

ABE 580
Homework 3: CSTBRs
Due Monday February 4, 2019

Objectives:

1. Analyze data from fermenter experiments to determine model parameters
2. Model the transitory behavior of a continuous, stirred, tank, bioreactor (CSTBR).

Software:

1. Microsoft Excel (version 95 or newer) with macros enabled.
2. SIMBAS Runge-Kutta ODE solver (simbas.xls).

Instructions:

A laboratory scale fermenter was operated as a CSTBR in order to obtain cell growth data for *Lactobacillus* grown anaerobically. The details of the fermenter are provided below. Data from the experiments are provided in the tables.

Due Next Monday (February 4, 2019):

1. Analyze the data to determine the model parameters for this system: μ_{\max} , K_m , Y_{sx} , and m_e . Explain how you calculated your estimates. Include appropriate plots to illustrate how the parameters were determined.
2. Use SIMBAS (or MatLAB if you prefer) to model of the transitory behavior of the CSTBR operating at the following settings and initial conditions.
 - Initial Conditions
 - $X = 0.1 \text{ g/L}$
 - $S = 50 \text{ g/L}$
 - Operating Conditions
 - $F = 75 \text{ mL/hr}$
 - $S_0 = 50 \text{ g/L}$
 - $X_0 = 0 \text{ g/L}$
3. Plot of transitory phase (up to steady-state) and provide a copy of the code
4. What are the values of X and S after the model reaches steady-state? How do these values compare to the analytical solution of the steady-state?
5. How long is the transitory period from initial conditions to steady-state?

Laboratory Fermenter

Total Volume	1000 mL
Working Volume (liquid volume)	800 mL
Temperature	35 C
Mixing	800 RPM
pH	5.5

Experimental Data

Concentrations in Effluent at Steady-State										
F	S ₀ = 200		S ₀ = 100		S ₀ = 50		S ₀ = 10		S ₀ = 5	
mL/hr	S (g/L)	X (g/L)	S (g/L)	X (g/L)	S (g/L)	X (g/L)	S (g/L)	X (g/L)	S (g/L)	X (g/L)
50	2.82	8.26	2.88	4.03	2.88	1.95	2.66	0.29	2.85	0.09
60	3.54	9.03	3.55	4.43	3.41	2.03	3.55	0.28	3.55	0.07
70	4.35	9.14	4.20	4.56	4.34	2.23	4.00	0.28	4.12	0.04
80	4.81	9.41	5.07	4.81	5.24	2.30	4.89	0.25	4.81	0.00
90	5.65	9.98	6.00	4.71	6.10	2.29	6.15	0.22	6.16	0.00
100	6.94	10.53	6.64	5.27	6.92	2.38	7.01	0.18	5.00	0.00
120	8.57	10.67	8.87	5.39	8.57	2.25	8.73	0.06	5.00	0.00
200	26.24	11.78	26.14	4.94	25.92	1.63	10.00	0.00	5.00	0.00