Department of Chemical Engineering

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MID TERM PAPER.

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CHEN19111011

Submitted to

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For

Thermodynamics.

Thermo-I

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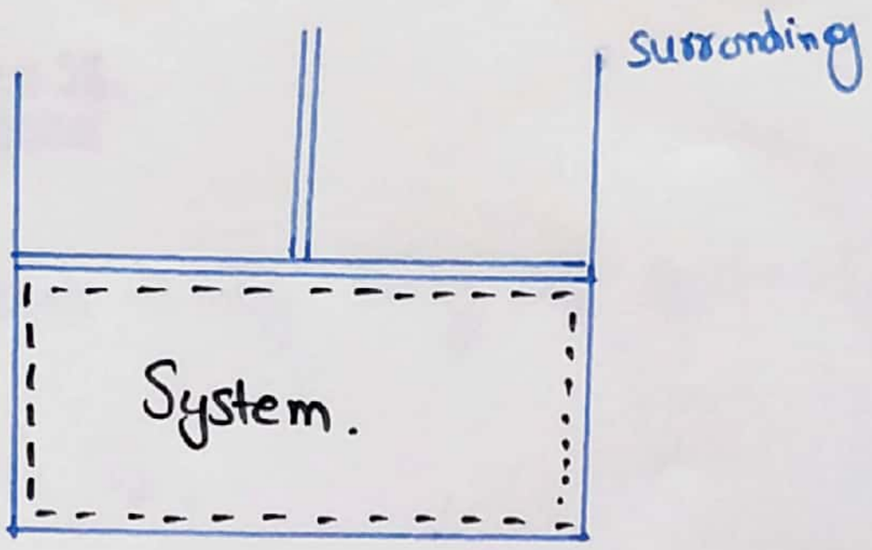
Qno1:-

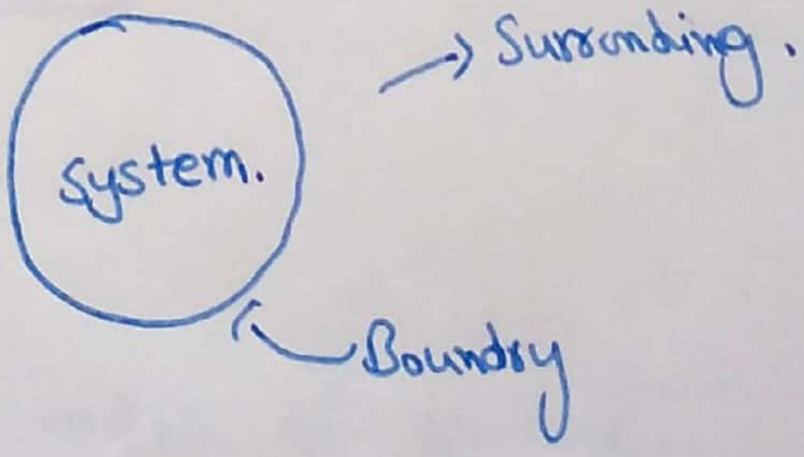
1) System:-

- It is the region in space upon which study is focused or concentrated.
- System refer to subject matter of analysis.



2). Surrounding:-

- Anything external to the system is known as surrounding.
- The part of the universe other then the system is called surrounding.



3). Isolated process.

Def:-

No mass or heat energy transfer within the system.

Type of System.	Heat Transfer	Mass Transfer	Example.
Isolated-system.	X	X	Universe 100%. Thermas-flask > 100%.

4). Adiabatic Process.

Def:- No-Heat transfer throug body of system.

$$P_1 V_1 T_1 = P_2 V_2 T_2.$$

But

$$\boxed{Q = 0.}$$

It is also called Isen-tropic.

$Q = 0$

$\Delta U = U_2 - U_1$.

$$W = U_1 - U_2$$

$$\boxed{W = -\Delta U.}$$

5). Extensive property:-

Def:- Property depend on mass of system.

1. Mass(m)
2. Volume(V)
3. Internal Energy(U)
4. K.E, P.E. etc.

Denotion:-

By Capital Letter.

Question no 2 :-

Data Given:-

$P = 7$ bar

$h = 2600$ kj/kg.

