Lab 6 – Nonlinear Curve Fitting-Part II

CO_2 Delivery for the Cultivation of Algae

CENG340—Introduction to Environmental Engineering

October 8, 2013

Due Date

Submit your memo via email before lab on October 22.

Learning Objectives

1. Communicate the results of a combined laboratory and modeling study in a formal memo to a client.
2. Create, discuss, and analyze a high-quality figures that that contain graphs with data and model fits.
3. Learn to fit laboratory data to mathematical models using non-linear curve fitting.

Overview

This lab is an continuation of Lab 3, where you learned to fit non-linear data to mathematical models, and present the data and model fit in a high-quality plot. In this assignment you will extend what you learned in Lab 3 and incorporate a plot into a clear and concise memo to a client.

Rationale

1. To be successful, engineers need to communicate results of preliminary experiments and final designs clearly and concisely to their colleagues, supervisors, and clients.
2. Figures or graphs can be an effective way to display data, but only if they're done well. A good figure should allow the reader to easily discern the point you are trying to make. Please refer to the DO's and DONT's document prepared by Prof. Malusis.
3. Environmental engineers use mathematical models that describe phenomena—such as aeration of an activated sludge reactor—to design treatment technologies. Such models can be used to predict the behavior of a treatment system, or, in some cases, may enhance the visual display of data.

Assignment—CO_2 Delivery

Bioprocess Algae LLC is designing a CO_2 delivery system for their raceway ponds, which are used to grow microalgae that will be converted into jet fuel. Since the cost of delivering CO_2 to raceway ponds represents about one-third of the total cost of growing algae for fuel production [1], a well designed delivery system is critical for producing biofuel from algae in an economically viable manner.

Bioprocess Algae contracted the engineering firm that you work for to conduct a laboratory study that will determine the effect of the three following designs on the rate of CO_2 input into raceway ponds ponds: (1) mixing only, (2) CO_2 gas delivery with a fine (small) diameter diffuser, and (3) CO_2 gas delivery with a coarse (large) diameter diffuser.

Assignment

The data file titled "CO_2 Delivery" is located at blahblahblah drive blah The file contains three sets of CO_2 concentration versus time data from an open raceway pond, where CO_2 was delivered via the three methods described above.

1. mixing only,
2. sparging with coarse (large) bubbles, and
3. sparging with fine (small) bubbles.

- Use KaleidaGraph (or another software) to fit the three-parameter (C_{sat}, C_0, and k) nonlinear mass transfer equation (Eq.1) that we used in lab last week, to each data set.

$$C = C_{sat} - (C_{sat} - C_0)e^{-kt} \tag{1}$$

where C = Aqueous concentration of dissolved CO_2 at time = t,

C_{sat} = Aqueous concentration of CO_2 when the water in the pond is in equilibrium with the atmosphere,

C_0 = Aqueous concentration of CO_2 at time = 0, and

k = First order rate coefficient.

- Create one plot that shows all three sets of C vs. t data points, and a line/curve that illustrates the model fit to each data set.
- Think about how well the model fits the data and if you think the model is appropriate or not. Note that we will not conduct proper statistical tests for goodness of fit, but you should be able to visually assess whether the model is appropriate or not.

- Create a column graph with three columns, showing the value of the mass transfer coefficient (k) on the y-axis that corresponds to each aeration method on the x-axis.

Deliverables

Summarize your work in a memo addressed to Dr. Toby Ahrens, the Chief Science Officer of Algae Bioprocess. Refer to the instructions handed out at the beginning of the semester for formatting and writing style. For this assignment include the following sections: (1) Introduction, (2) Methods,(3) Results and Discussion (this is where you'll include the figures you created), and (4) Conclusions. Make sure you to only include conclusions that come out of the data and model fits you present in the figures.

References

[1] Lundquist, Tryg J and Woertz, Ian C and Quinn, NWT and Benemann, John R "A realistic technology and engineering assessment of algae biofuel production," *Energy Biosciences Institute*, 2010.