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DEPARTMENT: CHEMICAL ENGINEERING

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Semester 3rd

CHEMICAL ENGINEERING

## System:-

A System " Everything under Consideratiatic". Everything is Called universe. The part of univers in Which we interested called our system.

## Surrounding:-

When We left the System from our universe the remaining universe is called surrounding. A boundery (Imaginery and real) seperat the ~~universe~~ System and Surrounding

## Adibatic Process:-

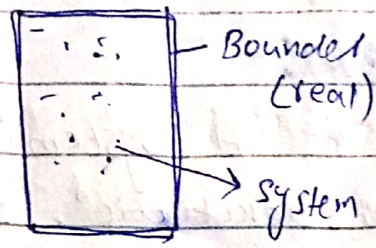
When at least one thermodynamic property of a System change it means the State of a system change, so the system undergoes the process.

In adibatic Process the heat remain Constent =

$Q = 0$ (When the system undergoes From State 1 to Stat 2 Q remain Same).

# Isolated System

A System in Which no mass or no Energy inter the system our system Called Isolated

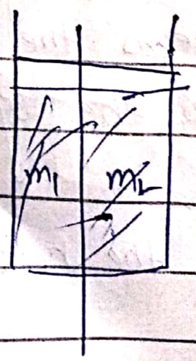



$m \neq 0$

(E) $Q \neq 0$

# Extensive Property:-

Extensive property are thoes property Which is dependent on the Size of the system. To Check Weather the property are Extensive We divide the system into two part if the property are Change our property are Extensive




$m_1 \neq m_2$

so mass is extensive Property.

# Q No 2

Given Data:

$p = 7\,bar$

$\hat{H} = 2600\,kJ/kg$

$\hat{V} = ?$

$\hat{U} = ?$

At Steam table and 7(bar) Pressure

⇒ Our Steam are Saturated Steam table and Contain some Water Vapour Content

So we Find dryness Fraction

$X = ?$

$$\hat{h} = \hat{h}_f + x\hat{h}_{gf}$$

$$2600\frac{kJ}{kg} = 697\frac{kJ}{kg} + X(2067)\frac{kJ}{kg}$$

$$2600\frac{kJ}{kg} - 697\frac{kJ}{kg} = X(2067)\frac{kJ}{kg}$$

$$1903\frac{\cancel{kJ}}{\cancel{kg}} \Big| \frac{\cancel{kg}}{2067\cancel{kJ}} = X$$

$$X = 0.92065$$

$$\boxed{X = 0.921}$$

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

$$0.921(0.2728)\,m^3/kg$$

$$\boxed{\hat{V} = 0.2511\,\frac{m^3}{kg}}$$

Now we calculat internal Energy.

$$\hat{U} = \hat{U}_f + x\hat{U}_{gf}$$

$$\hat{U} = 696\frac{kJ}{kg} + 0.921(2573 - 696)\frac{kJ}{kg}$$

$$\hat{U} = 696\frac{kJ}{kg} + 0.921(1877)\frac{kJ}{kg}$$

$$\hat{U} = 696\frac{kJ}{kg} + 1728.717\frac{kJ}{kg}$$

$$\boxed{\hat{U} = 2424.717\frac{kJ}{kg}}$$

# Q No 3

mass = $m$ = 10.0 kg

pressure = $P_{ini}$ = 20 bar

$V_{in}$ = 1.0 $m^3$

process = reversible

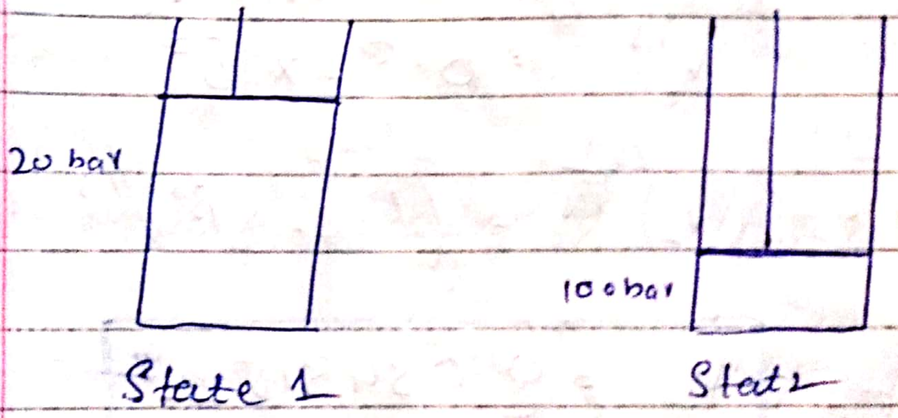
$P_{Final}$ = 100 bar

$PV^{1.5}$ = constant

**Solution:-**

We have reversible process and Process is

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




First we find specific volume of initial state.

