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Pg # 01

Q1

i) **System:**
In Engineering Thermodynamics, anything under consideration or observation or of our interest is called system.

Eg: water in the container

ii) **Surrounding:**
~~All~~ whole the universe except our system is reffered to as Surrounding

iii) **Adiabatic Process:** A process in which no heat enters or leaves the system is called adiabatic process

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iv) **Isolated System:**

The system in which energy and matter cannot exchange through system and boundries

v) **Extensive property:**

The thermodynamics properties which depend upon mass or size are called extensive properties

Example=

Volume, entropy

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PS # 03

Q2:

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:

As we know that

$$\hat{h} = h_f + x h_{fg} \longrightarrow (1)$$

using steam table

at 7 bar pressure

$h_f = 697.1\ kJ/kg$; $h_{fg} = 2064.9\ kJ/kg$

putting the value

$$2600\ kJ/kg = 697.1\ kJ/kg + x(2064.9\ kJ/kg)$$

$$x(2064.9) = 2600\ kJ/kg - 697.1\ kJ/kg$$
$$= 1902.9\ kJ/kg$$

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

$$\boxed{x = 0.92}$$

Now,

$$\hat{v} = x v_g$$

at $P = 7\,bar$, $v_g = 0.273\,m^3/kg$

$$\hat{v} = (0.92)(0.273\,m^3/kg)$$

$$\boxed{\hat{v} = 0.2514\,m^3/kg}$$

Specific internal energy

$$\hat{h} = \hat{u} + P\hat{v}$$

putting the values

$$2600\,kJ/kg = \hat{u} + \frac{7\,bar}{} \left| \frac{0.2514\,m^3}{kg} \right| \frac{10^5\,Pa}{1\,bar} \left| \frac{N}{1\,Pa\,m^2} \right.$$

$$2600\,kJ/kg = \hat{u} + 175980\,J/kg$$

$$\hat{u} = 2600\,kJ/kg - 175.9\,kJ/kg$$

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$$\boxed{\hat{u} = 2424.02\ kJ/kg}$$

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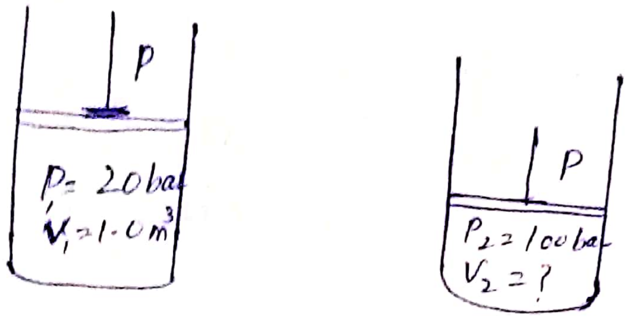
Q3

$P_1 = 2MPa$



, $P_2 = 10 MPa$

Mass of water = m = 10 kg

$\therefore 1 bar = 10^5 Pa$

$\therefore 1 MPa = 10 bar$

To find:

Work done = ?

heat transfer = q = ?

Solution:

As the process of the system

$$P\hat{v}^{1.5} = \text{constant}$$

So, it can be

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

specific volume = $\hat{v}_1 = ?$

$$\hat{v}_1 = \frac{V_1}{m} = \frac{1}{10.} = 0.1 \ m^3/kg$$

As

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

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

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

Putting the value

$$\hat{v}_2 = \left(\frac{2 \times (0.1)^{1.5}}{10}\right)^{1/1.5}$$

$$\boxed{\hat{v}_2 = 0.0341\ m^3/kg}$$

for calculation of work done

Sp. work done $= \hat{w}$

$$\hat{w} = -\int P_E \, d\hat{v}$$

As there are two states

$$\hat{w} = -\int_1^2 P_E \, d\hat{v}$$

As the process is reversible, so

$$P_E = P$$

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$$\hat{w} = -\int_{v_1}^{\hat{v}_2} P \, d\hat{v}$$

$$\therefore \quad P = \frac{P_1 \hat{v}_1^{1.5}}{\hat{v}^{1.5}}$$

$$\hat{w} = -\int_{\hat{v}_1}^{\hat{v}_2} \frac{P_1 \hat{v}_1^{1.5}}{\hat{v}^{1.5}} \, d\hat{v}$$

$$\hat{w} = -P_1 \hat{v}_1^{1.5} \int_{0.1}^{0.0341} \hat{v}^{(-1.5)} \, d\hat{v}$$

$$\hat{w} = -P_1 \hat{v}_1^{1.5} \left[\frac{\hat{v}^{-1.5+1}}{-0.5} \right]_{0.1}^{0.0341}$$

$$\hat{w} = \frac{+P_1 \hat{v}_1^{1.5}}{+0.5} \left[\hat{v}^{-0.5} \right]_{0.1}^{0.0341}$$

$$\hat{w} = 2 P_1 \hat{v}_1^{1.5} \left[\frac{1}{\hat{v}^{0.5}} \right]_{0.1}^{0.0341}$$

$$\hat{w} = 2 P_1 \hat{v}_1^{1.5} \left[\frac{1}{(0.0341)^{0.5}} - \frac{1}{(0.1)^{0.5}} \right]$$

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$$\hat{\omega} = 2 \times \frac{2\,MPa}{} \bigg| \frac{10^6\,Pa}{1\,MPa} \bigg| \frac{N}{1\,Pa\;m^2} \times (0.1)^{1.5} \left(5.415 - 3.16\right.$$

$$= 4 \times 10^6\,Nm/m^3 \times 0.031 \left(m^3/kg\right)^{1.5} \times 2.253 \left(kg/m^3\right)^{0.}$$

$$= 283372$$

$$\boxed{\hat{\omega} = 283.3\ kJ/kg}$$

heat transfer = q = ?

As we know

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

$$q = \Delta\hat{u} - \hat{w} \longrightarrow (ii)$$

first calculate $\Delta\hat{u}$

from steam Table

at $P = 2\,MPa$, $\hat{u}_1 = 2600.3\,kJ/kg$

Now, at $P = 10\,MPa$

Through interpolation

$$\hat{u}_2 = 3094.6\,kJ/kg$$

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

putting in (ii)

$$q = (3094.6\,kJ/kg - 2600.3\,kJ/kg)$$

$$- 283.3\,kJ/kg$$

$$q = 210\,kJ/kg$$

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