Code: 9A23603 **R09**

B.Tech III Year II Semester (R09) Supplementary Examinations May/June 2017

TRANSPORT PHENOMENA IN BIOPROCESS

(Biotechnology)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Explain with an illustration the working of co-axial cylinder viscometer.

(b) What are non-Newtonian fluids? Discuss how they are different from Newtonian fluids.

2 (a) Prove that the flow of a liquid in laminar flow between two infinite parallel flat plates which are stationary is given by $P_O - P_L = \frac{12\rho L\, V_{avg}}{(2B)^2}$, where L is the length of plate in the direction of flow, 2B is the distance between plates. Assume steady state, laminar, Newtonian and isothermal condition.

(b) Explain how Reynolds number is calculated for the system in which film is falling over a flat plate.

3 An incompressible fluid flows tangentially in the space between two cylinders; the outer one with radius R remains stationary. The inner cylinder with radius kR moving with an angular velocity Ωi. Develop an expression for the torque required to turn the inner cylinder at steady state under laminar flow condition using equations of change.

4 Write briefly about mixing and the importance of mixing in bioprocess.

5 (a) Describe briefly the mechanisms of energy transport.

(b) Define and give the dimensions of thermal conductivity k, thermal diffusivity α, heat capacity C_p.

6 (a) Derive the expressions for heat flux and temperature distribution for a spherical nuclear heat source surrounded by a spherical shell of aluminium cladding.

(b) Differentiate between free and forced convection.

7 (a) Explain the theory of ordinary diffusion in gases at low density.

(b) Derive an expression for the concentration distribution for diffusion of component A through a spherical stagnant gas film surrounding a droplet of liquid A.

8 (a) A 200-litre stirred fermenter contains a batch culture of Bacillus subtilis bacteria at 28℃. Air at 20℃ is pumped into the vessel at a rate of 1 vvm; (vvm stands for volume of gas per volume of liquid per minute). The average pressure in the fermenter is 1 atm. The volumetric flow rate of off-gas from the fermenter is measured as 189 lt min^{-1}. The exit gas stream is analyzed for oxygen and is found to contain 20.1% O_2. The dissolved-oxygen concentration in the broth is measured using an oxygen electrode as 52% air saturation. The solubility of oxygen in the fermentation broth at 28℃ and 1 atm air pressure is $7.8 \times 10^{-3}\ kg\ m^{-3}$. Given $R = 8.2 \times 10^{-5}\ m^3\ atm\ K^{-1}\ gmol^{-1}$.

(i) Calculate the oxygen transfer rate.

(ii) Determine the value of $k_L a$ for the system by using oxygen balance method.

(b) Discuss the effect of temperature and bubble size on oxygen transport.

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