INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Time : 3 hrs.

Date of Examination.....FN/AN **Full Marks** : 50

Autumn Semester 2016-2017 **4th yr B.Tech. / Dual Degree (Biotech. & Biochem. Eng.)**

Subject No. BT 40009 **Subject Name: Bioprocess Technology**

No. of Students : 37 of the Department of Biotechnology

Instruction : Answer all questions Assume suitable data, if required.

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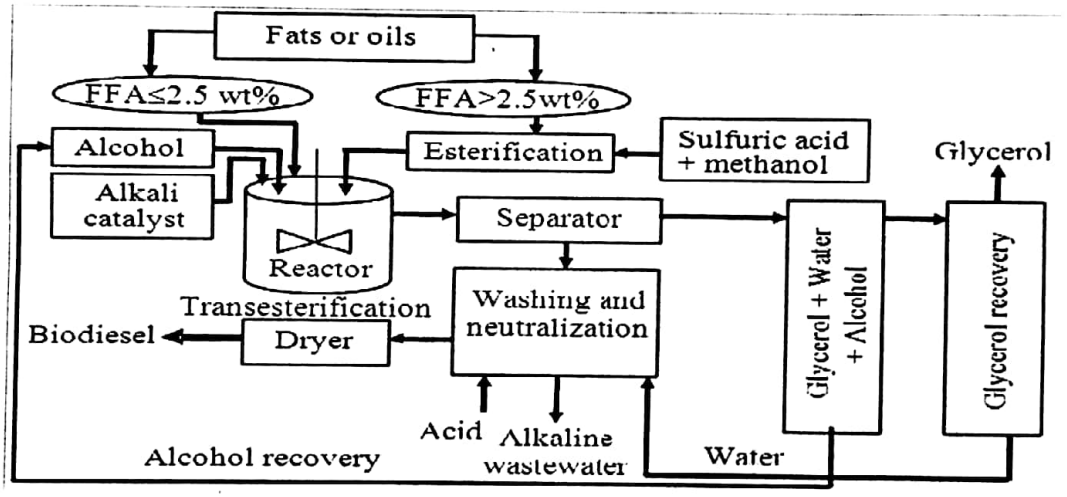
1. (a) (i) What is algal biorefinery?
(ii) Why has algal biodiesel gained more attention?
(iii) What is biocatalytic/enzymatic biodiesel?
(iv) What is your understanding of Biological/Algal CCS? [4]

(b) Briefly explain the important steps involved in the following process flow chart diagram for alkali catalyzed biodiesel production. What is ASTM D-6751? [2 + 1 = 3]

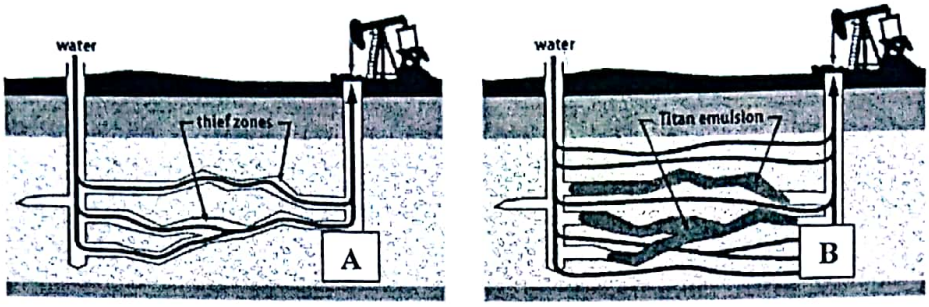


(c) Determine the amount of oil, catalyst and methanol required to produce 35×10^6 lb/yr (5 million gallons per year) of biodiesel. Molecular weight of FAMEs = 292; Molecular weight of methanol = 32; Molecular weight of glycerol = 92; Molecular weight of soybean oil = 885. Assume methanol/oil molar ratio as 6:1. [3]

