2021

BIOENERGY AND CONVERSION SYSTEMS

Full Marks: 60

Time: Two hours

The figures in the margin indicate full marks for the questions

Section A: Multiple Choice Questions: [1 x 15 =15]

1. Which one of the following products is not obtained by the thermo-chemical conversion process?
   a) Syngas
   b) Producer gas
   c) Ethanol
   d) Biochar

2. The main composition of biogas gas is
   a) O_2 and N_2
   b) CO_2 and H_2
   c) CO and H_2
   d) CH_4 and CO_2

3. During anaerobic digestion process, accumulation of volatile fatty acid (VFA) takes place
   a) Hydrolysis
   b) Acidogenesis
   c) Acetogenesis
   d) Methanogenesis

4. Which one of the following compounds is not use in the alkaline pre-treatment method for lignocellulosic biomass feedstock?
   a) KOH
   b) H_2O_2
   c) H_3PO_4
   d) NaOH

5. In biomass gasification process, in which zone the endothermic reaction takes place
   a) Drying zone
   b) Pyrolysis zone
   c) Reduction zone
   d) Oxidation zone

6. Which one of the following is not a feedstock for 1st generation biofuel production?
   a) Sugar cane
   b) Sweet sorghum
   c) Wheat
   d) Grass

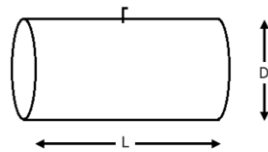7. Bio-diesel is produced commercially by which of the following conversion process?
   a) Gasification

b) Combustion
c) Transesterification
d) Pyrolysis

8. The total plant volume (V_p) of a Fixed dome plant: *Hemisphere Design Biogas Plant* is

a) $V_p = \dfrac{D^3}{2.236}$

b) $V_p = \dfrac{2}{3}\pi \left(\dfrac{D}{2}\right)^3$

c) $V_p = \pi \left(\dfrac{D}{2}\right)^3$ D=diameter

d) None of these

9. The total plant volume of balloon-digester biogas plant (D=10 unit , L =20 unit) is

D=diameter, L =length

a) 1571
b) 447
c) 262
d) 1450

10. From which one of the following biomasses, the ethanol production can be considered third-generation biofuel (ethanol)?

a) Woods
b) Sunflower
c) Microalgae
d) Sugar beet

11. The desired range of pH value for maximum biogas generation during anaerobic digestion process is

a) 5.5 - 6.0
b) 5.0 - 6.5
c) 6.8 - 7.3
d) 7.5 - 8.0

12. Match the Groups I and II and choose the correct combination option from the following:

Group -I	Group -II
X. Slow pyrolysis	i. High yield of liquid fuel
Y. Fast pyrolysis	ii. Carbon-rich solid residue
Z. Flash pyrolysis	iii. Gases and bio-oil

a)   X-iii, Y-i, Z-ii
b)   X-i, Y-ii, Z-iii
c)   X-iii, Y-ii, Z-i
d)   X-ii, Y-i, Z-iii

13. Match the Groups I and II and choose the correct combination option from the following:

	Group -I	Group -II
	X. In Gasification	i. The presence of microorganisms is needed
	Y. In Pyrolysis	ii. Partial oxygen is reqd.
	Z. In Fermentation	iii. No oxygen is reqd.

    a)   X-ii, Y-i, Z-iii
    b)   X-i, Y-ii, Z-iii
    c)   X-iii, Y-ii, Z-i
    d)   X-ii, Y-iii, Z-i

14. The gas generated through the biomass gasification is called-
    a) Biogas
    b) Producer gas
    c) Carbon dioxide gas
    d) Methane

15. Gasification of biomass is which type of conversion process?
    a) Chemical
    b) Biochemical
    c) Biological
    d) Thermo-chemical

Section B: Answer the following Questions   [5 x 3 = 15]

16. Explain briefly with block diagrams the Ethanol production processes from edible and non-edible cellulosic biomass.
17. Explain the Biomass Integrated Gasification Combined Cycle briefly.
18. Discuss the dual circulating fluidized bed gasifier briefly.

Section C: Solve the following Problems   [10 x 3 =30]

19. a) A pyrolysis experiment showed that the bio-oil yield was 85% by weight. If the density of the bio-oil was found to be 1.5 kg/L, calculate the bio-oil yield in litres /ton.   [3]
b) A biomass gasifier is used to run a compression ignition (CI) engine. The engine operates in the dual-fuel mode with 85% diesel replacement. The gasifier engine system produces 350 kW of power. Calculate the biomass feeding rate to the gasifier if the calorific value of biomass is 16500 kJ/kg. Given that, the efficiencies of the gasifier and engines are 77% and 37%, respectively.   [7]

20. Calculate the volume of cow dung based biogas plant required for cooking needs of a family of 7 people and lighting need with three 100 CP (candle power) lamps for 3 hours daily. Also, calculate the required number of cows to feed the plant.   [10]

    Consider the following data:
Biogas required for cooking = 0.200 m^3/person/day
Gas required for lighting a 100 CP mantle lamp =0.130 m^3/hr
One cow can produce = 10 kg/day/head of cow dung but assume; collectable cow dung is only 80%
Percentage of dry matter = 17%
Gas yield =0.34 m^3/kg of dry matter
Feedstock water ratio =1:1 and density of slurry =1050 kg/m^3
Assume, digester volume will be occupied by 80% slurry for HRT of 45 days.

21. a) What are the ranges of temperature at different zone of pyrolysis? Write four reactions that take place during pyrolysis.   [5]

b) Consider a floating drum biogas plant has to be installed in a village. If the diameter and height of the digester are 3 m and 1.5 m, respectively. Calculate the-   [5]
   i)   digester volume (V_d)
   ii)   gas storage volume (V_g)
   iii) total plant volume (V_p) of the digester.