac{kJ}{kg}$

Specific Enthalpy of vaporization $= \hat{h}_{fg} = 2067 \frac{kJ}{kg}$

Given total specific Enthalpy of steam $= \hat{h} = 2600 \frac{kJ}{kg}$

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For dryness fraction (for wet steam)

$$\hat{h} = h_f + x\,\hat{h}_{fg}$$

$$\Rightarrow x = \frac{\hat{h} - \hat{h}_f}{h_{fg}}$$

putting values in above equation

$$x = \frac{2600\ \frac{kJ}{kg} - \frac{697\ kJ}{kg}}{2067\ \frac{kJ}{kg}}$$

$$\boxed{x = 0.921}$$

For Specific volume

$$\hat{V} = x\,\hat{V}_g$$

$\Rightarrow$ From steam table @ 7bar and $2600\ \frac{kJ}{kg}$ of $\hat{h}$

specific volume of steam $= \hat{V}_g = 0.2728\ \frac{m^3}{kg}$

so

$$\hat{V} = (0.921) \times \left(0.2728\ \frac{m^3}{kg}\right)$$

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

For Specific Internal Energy

From steam table @ 7 bar and $2600\ \frac{kJ}{kg}$ of $\hat{h}$

we have

$\Rightarrow \hat{U}_f =$ Specific Internal Energy of liquid $= \hat{U}_f = 696\ \frac{kJ}{kg}$

Specific Internal Energy of vapours $= \hat{U}_g = 2573\ \frac{kJ}{kg}$

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Specific Internal Energy

$$\hat{u} = (1-x)\hat{u}_f + x\,\hat{u}_g$$

putting values

$$= (1 - 0.921)\,696\,\frac{kJ}{kg} + (0.921)\left(2573\,\frac{kJ}{kg}\right)$$

$$= 55\,\frac{kJ}{kg} + 2365\,\frac{kJ}{kg}$$

$$\Rightarrow \boxed{\hat{u} = 2420\,\frac{kJ}{kg}}$$

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Q # 1

(i) System

A system is set of substances and energy that is beign studies or under consideration. for example, raction are occuring in a jar, everthing insid the jar is system,

or The Region of universe in which we are intrested and Rest universe will be surrounding.

(ii) Surroundings:-

Except the system under consideration every thing in the universe is sorrounding

OR sorrounding is everthing else that is not defined by system.

OR Across system boundry other things are surroundings.

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(iii) Adiabatic System

In thermodynamics Adiabatic system or Adiabatic process is a type of thermodynamics process which occurs without transfering heat or mass between the system and surroundings

OR

Adiabatic system or process in which no heat in or no heat out from the system.

No heat exchange with surroundings

(4)(iv) Isolated System:-

An Isolated system is either of the following, a physical system so far removal from other systems that it does not interact with them. A thermoflask is the best example of an isolated system

OR

A system that does not allow the tranfer of either mass or energy to, or from its surroundings

Extensive property.

Properties which are quantity or mass dependant. are extensive. amount or volume of system define is compulsory for extensive property Fore exempl volume, amount of mole et cetore

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Q NO. 3

Solution

Given

Mass of water $= m = 10\ kg$

Initially pressure $= P_1 = 20\ bar = 2\ Mpa$

state ① volume $= V_1 = 1.0\ m^3$

state ② Pressure or final pressure $= P_2 = 100\ bar = 10\ Mpa$

As $P\hat{V}^{1.5} = \text{Const}$

work $= \hat{W} = ?$

Heat $= \hat{q} = ?$

For work

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

By gas law

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

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

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

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

$$= \left(0.2 \times 0.05167\right)^{0.667}$$

$$\hat{V}_2 = 0.342 \frac{m^3}{kg}$$

So

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

By Gas law

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

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

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

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

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putting "P" values in (1)

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

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

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

$$= (0.1264)(2.245) \text{ Mpa} \frac{m^3}{kg} = 0.2830 \text{ mpa} \frac{m^3}{kg}$$

$$= \frac{0.2830 \text{ mpa}}{} \left| \frac{m^3}{kg} \right| \frac{1000 \text{kpa}}{1 \text{ mpa}} \left| \frac{kN}{kpa \cdot m^2} \right| \frac{J}{N \cdot m} \quad \therefore N \cdot m = J$$

$$\hat{w} = 284.1 \frac{kJ}{kg}$$

For Heat

$$\hat{q} = ?$$

As we know

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

$$\Rightarrow \hat{q} = \Delta\hat{U} - \hat{w} \quad \text{——— (2)}$$

and

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

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From state 1

$P_1 = 2\ Mpa$

Find temp at T_1 is by linear Interpolation

At 2Mpa

$\hat{V}_l = 0.0012\ \frac{m^3}{kg}$

$\hat{V}_g = 0.0996\ \frac{m^3}{kg}$

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

By linear Interpolation

$T = 213.6°C$

AT state 1, $P_1 = 2Mpa$

$T_1 = 213.6\ °C$

$U_1 = ?$

$\hat{U}_1\ (\frac{kJ}{kg})$	$T\ (°C)$
2600.3	212.4
$\hat{U}_1$	213.6
2628.3	225

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By Linear Interpolation

$$\hat{U}_1 = 2602.99 \ \frac{kJ}{kg}$$

For State (2)

@ $P = 10 \text{ Mpa}$, $\hat{V}_2 = 0.0342 \ \frac{m^3}{kg}$

$\hat{U}_2 \ \frac{kJ}{kg}$	$\hat{V}_2 \ (\frac{m^3}{kg})$
3045.8	0.0328
$\hat{U}_2$	0.0342
3144.5	0.0356

By Interpolation

$$\hat{U}_2 = 3095.15 \ \frac{kJ}{kg}$$

so

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

$$= \left(3095.15 \ \frac{kJ}{kg} - 2602.99 \ \frac{kJ}{kg}\right)$$

$$\Delta\hat{U} = 429.2 \ \frac{kJ}{kg}$$

put the values of $\Delta \hat{U}$ & $\hat{w}$

in equation (2)

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

$$\Rightarrow \hat{q} = (492.2 - 283.8)\ \frac{kJ}{kg}$$

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