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Subject: Thermodynamics.
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Q1

**System:-**

Anything which are kept in consideration is called system

**Surroundings:-**

Everything external to the system is known as surrounding

**Adiabatic process:**

In this process, no heat transfer occurs occurs the system boundary

**Isolated system:**

In an isolated system, neither mass nor energy transfer takes place between the system and its surroundings.

**Extensive property:**

This property depend upon the size and mass.

=> Extensive property are additive.

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## Q2.

**Given Data**

$P = 7 \text{ bar}$

$\hat{h} = 2600 \text{ KJ/Kg}$

**Required**

$x = ?$

$\hat{v} = ?$

$\hat{u} = ?$

**Solution:-**

By using steam table

1. $\hat{h} = h_f + x h_{fg}$

$2600 = 697.1 + x(2064.9)$

$2600 - 697.1 = x(2064.9)$

$1902.9 = x(2064.9)$

$x = \frac{1092.9}{2064.9}$

$\boxed{x = 0.921}$

2. $\hat{V} = V_f + x V_{fg}$

$= 0.001108 + (0.921)(0.273 - 0.001108)$

$= 0.001108 + (0.921)(0.271892)$

$= 0.001108 + 0.25041$

$= 0.2515 \ m^3/Kg$

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3 $\hat{u} = U_f + x U_{fg}$.

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

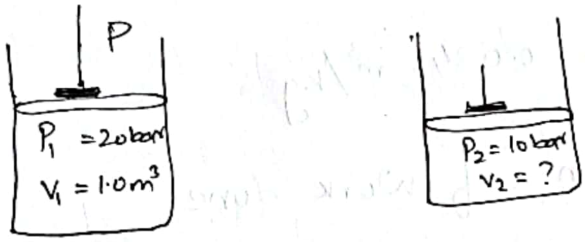
$= 696.3 + (0.921)(1874.8)$

$= 696.3 + 1726.6908$

$= 2420$ KJ/Kg.

Q3

$P_1 = 2MPa$




$P_2 = 10MPa$

Mass of water = m = 10.0 kg

∵ 1 bar = $10^5$ bar
1MPa = 10 bar

To find:

Work done = ?
heat transfer = ?

Solution,

As the process of the system
$P v^{1.5}$ = 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 = $\hat{v}_1 = ?$

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

As

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

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

Putting the value.

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

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

for calculation of work done.

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

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

As there are two states.

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

The process is reversible

$$P_E = P.$$

$$\hat{w} = -\int_{\hat{v}_1}^{\hat{v}_2} P d\hat{v}$$

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$$\hat{\omega} = -\int_{\hat{v}_1}^{\hat{v}_2} \frac{P_1 \hat{v}_1^{1.5}}{\hat{v}^{1.5}} \, d\hat{v} \qquad \therefore P = \frac{P_1 \hat{v}^{1.5}}{\hat{v}^{1.5}}.$$

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

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

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

$$= 2 P_1 v_1^{1.5} \left[ \frac{1}{\hat{v}^{0.5}} \right]_{0.1}^{0.0341}$$

$$= 2 P_1 V_1^{1.5} \left[ \frac{1}{(0.0341)^{0.5}} - \frac{1}{(0.1)^{0.5}} \right]$$

$$\hat{\omega} = 2 \times \frac{2 \cancel{MPa}}{} \left| \frac{10^6 \cancel{Pa}}{1 \cancel{MPa}} \right| \frac{N}{1 \cancel{Pa}\, m^2} \times (0.1)^{1.5} \, (05.415 - 3.162)$$

$$= 4 \times 10^6 \, Nm/m^3 \times 0.031 (m^3/kg)^{1.5} \times (2.253 \, (kg/m^3))^{0.5}$$

$$= 283372. \, J/kg.$$

$$\hat{\omega} = 283.3 \, kJ/kg.$$

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10MPa

$\cdot$ 1b

1M

Now

Apply $1^{st}$ Law

$$q = \Delta U - W$$

$$U_1 = 2600.3 \text{ kJ/kg}$$

For

$$\frac{U_2 - U(T=500)}{U(T=550) - U(T=550)} = \frac{V_2 - V(500^\circ C)}{V(T=550) - V(T=500)}$$

$$U_2 = U(T=500^\circ C) + [U(T=500) - U(T=500)]$$

$$U_2 = \left[\frac{V_2 - V(T=500)}{V(T=550) - V(T=500)}\right]$$

$$U_2 = 3045.8 + [3145.5 - 3045.8]\left[\frac{0.0342 - 0.03279}{0.03564 - 0.03279}\right]$$

$$U_2 = 3094.6 \text{ kJ/kg}$$

$$q = \Delta U - W \Rightarrow (U_2 - U_1) - W$$

$$\boxed{q = 210 \text{ kJ/kg}}$$

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