M.Tech. Second Semester (Chemical Engineering) (CBS)

13014 : Energy Technology & Conservation : 2 CE 4

P. Pages : 2 | **AU - 3284**

Time : Three Hours | Max. Marks : 80

Notes :
1. All question carry marks as indicated.
2. Answer **six** question.
3. Question No. **1** is compulsory.
4. Due credit will be given to neatness and adequate dimensions.
5. Assume suitable data wherever necessary.
6. Diagrams and chemical equations should be given wherever necessary.
7. Illustrate your answer necessary with the help of neat sketches.
8. Use of slide rule logarithmic tables, Steam tables, Moller's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.
9. Discuss the reaction, mechanism wherever necessary.
10. Use of pen Blue/Black ink/refill only for writing the answer book.

1. A furnace is fired with 100kg of coal containing 84kg carbon, 6kg H_2 and rest ash. 40% excess air is supplied for combustion. Calculate the composition by volume and weight of the gases leaving the furnace and also the orsat analysis. **15**

2. An equimolar mixture of CH_4 and C_2H_6 is used in a furnace for steam generation as gaseous fuel, 100% excess air is supplied for combustion because of faulty design of the jet not all carbon is burnt 50% of the carbon goes to CO_2 and rest CO. All the H_2 burns to H_2O and the H_2O formed is assumed to be in the liquid state. Calculate the air-fuel ratio (moles of air supplied | mole of fuel gas), the amount of heat actually released to that of the heat released had the combustion gone to completion. Data: - standard Heat of combustion (HHV/GHV) of $CH_4 = -8.91 \times 10^5$ kJ / kg·mole ($\Delta H_R = \Delta H_C^\circ$) **13**

$(\Delta H_C^\circ)\ C_2H_6 = -15 \cdot 61 \times 10^5$ kJ / kg·mol

$(\Delta H_C^\circ)\ CO = -2 \cdot 83 \times 10^5$ kJ / kg·mole

3. 0.34 m^3 of air is compressed from 103 kPa and 40°C to 1.75MPa. calculate the final temperature, final volume, change in work transfer, Heat transfer (Q), change in internal energy (ΔU), ΔH and ΔS if the compression is carried out:- **13**

i) Isothermally.
ii) Adiabatically
iii) Polytropically.

Tabulate all the result and comment on the result.

C_P air = 1.005, C_V = 0.718

R = 0.287, All expressed in kJ / kg°·k r = 1.4 and n = 1.3

4. In a steam power plant, the boiler absorbs 2881 kJ/kg of heat with an entering, liquid enthalpy of 120kJ/kg flowing at 'u' m/sec. steam leaves the boiler at 50 m/s with an enthalpy of 3000 kJ/kg. After producing 'W' work through a turbine steam leaves with a velocity of 250 m/sec and exit enthalpy of 'h' kJ/kg. **13**

A condenser removes 2200kJ/kg of heat from the steam and the liquid water is pumped track to the boiler with an enthalpy of 118kJ/kg before pumping. Assuming velocity of feed water before and after pump is same.

Draw a schematic diagram for the above situation and calculate

i) Enthalpy of steam leaving turbine.
ii) Velocity of liquid before and after feed pump.
iii) Cycle work and cycle efficiency.

5. A compressor changes the pressure of a gas from 100 kPa to 700 kPa. 10 kw of power is required to compress 3 kg/min of air. The compressor is cooled by cooling water to dessipate the heat at the rate of 30 kJ/min. Calculate the amount of cooling water to be circulated. The specific volume of gas is $0.88 m^3/kg$ and $0.18 m^3/kg$ and the internal energy is 220kJ/kg and 315 kJ/kg at 100 kPa and 700 kPa respectively. **13**

Pressure	Specific volume	U(internal Energy)
100	0.88	220
700	0.18	315
kPa	m^3/kg	kJ/kg

6. Three gaseous mixtures with the following molar compositions are to be blended in such a proportion that the final mixture contains 40% CH_4, 35% C_2H_6 and 25% C_3H_8. **13**

Gas	I	II	III
CH_4	25	35	55
C_2H_6	35	20	40
C_3H_8	40	45	05

In what proportion the above gases must be mixed.

7. If m kg of water at T_1 temperature is mixed with equal amount of H_2O at T_2°C isentropically. calculate **13**

i) ΔS of the universe
ii) Find the condition for maximum work.
iii) Show that this maximum work $= m C_p \left(\sqrt{T_1} - \sqrt{T_2}\right)$

8. An engine develope 25kw by consuming 7kg fuel/hr. The heating value of the fuel is 40000 kJ/kg calculate the **13**

i) Thermal efficiency of engine.
ii) The specific fuel consumption express as $kJ / kw \cdot hr$
iii) Work Done by the engine in 15min.

9. Discuss the following:- **13**

1) Adiabatic and Actual flame temperature.
2) Development of power generation.

10 Classify the various sources of biofuels and explain each briefly. **13**

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