**Fermenter Algorithm Suggestions**

1. **Determine fermenter dimensions.**

Derive batch fermentation rate equation by combining microbial growth with substrate consumption and cell formation. From mass balance of .9 So and .1 Sf determine the initial substrate concentration in the fermenter. Given that S = F(X ) .( eq 6.52 Shuler**,)** Integrate and determine time to consume X% substrate eq 6.53 Shuler**.** Assuming a fill time, determine number and volume of the fermenter(s) to meet production requirement.

1. **Determine agitator power requirement from oxygen requirement**

Using standard agitation system relationships (Table 3.4-1 Geankoplis CJG ) and (page 290 Shuler) estimate dimensions of the fermenter and dia of agitator.

From max cell concentration and desired outlet excess O2 concentration determine volumetric flow rate of air required. From the desired outlet O2 concentration determine the necessary kla to maintain the desired OUR using Eq 10.1. Determine the agitator N rpm to maintain kla. Since CO2 is being produced and the concentration of O2 will be reduced but must be maintained significantly above the C critical.

Given Fig 3.5-6 CJG, eq 4.3 Jackson, and eq 10-2b in Shuler determine N to maintain the required kla. Hint: find Pu = f(N) and determine vs in eq 10-2b and Q in eq 4.3 Jackson from airflow and fermenter dimensions.

1. **Determine size of heat exchanger**

Using eq 6.29 Shuler determine heat generated from oxygen consumption. Determine area of heat exchanger using Sec 4.13A CJG page 326. Heat exchange tube info CJG Table A.5-2 p 997

1. **Determine type and size of air blower**

Using heuristics of Table 2.10-3 determine diameter of pipe desired. Pressure drop of a compressible gass Eq 2.11-10 CJG,

Using mechanical energy balance determine the total pressure drop for pumping air, 1) pressure drop from pipe –sparger assume spiral tube in fermeter bottom (Section 2.11 CJG), 2) from head (Section 2.2 CJG), and 3) the sparger (assume similar to open globe value Table 2.10-1). Power and temp for blower Eq 3.3-15 to 3-17