Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	FERMENTATION ENGINEERING TECHNOLOGY
COURSE CODE	:	BNN 30304
PROGRAMME CODE	:	BNN
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Differentiate between *airlift bioreactor* and *stirred tank bioreactor* in terms of their configuration, oxygen requirements and applications.

(6 marks)

(b) The oxygen demand of fermentation process is normally satisfied by aerating and agitating the fermentation broth. As an engineering technologist (working in research and development department) who is responsible in setting up a laboratory scale (10 L) for batch stirred tank bioreactor:

(i) Explain on how a complete aeration and agitation could be achieved during fermentation process.

(4 marks)

(ii) Draw a schematic diagram (with labels) of motor and impeller used in that bioreactor.

(4 marks)

(c) Foams are dispersion of gas in liquid, results from agitation and aeration.

(i) Choose **TWO (2)** types of foam control in avoiding undesirable microbiological, economic and chemical engineering consequences in fermentation industry.

(2 marks)

(ii) List **TWO (2)** important properties of antifoam and interpret on how it works during fermentation.

(4 marks)

Q2 (a) Illustrate mass transfer steps (with a diagram) involved in transport of oxygen from the interior of gas bubbles to the site of intracellular reaction.

(8 marks)

(b) Oxygen transfer coefficient, k_La is considered as a single parameter which known as volumetric or overall oxygen transfer rate. During experiment, the air supply to a fermenter was turned off for a short period of time and then restarted. A value for C* of 7.3 mg/l has been determined for the operating conditions. Calculate the oxygen uptake rate and k_La in this system by referring the tabulated measurements of dissolved oxygen (DO) values in **Table Q2 (b)**.

(8 marks)

(c) A fermentation broth with viscosity 10^{-2} Pa.s and density 1000 kg/m^{3}is agitated in a 50 m^3 baffled tank using a marine propeller 1.3 m in diameter. Calculate the power required for a stirrer speed of 4 s^{-1}. ($N_p = 0.35$)

(4 marks)

Q3 (a) Exhibit a stable structure is an important characteristic for an enzyme to be chosen and widely-used in industry. One method to achieve stabilization is through protein engineering. Thoroughly discuss **ONE (1)** enzyme that is structurally engineered for stability and relate its application in the industry.

(5 marks)

(b) Bioprocessing often involves the use of immobilized enzymes in a bioreactor.

(i) Define immobilization of enzyme.

(1 mark)

(ii) Discuss **TIIREE (3)** advantages of employing immobilized enzymes in industry.

(3 marks)

(iii) Provide **ONE (1)** application of a named immobilized-enzyme. In your answer, thoroughly explain the technique used to immobilize the named enzyme, its support material(s), the substrate and the product.

(6 marks)

(iv) Pectinases are enzymes that are routinely used in industry to increase the volume and clarity of fruit juice extracted from apples. In reference to Figure **Q3(b)(iv)**, analyse and compare the capabilities of free enzyme, enzymes bound to gel membrane surface and enzymes immobilize inside beads in extracting fruit juice.

(5 marks)

Q4 Fermentation processes utilize microorganisms such as the bacteria and fungi to convert solid or liquid substrates into numerous products for the benefits of humankind.

(a) Name **ONE (1)** fermented product and its related industry.

(1 mark)

(b) Illustrate the general process flow of fermented product mentioned in **Q4(a)**.

(5 marks)

(c) Extensively explain on the type or technology related to bioreactor used for the production of **Q(4)(a)**.

(6 marks)

(d) Discuss **TWO (2)** advantages and limitations of the bioreactor in **Q(4)(c)**.
(4 marks)

(e) Under certain environmental conditions, some organisms used in fermentation can be disruptive to health or certain fermentation products are toxic. Identify **TWO (2)** potentially harmful microorganisms and recommend **TWO (2)** measures that could be taken to reduce the risks when working with the microorganisms.
(4 marks)

Q5 (a) State **ONE (1)** example of potential fermentation hazard and briefly describe **TWO (2)** possible events that lead to maximum generation of the hazard.
(3 marks)

(b) Discuss **TWO (2)** preventive actions that could be employed to reduce exposure to hazardous substances during fermentation processes.
(2 marks)

(c) Choose and explain **FIVE (5)** significant steps to maximise the profits in fermentation industry.
(5 marks)

(d) Thoroughly debate on the future of fermentation technology.
(10 marks)

-END OF QUESTIONS -

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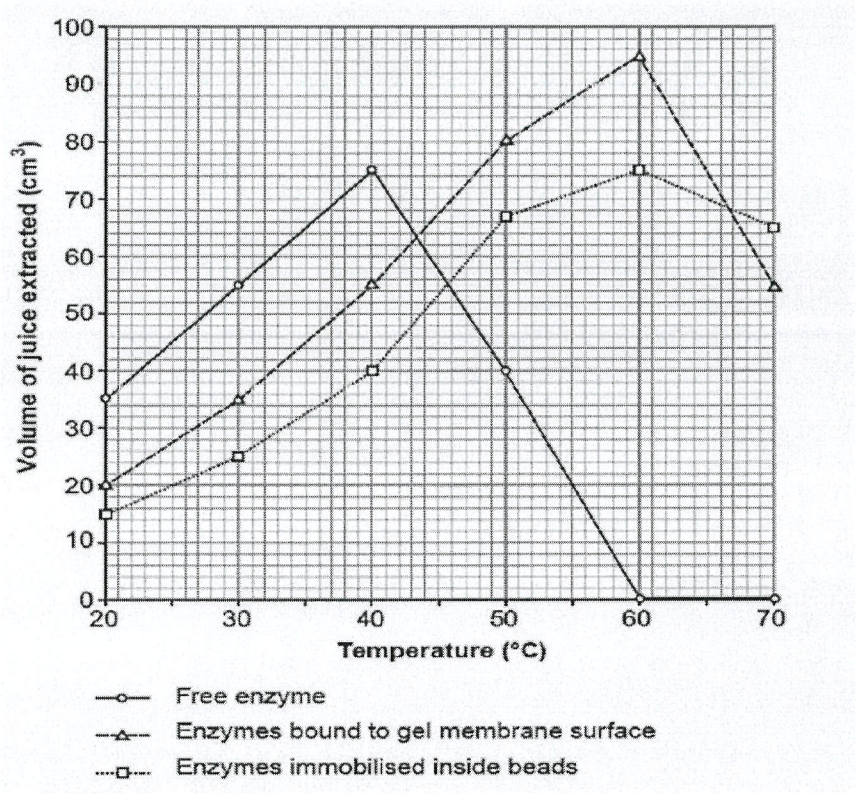

Figure Q3(b)(iv)

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Table Q2 (b) Tabulated measurement of dissolved oxygen (DO)

Time (min)	DO (mg/ml)
-1	3.3
0	3.3
1	2.4
2	1.3
3	0.3
4	0.1
5	0.0
6	0.0
7	0.3
8	1.0
9	1.6
10	2.0
11	2.4
12	2.7
13	2.9
14	3.0
15	3.1
16	3.2
17	3.2

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FORMULA:

1. $V = \pi r^2 H$
2. $Re = \frac{ND^2 \rho}{\mu}$
3. $N = \frac{P}{\rho N^3 D^5}$
4. $P = k_1 \mu N^2 D^3$
5. $P = N_P \rho N^3 D^5$
6. $OTR = k_L a\ (C^* - C_L)$
7. $OUR = q_{o2} X$