Ref. No.: Ex/PG/EST/T/129A/2018

M.Tech. Energy Science & Technology First Year Second Semester Examination - 2018

Subject: Bio-Energy Systems

Time: Three hours **Full Marks: 100**

Answer **any five** questions.

1. a) What is active biomass and what is substrate biomass ? Is it always required to recycle active biomass in an anaerobic digestion process ? 4

   b) Write in short, with neat sketches, the working principles of an 'anaerobic filter reactor' and 'upflow anaerobic sludge blanket reactor'. 16

2. What is an enzyme catalyzed reaction? Deduce the Michaelis-Menten equation for enzyme catalyzed reaction. How do you obtain the numerical values of K_m and V_m from the Michaelis Menten equation ? 20

3. a) Define 'loading' of an anaerobic reactor. What is hydraulic retention time (HRT) and what is mean cell retention time (MCRT) ? Show that for a CSTR without cell recycle MCRT and HRT are same. 8

   b) Design a continuous stirred tank reactor (CSTR) for methane production from primary sewage sludge containing 4% dry solids of which 60% is volatile. The sewage sludge is produced at a rate of 1500 m^3/day and is to be digested sufficiently to destroy 50% of volatile solids. What volume must the digester have and what will be the loading on the digester, if the temperature is maintained at 37^0C ? Required MCRT for 50% destruction of volatile solids is 13 days. 12

4. Discuss with neat sketches the Down-draft and Up-draft gasifiers used for biomass gasification. What are the different factors that should be taken into consideration while selecting a biomass gasifier for a specific purpose ? 20

5. a) Write short notes on :
   i) Fluidized bed anaerobic reactor
   ii) Fluidized bed biomass gasifier 2x4

   b) Find the d : h (diameter to height ratio) for the reactor of a $3m^3$ KVIC type biogas plant (cattle dung based), based on the following data.

   i) HRT = 55 days
   ii) Gas production from cattle dung = 0.036 m^3/kg
   iii) Density of slurry = 1020 kg/m^3 (Total solids (TS) content 10%, 1:1 mixture of dung and water)
   iv) Feeding once a day
   v) Reactor height for $3m^3$ KVIC digester model = 4.8 m

   12

6. How 'landfill gas' (LFG) is generated from municipal solid waste dumped into a landfill site ? Describe **any two** mathematical models used to calculate LFG emissions from landfill sites. 20

7. What are the different components of an improved wood stove ? Explain their functions. Describe how the thermal efficiency of a wood stove is measured.

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