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Code: 9A23405

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

BIOPROCESS ENGINEERING

(Biotechnology)

Time: 3 hours

Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

- 1 Give an overview of the traditional and modern applications of biotechnology.
- 2 (a) Write the generalized mass balance equation and also give the simplified form for steady state operation.
(b) Discuss about material balance with recycle, bypass and purge streams.
- 3 (a) Define intensive and extensive properties. Explain with examples for each.
(b) Write the general energy balance equation and explain the terms involved.
- 4 Give an overview of aerobic and anaerobic fermentation processes and their applications.
- 5 Discuss in detail about medium formulation for optimal growth and product formation. Give examples of simple and complex media.
- 6 Aerobic degradation of an organic compound by a mixed culture of organisms in waste water can be represented by the following reaction:
$$C_3H_6O_3 + aO_2 + bNH_3 \rightarrow cC_5H_7NO_2 + dH_2O + eCO_2$$
 - (a) Determine a, b, c, d and e if $Y_{X/S} = 0.4g X/g S$.
 - (b) Determine the yield coefficients Y_{X/O_2} and Y_{X/NH_3} .
 - (c) Determine the degree of reduction for the substrate, bacteria and RQ for the organism.
- 7 Discuss in detail about energetic analysis of microbial growth and product formation.
- 8 Write a brief note on:
 - (a) Growth of filamentous organisms.
 - (b) Growth associated and non-growth associated product formation kinetics.

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- 1 Discuss in detail about an integrated bioprocess.
- 2 (a) What is the law of conservation of mass? Write the general mass balance equation.
(b) What are the various steps involved in material balance calculations? Discuss them briefly.
- 3 (a) Define enthalpy and write about its calculation procedure.
(b) Write the procedure for energy balance calculations without reaction.
- 4 Give an overview of whole cell immobilization processes and their uses.
- 5 Discuss in detail about the medium requirements for fermentation processes.
- 6 Aerobic degradation of benzoic acid by a mixed culture of microorganisms can be represented by the following reaction:
$$\text{C}_6\text{H}_5\text{COOH} + a\text{O}_2 + b\text{NH}_3 \rightarrow c\text{C}_5\text{H}_7\text{NO}_2 + d\text{H}_2\text{O} + e\text{CO}_2$$

(a) Determine a, b, c, d and e if RQ = 0.9.
(b) Determine the yield coefficients, $Y_{X/S}$ and Y_{X/O_2} .
(c) Determine the degree of reduction for the substrate and bacteria.
- 7 Give a brief account of:
(a) Thermodynamics of microbial growth.
(b) Estimation of heat of reaction with:
(i) Oxygen as electron acceptor
(ii) Oxygen not the principal electron acceptor
- 8 Describe in detail the phases of cell growth in batch cultures.

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Answer any FIVE questions
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- 1 What are the various upstream and downstream operations involved in bioprocesses? Give an outline about them.
- 2 Give a detailed account of:
 - (a) Electron balances
 - (b) Biomass yield
 - (c) Product stoichiometry
 - (d) Maximum possible yield
- 3
 - (a) Write the procedure for energy balance calculations without reaction.
 - (b) Discuss briefly about enthalpy changes due to reaction.
- 4 Write about solid-substrate fermentation and slurry fermentation and their applications.
- 5 Discuss in detail about the carbon, nitrogen, oxygen, minerals, vitamins and other complex nutrient requirements in the medium and their sources respectively for the growth of microorganisms.
- 6 Assume that the experimental measurements for a certain organism have shown that cells can convert two-thirds (wt/wt) of the substrate carbon to biomass.
 - (a) Calculate the stoichiometric coefficients for the following biological reaction:
$$C_6H_{12}O_6 + aO_2 + bNH_3 \rightarrow c(C_{4.4}H_{7.3}N_{0.86}O_{1.2}) + dH_2O + eCO_2$$
 - (b) Calculate the yield coefficients $Y_{X/S}$ and Y_{X/O_2} .
 - (c) Calculate the degree of reduction for the substrate and bacteria.
- 7 Write in detail about energetic analysis of microbial growth and product formation.
- 8 Give an overview of:
 - (a) Unstructured models for batch growth.
 - (b) Growth of filamentous organisms.

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BIOPROCESS ENGINEERING

(Biotechnology)

Time: 3 hours

Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

- 1 Write briefly about the various unit operations involved in bioprocesses.
- 2 (a) Write the procedure for material balance calculations.
(b) Discuss about material balance with recycle and bypass.
- 3 (a) Give a detailed account of energy changes in non-reactive processes.
(b) Define heat of combustion, heat of reaction and show how standard heat of reaction can be calculated from standard heat of combustion data.
- 4 Discuss in detail about the general requirements of fermentation processes.
- 5 (a) Define simple and complex media and give examples for each.
(b) Discuss briefly about design and usage of various commercial media for industrial fermentations.
- 6 Aerobic growth of *s.cerevisiae* on ethanol is simply described by the following overall reaction:
$$C_2H_5OH + aO_2 + bNH_3 \rightarrow cCH_{1.704}N_{0.149}O_{0.408} + dCO_2 + eH_2O$$

(a) Determine the coefficients a, b, c, d and e, where RQ = 0.66.
(b) Determine the biomass yield coefficient $Y_{X/S}$ and oxygen yield coefficient Y_{X/O_2} .
- 7 Discuss in detail about oxygen consumption and heat evolution in aerobic cultures.
- 8 Give a brief account of:
(a) Substrate and product inhibition on cell growth and product formation.
(b) Structured models for growth and product formation.
