

MANIPAL INSTITUTE OF TECHNOLOGY

V SEMESTER B.TECH BIOTECHNOLOGY

END SEMESTER EXAMINATION, NOV/DEC 2017

## SUBJECT: BIOFUELS ENGINEERING [BIO4014]

**REVISED CREDIT SYSTEM** 

Time: 3 Hours

MAX. MARKS: 50

## Instructions to Candidates:

✤ Answer ALL the questions.

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✤ Missing data may be suitable assumed.

1A.	What are the second generation biofuels?	1
1B.	Explain the suitability of the following feedstocks for biofuel - Domestic wastewater (for biogas), cell debris from de-oiled microalgae (for ethanol), jackfruit seed (for ethanol)	3
1C.	With scheme explain the procedure for obtaining Life Cycle Analysis of biodiesel from microalgae using a photo-bioreactor with solar illumination.	3
1D.	Dehydration of ethanol from fermentation is preferably carried out by industries using PSA (Pressure Swing Adsorption). With the help of a schematic, elucidate the two bed process for obtaining 99.99% ethanol from 95% ethanol.	3
2A.	What is an AFEX process? List out the important process parameters and its strengths and weaknesses. Include schematic	3
2B.	Calculate the theoretical ethanol yield (L) from 10kg mash containing 15% starch, 10% sucrose, 50% water and rest solids. Density of ethanol = $0.79 \text{ kg/L}$	3
2C.	Explain dry milling process for ethanol from broken rice. Use schematic diagram. Also list out the various enzymes involved in the process. Due to unavailability of broken rice and restrictions on the use of food quality rice, it was decided to switch to cheaply available broken wheat. What are the required changes in the process?	3 1
3A.	Illustrate the various processes, principles used, their advantages and disadvantages, for harvesting of microalgae	3
3B.	With the help of equations, explain the transesterification reactions giving all the three steps. Include side reaction for soap formation	3
3C.	Write the features of homogenous acid catalysis and heterogeneous base catalysis for biodiesel production from the perspectives of cost, recyclability, FFA, reaction conditions, purification of products and product yield	3
3D.	List out all the challenges for biodiesel from microalgae	1
4A.	The formula of a sludge as feed to biogas plant is C <sub>18</sub> H <sub>30</sub> O <sub>2</sub> NS. 100 kg of this feed was subjected to anaerobic degradation. Efficiency of degradation was 75%. Compute a) Gas composition (mole %)	4

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b) $Nm^3$ of gas obtained						
c) Selling price of the gas obtained (in ₹)						
International Gas Price =\$3 per MM Btu; C.V of CH <sub>4</sub> = 55.7 KJ/g; 1 Btu =1055						
1\$=₹ 65, Coefficients of CO <sub>2</sub> is $1/8(4c-h+2o+3n+2s)$ .						
A biogas plant using organic sludge was under normal operating conditions. There						
was a reported drop in biogas yield. Describe the remedial actions the in-charge						
engineer needs to take up.						
For a UASB treatment process treating an industrial wastewater determine,						
(i) Size and dimensions of the reactor	2					
(ii) Detention time	_					
(iii) Strategies to increase effectiveness of the process	1					
Data: $Q = 1200 \text{ m}^3/\text{d}$ , sCOD= 1850 g/m <sup>3</sup> , pCOD= 250 g/m <sup>3</sup> ,	1					
L <sub>org</sub> =12 kg –COD(total)/m <sup>3</sup> .d, V=1 m/h, Effectiveness=0.90,						
Height for gas collection is 20% of liquid height.						
Write down the two half-cell reactions and compute the COD as g-COD/g-sugar for	2					
Pentose sugar $C_5H_{10}O_5$ .						
Explain the voltage polarization curve in the case of MFC. Clearly spell out the three	3					
different behaviors observed and the remedies for the same.						
Compute the Coulombic efficiency for a MFC with the following experimental data						
Anode Volume = $20 \text{ mL}$						
Internal Resistance = $900\Omega$						
Average Voltage = $0.35V$						
Duration of experiment = 80 hours						
Anodic COD = $1 \text{ g/L}$						
With a schematic, explain the Sequential Dark and Photo Fermentation for the	3					
generation of Bio-Hydrogen gas.	-					
	<ul> <li>b) Nm<sup>3</sup> of gas obtained</li> <li>c) Selling price of the gas obtained (in ₹)</li> <li>International Gas Price =\$3 per MM Btu; C.V of CH<sub>4</sub> = 55.7 KJ/g; 1 Btu =1055 J, 1\$= ₹ 65, Coefficients of CO<sub>2</sub> is 1/8(4c-h+2o+3n+2s).</li> <li>A biogas plant using organic sludge was under normal operating conditions. There was a reported drop in biogas yield. Describe the remedial actions the in-charge engineer needs to take up.</li> <li>For a UASB treatment process treating an industrial wastewater determine,</li> <li>(i) Size and dimensions of the reactor</li> <li>(ii) Detention time</li> <li>(iii) Strategies to increase effectiveness of the process</li> <li>Data: Q = 1200 m<sup>3</sup>/d, sCOD= 1850 g/m<sup>3</sup>, pCOD= 250 g/m<sup>3</sup>,</li> <li>L<sub>org</sub>=12 kg -COD(total)/m<sup>3</sup>.d, V=1 m/h, Effectiveness=0.90,</li> <li>Height for gas collection is 20% of liquid height.</li> <li>Write down the two half-cell reactions and compute the COD as g-COD/g-sugar for Pentose sugar C<sub>5</sub>H<sub>10</sub>O<sub>5</sub>.</li> <li>Explain the voltage polarization curve in the case of MFC. Clearly spell out the three different behaviors observed and the remedies for the same.</li> <li>Compute the Coulombic efficiency for a MFC with the following experimental data Anode Volume = 20 mL</li> <li>Internal Resistance = 900Ω</li> <li>Average Voltage = 0.35V</li> <li>Duration of experiment = 80 hours</li> <li>Anodic COD = 1 g/L</li> <li>With a schematic, explain the Sequential Dark and Photo Fermentation for the generation of Bio-Hydrogen gas.</li> </ul>					