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Page # 01

Q No: 1

i System :-

Anything under observation called as System.

example:
A gas in cylender is a system

ii Surrounding :-

Remainig Portion of universe except System called as Surrounding.

example: Remainig part of universe except system.

iii Adiabatic process :-

The process in which no heat transferr accrose the System and sorrouding called as adiabatic process.

example:
where $Q = 0$

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iv Isolated system:-

The system in which energy and matter cannot exchange, or through system and boundries.

example:- Thermoflask is example, etc

v Extensive property:-

The property which depend upon the extent mass or size called as Extensive property.

* Extensive property are denoted by Capital letter.

Example:

~~Vol~~ Enthalpy, entropy etc.

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Q No:2

Given Data:-

Pressure $= P = 7 \, bar$

Specific enthalpy $= \hat{h} = 2600 \, kJ/kg$

Find:

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

Specific internal energy $= \hat{U} = ?$

Solution:-

As we know that;

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

By, using steam table; at 7 bar

$$h_f = 697.1 \, kJ/kg$$

$$h_{fg} = 2064.9 \, kJ/kg$$

Putting values;

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

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$$\Rightarrow \quad x(2064.9) = 2600 \text{ kJ/kg} - 697.1 \text{ kJ/kg}$$

$$= 1902.9 \text{ kJ/kg}$$

$$x = \frac{1902.9 \text{ kJ/kg}}{2064.9 \text{ kJ/kg}}$$

$$\boxed{x = 0.92}$$

Now;

$$\hat{V} = x V_g$$

at 7 bar, $V_g = 0.273 \text{ m}^3/\text{kg}$

$$\hat{V} = (0.92)(0.273 \text{ m}^3/\text{kg})$$

$$\boxed{\hat{V} = 0.2514 \text{ m}^3/\text{kg}}$$

Specific internal energy

$$\hat{h} = \hat{U} + P\hat{V}$$

putting values,

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

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

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

$$\boxed{\hat{u} = 2424.1\ kJ/kg}$$

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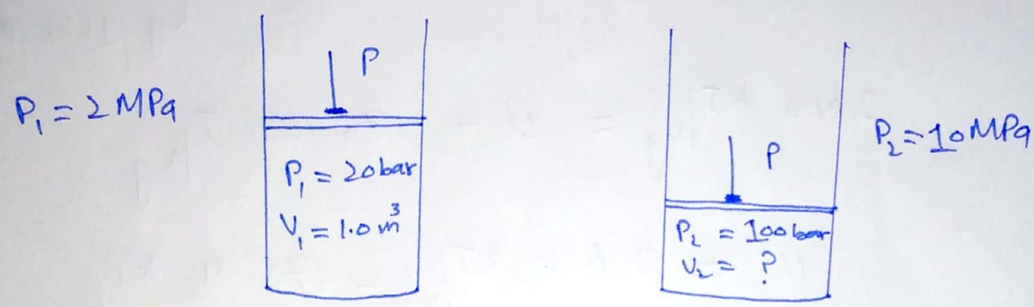
Q No: 3



Mass of water $= m = 10\ kg$

as

$1\ bar = 10^5\ pa$

$1\ MPa = 10\ bar$

Find;

Work done $= ?$

heat transfer $= q = ?$

Solution:

As the process of the system

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

So, it can be as;

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

Specefic Volume $= \hat{v}_1 = ?$

$$\hat{v}_1 = \frac{V_1}{m}$$

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So,

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

As,

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

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

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

Putting the values;

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

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

Now, calculation for work done;

Specific work done $= \hat{W}$

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

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As there are two states;

$$\hat{W} = -\int_1^2 P_E \, d\hat{V}$$

As process is reversible, so,

$$P_E = P$$

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

$$\hat{W} = -\int_{\hat{V}_1}^{\hat{V}_2} \frac{P_1 \hat{V}_1^{1.5}}{\hat{V}^{1.5}} \, d\hat{V} \qquad \because P = \frac{P_1 \hat{V}_1^{1.5}}{\hat{V}^{1.5}}$$

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

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

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

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

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$$\hat{W} = 2 \times \frac{2\ MPa \,\Big|\, 10^6\ Pa \,\Big|\, N}{\Big|\ 1\ MPa \,\Big|\, Pa.m^2} \times (0.1)^{1.5}\,(5.415 - 3.162)$$

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

$$\hat{W} = 283372$$

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

heat transfer = q = ?

As we know;

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

$$q = \Delta \hat{U} - \hat{w} \quad \rightarrow (ii)$$

first calculate $\Delta \hat{U}$

from steam table : at

$P = 2\ MPa$

$\hat{u}_1 = 2600.3\ kJ/kg$

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Now, at $P = 10\,MPa$

By interpolation;

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

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

putting in (ii)

$$q = (3094.6\ kJ/kg - 2600.3\ kJ/kg) - 283.3\ kJ/kg)$$

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