Ref. No.: Ex/ChE/T/323/2017 (Old)

B.E. Chemical Engineering 3rd Year 2nd Semester Examination, 2017(Old)

ENERGY RESOURCES AND THEIR UTILIZATION

Time: Three Hours Full Marks: 100

Answer any *five* questions
Assume missing data, if any
All the symbols/terms have usual significance

1. (i) Using 'Float and Sink Test' data, explain the development of different Washability curves (use representative data table) mentioning significance.

1. (ii) Describe the operations of a 'Baum Jig' and a 'Cyclone washer' for coal washing using schematic and state their advantages and disadvantages.

1.(iii) A coal has the following proximate analysis on air dried basis:
M=Moisture=1.5%,A=ash=15.5%,VM=Volatile matter=285,FC=fixed carbon=55%.
Calculate its ash% on dry basis and volatile matter on d.a.f and d.m.m.f basis.

[10+6 + 4]

2. (i) Justify the statement: " For storage of a given weight of coal, smaller proportion of fine coal particles & smaller size of storage piles are recommended."

2. (ii) Briefly discuss the operation of a low temperature carbonization plant.

2.(iv) Differentiate between Low temperature Carbonization (LTC) and High temperature carbonization (HTC).

[4+8+8]

3. (i) What are the 'Reaction Zones' in a gas producer ? Explain using a schematic. Also mention the significance of 'Neumann Reversal Reaction'.

3.(ii) Describe the 'Integrated Gasification Combined-Cycle' (IGCC) using a process flow diagram and mention its advantages.

3.(iii) Briefly describe the principle of operation of a "Recuperative Furnace" using a schematic.

[8+8 + 4]

4. (i) A naphtha feed stock for a hydrotreater has the following properties:
API gravity=55°
'S' as mercaptans (wt.%)=0.5
'S' as sulfides(wt.%)=0.3
'S' as thiophenes(wt.%)=0.2
'N' as pyrrole(wt.%)=0.15
'N' as pyridine(wt.%) =0.10

Compute the H_2 requirement in scft/day for complete removal of 'S' and 'N' from 10000BPD feed.

4. (ii) Write 'Short Note' on the following:

a. Characterization Factor Method for crude Classification
b. "Carbon residue Test"
c. "Flash point & Fire Point Test"

[8+ (4x3)]]

5.(i) Enumerate four common biofuels produced from biodegradable resources mentioning the pertinent feedstock(s) and conversion technologies involved.

5. (ii)What are the avenues to reduce cost of biodiesel production? Briefly elucidate. Briefly state the merits and demerits (if any) of biodiesel over its petroleum equivalent?

5.(iii) Briefly state the salient features of "Fast Pyrolysis" of lignocellulosic biomass for production of "bio oil". Use a simplified flow diagram of Bubbling Fluid Bed Pyrolysis.

[4+(3+3)+(5+ 5)]

6.(i) Define 'power coefficient' and "solidity" of a typical wind machine. Enumerate its typical variation with 'tip speed ratio' for 'multi blade' and 'propeller' type wind machine.

6. (ii) Calculate the main dimensions of the rotor of a multi-blade windmill operating at a design wind speed of 25 kmph. The windmill drives a water pump having a capacity of 5.1 m^3/h and a lift of 9 m. Assume water density to be 996 kg/m^3; the efficiency of reciprocating water pump to be 0.6; the transmission efficiency from the rotor to the pump to be 0.9; Maximum power coefficient = 0.31 and the corresponding value of tip speed ratio= 0.75

Air density= 1.2 kg/m^3; number of blades= 18; Solidity= 0.5

[(5+5) + 10]

7.(i) Briefly explain the working principle of a 'solar pond' using a schematic.

7.(ii) Briefly elucidate the working principle of a 'solar cell'.

7. (iii) What are "Short circuit current" and "open circuit voltage" ? Explain graphically the variation of 'maximum conversion efficiency' with the "Band gap Energy" of a solar cell? **[6+6+ (4+4)]**

8. (i) In a conventional liquid flat-plate solar collector, having two glass covers, the average temperature of the absorber plate is 343 K and the temperature of the glass cover which is immediately above the plate is 325 K. The value of the convective heat transfer coefficient between the absorber plate and first cover is 2.683 W/ (m^2. K). It is given that the emissivity of the plate is 0.92 and emissivity of glass cover is 0.88. The ambient air temperature is 297 K. Find the value of heat lost from the top of the solar collector per unit area. The value of Stefan-Boltzman constant is 5.67 x 10^{-8} W/(m^2 .K^4).

8. (ii) Briefly mentioning the components of a typical 'Nuclear Reactor', explain the operating principle of a 'Pressurized Water Reactor' (PWR) to harness nuclear energy (use schematic). **[10 +10]**