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Session BS-CHEN-3

Mid Exam Thermodynamic I

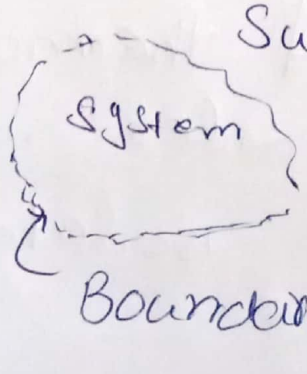
Q1 Define the terms.

System

A System is defined as "Any thing under ~~Consen~~ Consideration is called System.

Surrounding

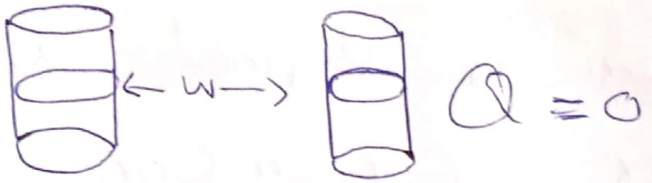
It is define as everything external to the System ~~and~~ ~~Surrounding~~ is called Surrounding



Adiabatic Process

It is a thermodynamic process.

It is the process in which no heat transfer occours across the system boundary is known as adiabatic process.



Isolated System

The system in which no mass or energy cross the boundary is called isolated system. Ex

Example

A thermoflask and water cooler is the example of isolated system

Extensive Property

It is a physical quantity whose value is proportional to the size of the system it describe or to the quantity of matter in the system.

Example

Entropy, Enthalpy etc.

Q2 Solve it

Given Data

$P = 7 bar$

$\hat{h} = 2600 kJ/kg$

To find

$x = ?$ = Dryness fraction

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

$\hat{u} = ?$ = Specific internal Energy

Solution

For dryness fraction:

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

$$2600 = 697.1 + x(2064.9)$$

$$2600 - 697.1 = x(2064.9)$$

$$1902.9 = x \cdot 2064.9$$

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

$$\boxed{x = 0.9211}$$

For Specific volume

$$\hat{v} = v_f + x + v_{fg}$$

$$\hat{v} = 0.001108 + 0.921(0.273 - 0.001108)$$

$$\hat{v} = 0.001108 + 0.25041$$

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

For Specific Internal Energy

$$\hat{u} = u_f + x u_{fg}$$

$$\hat{u} = 696.3 + (0.921)(2571.1) - 696.3$$

$$\hat{u} = 696.3 + 2726.69$$

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

Q 3 (5)

Given Data

$m = 10.0\,kg$

$P_1 = 20\,bar$

$V_1 = 1.0\,m^2$

$P_2 = 100\,bar$

PV relation $= PV^{1.5} = constant$

(a)

~~$T = ?$~~

~~$P_1 = \frac{20\,bar \mid 100\,kPa}{1\,bar} = 2000\,kPa = 2\,MPa$~~

~~$\hat{V}_1 = \frac{1.0\,m^3}{10\,kg} = 0.1\,m^3/kg$~~

To Find $= \hat{W} = ?$

$P = \frac{100\,bar \mid 100\,kPa}{1\,bar} = 10\,MPa$

$\hat{V}_2 = ?$

$P_1 \hat{V}_1^{1.5} = P_2 \hat{V}_2^{1.5} \Rightarrow V_2^{1.5} = \frac{P_1 \hat{V}_1^{1.5}}{P_2}$

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

$= \left[\frac{2\,MPa \mid (0.1\,m^3)^{1.5} \mid 1}{(kg) \mid 10\,MPa}\right]^{1.5}$

$= \left((0.2 \times 10.1)^{1.5}\right)^{1.5} = m^3/kg$

$= (0.0 \times 0.0316)^{1/1.5} = (0.2 \times 0.0316)^{(0.66)}$

$$\hat{V}_2 = 0.0342 \ m^3/kg$$

$$\hat{W} = \int_{0.1}^{0.0342} P_2 \cdot d\hat{V} = -\int_{0.1}^{0.0342} P \cdot d\hat{V}$$

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

$$P = 7 \ MPa \left| \left(\frac{0.1 \ m^3}{kg} \right) \right| \left(\frac{kg}{\hat{V} \ m^3} \right)^{1.5}$$

$$P = \frac{0.0632}{\hat{V}^{1.5}} \ mpa$$

$$\hat{W} = \int_{0.1}^{0.0342} \frac{0.0632}{\hat{V}^{1.5}} \, d\hat{V}$$

$$= -\frac{0.0632}{0.5} \left| \frac{1}{(0.0342)^{1.5}} - \frac{1}{0.1^{1.5}} \right|$$

$$\hat{W} = 283.8 \ kJ/kg$$

b) $Q \rightarrow ?$

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

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

$U_1 = ?$

$U_1 = (kJ/kg)$	$T(^\circ C)$
2600.3	212.4

u_1 2136

26283 225

$u_1 = 2602.98\ kJ/kg$ $\hat{V}_2 = 0.0342\ m^3/kg$

At State 2

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

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

$\Rightarrow$

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

$= (3095.15 - 2602.97)\ \frac{kJ}{kg}$

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

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

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

$q = (492.18 - 283.8)\ kJ/kg$

$q = 208.38\ kJ/kg$