Ref. No. : EX/PG/BPE/T/123A/2018

M. E. Bioprocess Engineering 1st Year 2nd Semester Examination 2018

Bioenergy Engineering

Answer question no. 5 and any three from the rest

All questions carry equal marks

Assume any missing data

All symbols have usual significance

Full Marks: 100

1. a) Discuss on the production strategies of ethanol from lignocellulosic biomass using mesophilic microorganisms. 18

b) Discuss on the role of lipase in the production of biodiesel from vegetable oil. 7

2. a)The gas in the headspace of a 1 L bioreactor (0.8L liquid and 0.2 L gas space) operated as a batch reactor is sampled. The H_2 concentration of gas was determined at 70°C with GC to be 0% at the beginning of exponential phase and 25% after 1.5 h. The gauge pressure in the head space of the reactor at 1.5h is 175 kPa at the culture condition. Calculate the H_2 concentration (mmol H_2 gas/L media) the rate of production of hydrogen (mmol H_2 gas/L-h), the equilibrium concentration of H_2 (mmol H_2 dissolved/L media). The value of kH at 70oC=7.21x10-6M/kPa. 15

2. b)Discuss on the roles of the enzymes, hydrogenase and nitrogenase during bio-hydrogen production. 10

3. Discuss on the construction of single-chamber MFC . Liu and Logan evaluated the performance of a single-chamber MFC design using an air cathode, operated in batch mode with anode surface area of 7.05x10-4 m2 , anode chamber volume 0.028L, 500Ω resistor and a medium with 0.6 g COD/L without PEM. Without the PEM, the maximum voltage increased suddenly to 0.52V and decreased to,<0.04V after 15h.Determine all relevant parameters of the cell including coulombic efficiency.Faraday's constant=96485C/mol of electron. 10+15
4. Write down the energy balance equation for a typical continuous stirred tank bioreactor. 10
   b) Biogas has to be produced from municipal wastes containing carbohydrate, protein and fat. Write down the reaction pathways for this process. 15
5. a) Ethanol is being produced from glucose using *S. cerevisiae*. 0.45 C-moles of ethanol and 0.25 C-moles of biomass of elemental composition $CH_{1.8}O_{0.56}N_{0.17}$ were produced per C-mole of glucose using 0.04 moles of ammonia. Assuming the inlet and outlet streams are maintained at 25°C, what is the heat load on the reactor? The heats of combustion of ammonia is 383 kJ/mol that of glucose 467.8kJ/C- mol and for ethanol 684.5kJ/ mol. 20
   b) Explain the concept of CDM 5

6. A biologist is trying to genetically engineer bacteria to produce valuable organic chemicals from the inexpensive organic sugar xylose found in many plants and berries. One such microorganism appears capable of producing 2,3-butanediol. The following data are available

Chemical	Formula	ΔcH, J/mol
2,3-butanediol	$C_4H_{10}O_2$	2461.0
Xylose	$C_5H_{10}O_5$	2345.2

Test the generalized degree of reduction approximation and energy regularity correlation for each of these compounds using the reported heat of combustion data. Estimate the maximum amount of 2,3-butanediol that may be produced per mole of xylose assuming no additional biomass production. Assuming that no biomass is produced (hence no requirement of nitrogen source determine the amount of CO_2 produced and O_2 and H_2O consumed as a function of amount of 2,3-butanediol produced.. 25