$$\hat{V} = \frac{V}{m}$$

$$\hat{V} = \frac{1.0\,m^3}{10\,kg} = 0.1\,\frac{m^3}{kg}$$

Nowe We Find Final Volume.

$$P_1 V_1^{1.5} = P_2 V_2^{1.5}$$

$$\frac{P_1 V_1^{1.5}}{P_2} = V_2^{1.5}$$

$$V_2^{1.5} = \frac{\cancel{100}\ 20\,bar \;\; (0.1\,m^3)^{1.5}}{kg \;\; 100\,bar}$$

$$\boxed{\cancel{V_2^{1.5} = 0.0342 \frac{m^3}{kg}}}$$

$$V_2^{1.5} = 6.32 \times 10^{-3}$$

$$(V_2)^{1.5 \cdot \frac{1}{1.5}} = (6.32 \times 10^{-3})^{1/1.5}$$

$$\boxed{V_2 = 0.034315 \frac{m^3}{kg}}$$

Now We Calculate Work done

For reversible Process

$$W = -\int_{V_1}^{V_2} P_E \, dV$$

$$W = -\int_{V_1}^{V_2} P \, dV \quad —— 7$$

As $P_E = P$.

So by ideal gas law

$$PV^{1.5} = P_1 V_1^{1.5}$$

$$P = \frac{P_1 V_1^{1.5}}{V^{1.5}}$$

Put the value in Z.

$$W = -\int_{0.1}^{0.034} \frac{P_1 V_1^{1.5}}{V^{1.5}} dV$$ ∴ unit cancel of volume.

$$W = -P_1 V_1^{1.5} \int_{0.1}^{0.034} \frac{1}{V^{1.5}} dV$$

$$W = -2P_1 V_1^{1.5} \left[ \frac{1}{V^{0.5}} \right]_{0.1}^{0.034}$$ (Direct step)

$$W = -2P_1 V_1^{1.5} \left[ \frac{1}{(0.034)^{0.5}} - \frac{1}{(0.1)^{0.5}} \right]$$

$$W = +0.632 \frac{\text{bar}\,m^3}{kg} (5.40 - 3.16)$$ $-2 = \frac{1}{0.5}$

$$W = +1.414 \frac{\text{bar}\,m^3}{kg} \left| \frac{1.01\,atm}{1\,bar} \right| \frac{10^5\,Pa}{1\,atm} \left| \frac{N}{1\,Pa} \right| \frac{kJ}{1\,Pa\,m^3} \left| \frac{1\,kJ}{1000\,J} \right.$$

$W = +283.2 \frac{KJ}{kg}$

+ Compress Work

Now we Find $q = ?$

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

For initial temperature we look Steam tabble.

| $T(°C)$ | $\hat{V}(m^3/kg)$ |
|---|---|
| 212.4 | 0.0996 |
| T | 0.1 |
| 225 | 0.1038 |

$$\frac{T - 212.4}{225 - 212.4} = \frac{0.1 - 0.0996}{0.1038 - 0.0996}$$

$$\boxed{T = 213.6°C}$$

$q = \Delta U - W$

$\Delta U = U_2 - U_1$

$U_1 = ?$

we use interpolation

| $U_1$ (kJ/kg) | T (°C) |
|---|---|
| 2600 | 212.4 |
| $u_1$ | 213.6 |
| 2628 | 225 |

$$\frac{u_1 - 2600}{2628 - 2600} = \frac{213.6 - 212.4}{225 - 212.4}$$

$$u_1 = 2602.97 \frac{kJ}{kg}$$

Now we find $U_2$

| $\hat{U}_2 \frac{kJ}{kg}$ | $\hat{V}_2 \frac{kJ}{kg}$ |
|---|---|
| 3045.8 | 0.0328 |
| $U_2$ | 0.342 |
| 3144.5 | 0.0356 |

$U_2 = 3095.15 kJ/kg$ ∴ direct

$\Delta u = U_2 - U_1$

$= 492.18 kJ/kg$

$$q = (492.18 - 283.3) \frac{kJ}{kg}$$

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