29/11/2006

# BEL 301: Bioprocess Engineering

**Major Examination Sem-I, 2006-07**

**29th November 2006: Time $10^{30}$ - $12^{30}$; Venue II –378**

**Note: Answer all questions. Maximum marks 40.**

Q.1 Show that the generation time of a single cell is actually less than the overall doubling time of the population. **[4 marks]**

Q.2 An industrial unit produces 800 tonnes per year of active dry yeast (ADY) using molasses as the growth medium in a continuous stirred reactor of volume 40 $m^3$. Growth of yeast cells on molasses can be assumed to follow the Monod kinetics with the following data:

$\mu_m = 0.5h^{-1}$
$Ks = 0.2\ kg.m^{-3}$
$Y_{x/s} = 0.8\ kg.kg^{-1}$
$S_F = 10\ kg.m^{-3}$
Number of productive days per year = 340

The management, based on the feedback received from its marketing division, has taken a decision to increase the unit's output by 50%. However, economic considerations do not favor scrapping the present reactor. The company's engineers are divided over the manner in which the production should be increased. One group wants the present system to be continued, but with the addition of a continuous centrifuge which can separate the cells and recycle part of it to the reactor. The second group wants a second reactor to be installed in series with the existing one. The company's management approaches you as an independent expert to sort out the problem. What are your suggestions/comments? **[8 marks]**

Q.3 Explain how you will use the experimental data obtained from a batch cultivation study to design a continuous cultivation process for the same organism carried out in a number of stages in series. What are the assumptions involved in this procedure? **[4 marks]**.

Q.4 A bioreactor, fitted with two sets of flat blade turbine impellers, is operating at 60-rpm agitation and 0.4 vvm aeration. The physical properties of broth are density=1200 $kg/m^3$, viseosity=0.02 kg/(m.sec). The tank diameter ($D_t$) is 3 m and impeller diameter ($D_i$) 1.5m. The liquid depth ($H_L$) is 5m. Assume eorrection factor due to dissimilar geometrical ratios to be 0.86. Compute the following:

(i) Modified Reynold's number **[2-marks]**
(ii) Un-gassed power requirement (HP), **[4-marks]**
(iii) Acration number, **[4-marks]**

Q.5 Discuss problems associated with scale-up of fermentation process in relation to oxygen transfer effeets. **[4-marks]**

Q.6 Show that for a volumetric scale-up ratio of 125, the modified Reynolds number in large-scale fermentor increases 5 times and power input per unit volume is decreased by 0.2 times of their values in bench scale fermentor, if the scale-up is done on the basis of equal impeller tip speed. **[4-marks]**

Q.7 List all the resistances, which the oxygen molecules encounter in their transfer from gas bulk in air bubble to cells in liquid bulk. How will you determine specific oxygen uptake rate by dynamic method. **[6-marks]**

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