Total number of printed pages – 2

B. Tech

PCBT 4402

Seventh Semester Examination – 2013

BIOREACTOR DESIGN AND ANALYSIS

BRANCH : TEXTILE, BIOTECH

QUESTION CODE : C-150

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any five from the rest.
The figures in the right-hand margin indicate marks.

1. Answer the following questions :   2×10

    (a) What is a homogeneous reaction ?

    (b) What is an adiabatic reactor ?

    (c) What is rheology ?

    (d) Give two advantages of immobilizing enzymes in reactors.

    (e) What is a trickling bed reactor ?

    (f) Write down five important parameters to be controlled in bioreactors.

    (g) Why is residence time distribution important in bioreactors ?

    (h) Name three methods commonly used for measurement of $k_L a$.

    (i) Write down the expression for Fick's law of diffusion, with proper units of each term.

    (j) What kind of valves is used in bioreactors ?

2. (a) Describe the working of a fluidized bed reactor with proper diagrams.   5

    (b) Aerobic production of acetic acid from ethanol is shown as follows :

    $$C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$$

    The bacteria are added to medium containing 10 gL^{-1} ethanol. After some time, the ethanol concentration is 2 gL^{-1} and 7.5 gL^{-1} acetic acid is produced. Find out the observed and theoretical yields.   5

P.T.O.

3. (a) Describe the principle of a membrane reactor. Explain two of its major advantages. 5

   (b) An enzyme is used to produce a compound. The V_{max} for the enzyme is 2.5 mmol.m^{-3}.s^{-1}; K_m is 8.9 mm. The initial concentration of substrate is 12 mm. The half life of the enzyme is 4.4 h. Find out batch reaction time for 95 % substrate conversion. 5

4. Consider scale up of fermenter from 10 L to 10,000 L. The small fermenter has a height to diameter ratio of 3 : 1. Impeller diameter is 30 % of tank diameter. The agitator speed is 500 rpm. Determine dimensions (height and diameter) and speed for large fermenter for constant P/V conditions of scale up. 10

5. (a) Show the various paths followed for transfer of oxygen from bulk gas to cell interior, in a neat labelled diagram. Mention the points where high resistances to oxygen transfer occur. 5

   (b) Write a short note about design and analysis of non ideal reactors. 5

6. (a) Compare the modes of operation in CSTR and PFR in terms of substrate conversion and product formation. 5

   (b) What is specific death constant ? Differentiate between theoretical yield and observed yield. 5

7. (a) Write down the principle of a fed batch reactor. Find out an expression for fed batch time, with respect to X, $Y_{x/s}$ and F. 5

   (b) How will you design CSTRs associated with recycling of cells ? 5

8. Answer any **two** of the following : 5×2

   (a) Applications of three phase trickling bed reactors

   (b) Online sensors for bioreactor analysis

   (c) Perfusion reactor for animal cell culture

   (d) Different types of spargers used in reactors.