

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)

CLASS: M.Tech  
BRANCH: BT

SEMESTER : II  
SESSION : SP/19

SUBJECT: BE506 BIOPROCESS PLANT DESIGN

TIME: 3 Hours

FULL MARKS: 50

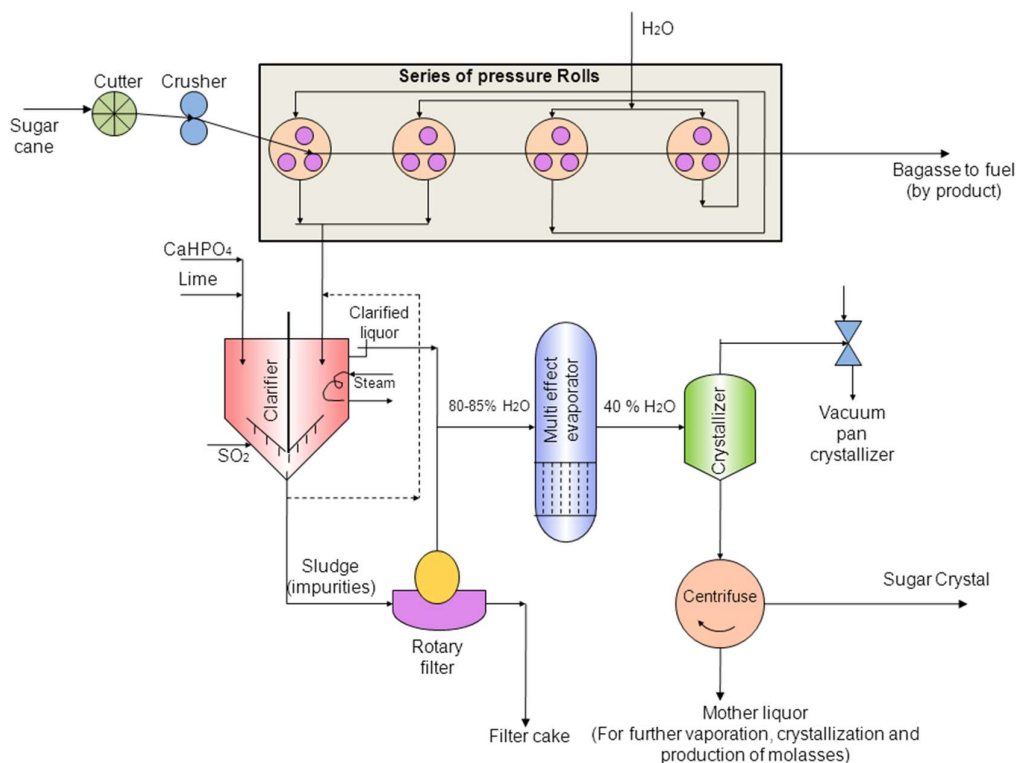
**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
  2. Attempt all questions.
  3. The missing data, if any, may be assumed suitably.
  4. Before attempting the question paper, be sure that you have got the correct question paper.
  5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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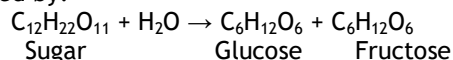
- Q.1(a) The enzyme glucose oxidase is used commercially to remove glucose from dehydrated egg to improve colour, flavour, and shelf life. The reaction is: [5]
- $$\underset{\text{(glucose)}}{\text{C}_6\text{H}_{12}\text{O}_6} + \text{O}_2 + \text{H}_2\text{O} \rightarrow \underset{\text{(gluconic acid)}}{\text{C}_6\text{H}_{12}\text{O}_7} + \text{H}_2\text{O}_2$$
- A continuous-flow reactor is set up using immobilised enzyme beads that are retained inside the vessel. Dehydrated egg slurry containing 2% glucose, 20% water, and the remainder unreactive egg solids is available at a rate of 3000 kg h<sup>-1</sup>. Air is pumped through the reactor contents so that 18 kg oxygen are delivered per hour. The desired glucose level in the dehydrated egg product leaving the enzyme reactor is 0.2%. Determine:
- (i) Which is the limiting substrate?
  - (ii) The percentage excess substrate/s
  - (iii) The composition of the final egg product
- Q.1(b) You are the Head of Technical Division of a Biotechnology firm that plans to diversify their production line. The company decides to synthesis protein using mammalian cells for monoclonal antibody production. Your responsibility is to prepare the project overview including various costing involved in the process plant to lodge a budget proposal to the management. Neatly sketch in a flow diagram, your analysis of costing under various parameters for the above-mentioned product. [5]
- Q.2(a) What is the major classification of materials of construction in process industries? Mention the commonly used material under each category and give a brief note on any 3 of the materials under each category. [5]
- Q.2(b) Selection of material is an important task in any process industry. Explain how you would plan for studying selection of material of construction. [5]
- Q.3(a) What are the major vessels in a Biotechnology for industrial application? What are the basic considerations of design of a Bioreactor? [5]
- Q.3(b) **GAS HANDLING WITH A RUSHTON TURBINE:** A fermenter of diameter and liquid height 1.4 m is fitted with a Rushton impeller of diameter 0.5 m and off-bottom clearance 0.35 m operated at 75 rpm. The fermentation broth is sparged with air at a volumetric flow rate of 0.28 m<sup>3</sup> min<sup>-1</sup>. Half-way through the culture some bearings in the stirrer drive begin to fail and the stirrer speed must be reduced to a maximum of 45 rpm for the remainder of the process. [5]
- (i) Under normal operating conditions, is the gas completely dispersed?
  - (ii) After the stirrer speed is reduced, is the impeller flooded or loaded?
- Gas flow number,  $Fl_g = F_g / N_i D_i^3$   
Froude No,  $Fr = N_i^2 D_i / g$   
 $Fl_g = 30 (D_i / D_T)^{3.5} Fr$  - flooding - loading transition  
 $Fl_g = 0.2 (D_i / D_T)^{0.5} Fr^{0.5}$  - for complete gas dispersion
- Q.4(a) Discuss Clean- In- Place (CIP) system design for Bioprocess industries. [5]
- Q.4(b) Discuss the principle design concepts you will consider for design and operation of biohazard contaminant facilities. How will you plan your plant layout for a bioprocess? industry to handle contaminants efficiently. [5]

Q.5 Manufacture of sugar from sugarcane

[5]



Sucrose ( $C_{12}H_{22}O_{11}$ ), is a disaccharide that occurs naturally in most fruits and vegetables. Sugar occurs in greatest quantities in sugarcane and sugar beets from which sugar is separated economically and commercially. Loss of sucrose by inversion to glucose and fructose (monosaccharide) is represented by:



Manufacturing process of sugar from sugarcane is shown in the above flow sheet. Analyse the process of sugar production process and answer the following question

- (i) What is special about the sugar production process from sugarcane? Analyse w.r.t to green technology. [3]
- (ii) What are the by-products of sugar industries? [1]
- (iii) Discuss energy economy in the sugar manufacturing process. [2]
- (iv) What is the problem in storage of sugarcane? [2]
- (v) What are the environmental problems faced by sugar industries? [2]

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