ALTERNATIVE to (c)

(c) A 20 L CFSTR was operated at a dilution rate of 0.1 h^{-1} with 1 M algal lipid as substrate. Steady state lipid concentration of 0.3 M was achieved when substrate conversion was 70%. Effectiveness factor was 0.6 and K_M of the immobilized lipase was 0.01 M. Perform the mass balance and evaluate V_{Max} per unit volume of the reactor. [3]

(d) What is MEOR? Outline the mechanisms of MEOR as per the phenomena shown in the following Figures [A] and [B]. [2.5]



2. (A) Mention three major classes of industrial enzymes, each with two examples of natural microorganisms producing them through fermentation technology. [1.5]

(B) Mention two types of major sources of industrially useful biocatalysts, with a comparison of their advantages and disadvantages. [2]

(C) Depict through a flowchart the major steps involved in the discovery of biocatalysts from metagenomes. [1.5]

(D) (i) Explain the principle of whole genome amplification or multiple displacement amplification of genome. (ii) Mention its three important applications. [1+0.5]

(E) (i) What do you understand by small-insert and large-insert metagenomic libraries? (ii) Compare their advantages and disadvantages. [0.5+1]

(F) (i) What are the two different types of screening strategies for successful recovery of biocatalysts from metagenomic libraries? (ii) Compare their advantages and disadvantages. [0.5+1]

(G) (i) Name four bacterial species commonly used for heterologous expression of metagenomic clones. (ii) Write at least four critical factors, which may affect the successful recovery of metagenome-derived biocatalysts through heterologous expression. [0.5+1]

(H) What are the two major types of detection systems for functional screening of metagenomic clones for recovery of biocatalysts through heterologous expression? Explain briefly. [0.5+1]

3. a) Answer to the points: [8x1=8]

i) What do you mean by dry and fine wine? Why old wine is more costly?

ii) What do you mean by non-tax alcohol? Give at least 4 examples of distilled liquors.

iii) Discuss the process for the preparation of seed culture for the citric acid industry.

iv) What do you mean by malted food? Discuss the special characteristics of this food.

v) What do you mean CAM and CAA? How will you produce CAA?

vi) Discuss the effect of Fe^{++} and Mn^{++} on the citric acid fermentation process.

vii) Write the names of different filtration processes used in the citric acid producing industry.

viii) What is Gear pump? Discuss the uses of this pump.

b) 200 m^3 of citric acid fermentation broth has been harvested in harvesting tank, the broth has 11% (w/v) of cell mass and 12% w/v of citric acid. Compute the followings:

i) Total amount of mycelium produced;

ii) Lime required for calcium citrate precipitation process;

iii) Maximum of amount of gypsum produced ($CaSO_4$ $2H_2O$);

vii) Amount of water is to be removed to increase the citric acid concentration from 22% to 60% w/v.

[1+1.5+1+1]

4. A) Assuming a random distribution, what is the probability that bacterial cells undergoing division will generate a plasmid free cell if:

i. All cells have 80 plasmid monomers during division.

ii. Half the cells have plasmids in form of dimers and one fourth has plasmid tetramers.

iii.

B) Assuming a simplest model containing only two cell types (plasmid bearing n+ and plasmid less n-) in a single-stage chemostat, derive an expression that shows; the fraction of plasmid less cells (f-) at a given time t depends on the specific growth rates and the rate of generation of plasmid-free cells from plasmid bearing cells (R).

C) What cell types are used to express and purify recombinant tissue plasminogen activator? Why removal of DNA is essential from a preparation of tissue plasminogen activator. How is the DNA removed?

D) Discuss the steps involved in unfolding and refolding of proinsulin and its enzymatic conversion to insulin. How does Humulin R differ from Lys-Pro Insulin in sequence and function?

E) Discuss the Mix and split combinatorial method for creating libraries of affinity ligands.

[2+3+2+4+1.5]