BEL301: BIOPROCESS ENGINEERING

MAJOR Sem-I 2008-09: November 24, 2008, 10:30 – 12:30 am in II-378

(Total Marks = 50)

NOTE: Answer Part-A and Part-B in separate answer books

Part A: Dr. J. Gomes (25 Marks)

1. The data for the batch production of *L*-lysine is given in Fig. 1 below. It is suggested that the rate of formation of *L*-lysine may be described by the Luedeking-Piret model for product formation. You will need to develop a method to determine approximately the coefficients of the model.

   a. State your assumptions, describe the method and compute the values of the Luedeking-Piret model coefficients.
   b. What are the values of the coefficients $Y_{P/S}$ and $Y_{X/S}$?

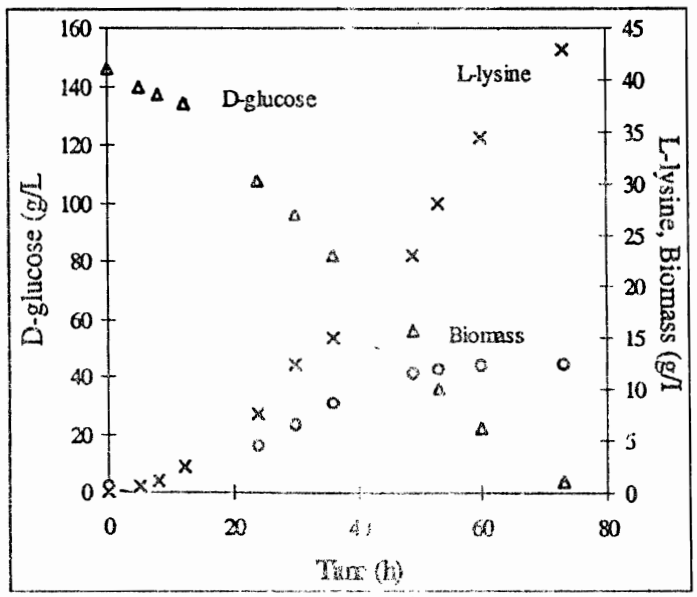

Figure 1. Data for *L*-lysine production

(6+3 marks)

2. A certain bioprocess is carried out in the following way. It is first carried out in batch mode and then in the fed-batch mode. The process is described in terms of the cells mass concentration (x) and substrate concentration (s). The growth follows Monod kinetics $\mu(s) = \dfrac{\mu_{\max} s}{K_M + s}$, the yield coefficient is $Y_{x/s}$, the maintenance coefficient is m_S and the reactor volume is denoted by V. At the beginning of the fed-batch process $x=x_0$, $s = s^*$ and $V = V_0$. The substrate feed rate is F and the substrate concentration in the feed is s_F. During the fed-batch mode of operation, it is desirable to maintain the bioprocess at a constant at $\mu = \mu(s^*)$. Determine the flow rate $F(t)$ for achieving this. (3 marks)

3. From a Biochemical Engineering perspective discuss the following
   a. Balanced growth
   b. Pseudo steady state in fed-batch reactors
   c. Structured model intracellular metabolites
   d. Influence of gene regulation on product synthesis (2+2+2+2 marks)

Part-B : Dr. Vikram Sahai (25-Marks):

Note: Use notation symbols as given in lecture classes.

Q.1 Define pseudoplastic behavior of a fermentation broth in terms of rheogram. How do you calculate the apparent viscosity for such broths? (2+2-marks)

Q.2 Dimensions of a bioreactor equipped with two sets of standard flat blade turbine impellers and four baffled plate as per standard notations are: D_t=3m: D_i=1.5m: W_b=0.3 m: H_L=5m. The fermentor is used for a specific fermentation, where ρ=1,200 kg/m^3 and μ=0.02 kg/ (m sec). Agitator rotational speed (n) is 60 rpm and aeration rate is 0.4 vvm. Calculate the following:

(a) Un-gassed power input (P), HP, assuming correction factor on account of geometrical dissimilarities, to be 0.86
(b) Superficial space velocity of air (v_s), m/h
(c) Aeration Number (3+3+3=9 marks)

Q.3 A fermentation process bench scale fermentor (V=80L) is to be scaled-up to a large scale fermentor (V=10,000 L) on the basis of equal Reynold's number. Calculate the following for the 'large scale fermentor' taking their values to be unity for the bench scale fermentor:

(a) Energy input/Volume, (P_2/V_2)
(b) Impeller shear rate, (n_2Di_2),
(c) Pumping rate of impeller, (Q_2/V_2). (3+3+3=9 marks)

Q4. Describe the three mechanism of collection of air borne contaminating microorganism by a single fiber. Do not give expressions for collection efficiency. What happens to the collection efficiency of the individual mechanisms with increase in upstream air velocity? (3 marks)