Required:-

$x = ?$

$\hat{v} = ?$

$\hat{u} = ?$

Solution:-

① $\hat{h} = h_f + x.h_{fg}$

$2600 = 697.1 + x(2064.9)$

$2600 - 697.1 = x(2064.9)$

$1902.9 = x(2064.9)$

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

$x = 0.921$

② $\hat{v} = v_f + x.v_{fg}$

$= 0.001108 + (0.921)(0.272 - 0.001108)$

$= 0.001108 + (0.921)(0.271892)$

$= 0.001108 + 0.25041$

$= 0.2515 \ m^3/kg.$

③ $\hat{u} = u_f + x.u_{fg}$

$= 698.3 + (0.921)(2571.1 - 698.3)$

$= 696.3 + (0.921)(1874.8)$

$= 696.3 + 1726.6908$

$= 2420 \ kJ/kg.$

So,

$\hat{v} = 0.2515 \ m^3/kg$

$\hat{u} = 2420 \ kJ/kg$

Answer.

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Qno3 :-

→ **Data Given :-**

$m = 10.0 kg$

$P_1 = 20 bar$

$V_1 = 1.0 m^3$

$P_2 = 100 bar.$

$$P v^{1.5} = \text{constt.}$$

→ **To-find :-**

$W = ?$

$q_V = ?$

→ **Solution :-**

a). $P_2 = \frac{100 bar}{1 bar} \left| \frac{100 kPa}{} \right. = 10,000 kPa = 10 MPa.$

$\hat{v}_2 = ?$

$$P_1 \hat{v}_1^{1.5} = P_2 \hat{v}_2^{1.5} \Rightarrow \hat{v}_2^{1.5} = \frac{P_1 v_1^{1.5}}{P_2}$$

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

$$\hat{v}_2 = \left[\frac{2 MPa}{} \left| \left(\frac{0.1 m^3}{kg} \right)^{1.5} \right| \frac{1}{10 MPa} \right]^{\frac{1}{1.5}}$$

$$\hat{v}_2 = (0.2 \times (0.1)^{1.5})^{\frac{1}{1.5}} \; m^3/kg.$$

$= (0.2 \times 0.0316)^{\frac{1}{1.5}}$ $= (0.2 \times 0.0316)^{0.667}$

→ $\hat{v}_2 = 0.0342 \ m^3/kg.$

$$\hat{w} = -\int_{0.1}^{0.0342} P_E \cdot d\hat{v} = -\int_{0.1}^{0.0342} P \cdot d\hat{v}$$

$$P_1 \hat{v}_1^{1.5} = P_1 \hat{v}_1^{2.5} \Rightarrow P = \frac{P_1 \hat{v}_1^{1.5}}{\hat{v}_1^{1.5}}$$

$$P = 2MPa \left| \left(\frac{0.1 m^3}{kg}\right)^{1.5} \right| \left(\frac{kg}{\hat{v}\ m3}\right)^{1.5}$$

→ $P = \frac{0.0632}{\hat{v}^{1.5}} \ MPa.$

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

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

$$= -\frac{0.0632}{-0.5} \left[\frac{1}{0.0342^{0.5}} - \frac{1}{0.1^{0.5}} \right]$$

$$= \frac{0.2838 \ MPa.m^3}{kg} \left| \frac{1000 \ kPa}{1 MPa} \right| \frac{1 kN}{1 kPa.m^2}$$

$\hat{w} = 283.8 \ kJ/kg.$

b). $q_v = ?$

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

At state 1, $P_1 = 2 MPa$ $T_1 = 213.6\ ^\circ C$

$u_1 = ?$

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

$u_1 = 2602.97\ kJ/kg.$

At state 2, $P_2 = 10 MPa$, $\hat{v}_2 = 0.0342\ m^3/kg.$

$\hat{u}_2$ (kJ/kg)	$\hat{v}_2$ (m^3/kg)
3045.8	0.0328
$\hat{u}_2$	0.0342
3144.5	0.0356.

$\hat{u}_2 = 3095.15\ kJ/kg.$

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

$$= (3095.15 - 2602.97)\ kJ/kg$$

$$\boxed{\Delta\hat{u} = 492.18\ kJ/kg}$$

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

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

$$\hat{q} = (492.18 - 283.8)\ kJ/kg.$$

$$\boxed{\hat{q} = 208.38\ kJ/kg.}$$