Parameter estimation – Homework 5

Deadline: 23th of March, 11:59:59 pm

Submission via Moodle

Task

We consider the dynamical model of a simple mixing system as it is depicted in Figure 1. The system - which is a tank of constant volume V $[m^3]$ - is fed with two inlet flows of rates F_1 and F_2 $[m^3/min]$. Both of the two input flows contain dissolved materials A_1, $A2$ with constant concentrations c_{01} and c_{02} $[kmol/m^3]$. In the tank the dissolved materials reacts with reaction rate k. This reaction results in a material denoted by A_3. The tank has also an outlet flow of rate F. We assume that the tank is well-stirred implying that the reactant and product concentrations of the outlet flow are the same as those of the tank.

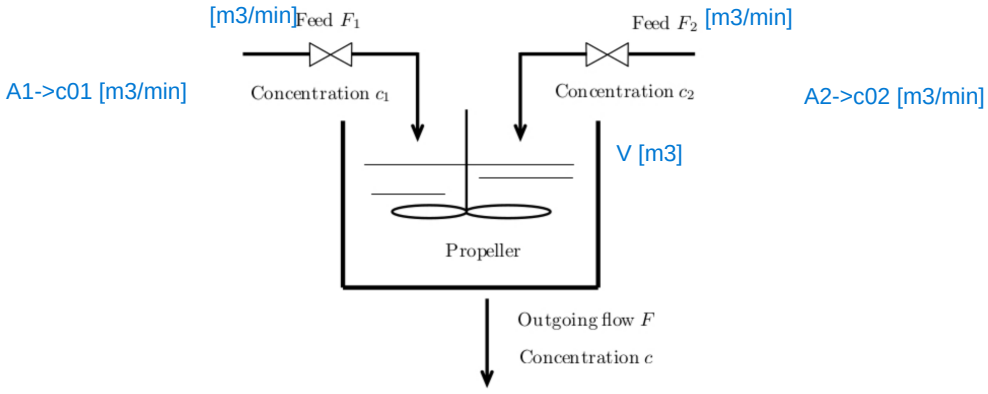

Figure 1: A simple heat exchanger cell consisting of two lumps

The continuous time ODE characterizing the dynamical behavior of the above system is as follows:

$$\frac{dc_1}{dt} = \frac{F_1 \cdot c_{01}}{V} - k \cdot c_1 \cdot c_2 - \frac{F \cdot c_1}{V}$$
$$\frac{dc_2}{dt} = \frac{F_2 \cdot c_{02}}{V} - k \cdot c_1 \cdot c_2 - \frac{F \cdot c_2}{V}$$
$$\frac{dc_3}{dt} = k \cdot c_1 \cdot c_2 - \frac{F \cdot c_3}{V}$$

Where c_i denotes the concentration of A_i for $i = 1, 2, 3$ (i.e. $c_i = [A_i]$). The following parameter values are known constants:

$$c_{01} = 1\ [\frac{kmol}{m^3}], \qquad c_{02} = 2\ [\frac{kmol}{m^3}], \qquad V = 50\ [m^3].$$

Observation data of the system is contained in the supplementary file *mixing_system.xlsx*, columns represent the concentrations of c_1, c_2 and c_3 in order. We can assume constant equidistant sampling time $h = 1.0$. Your task is to identify the unknown parameter values of the above model. Note that the parameter values may change in time, so you are supposed to implement a recursive algorithm keeping track all parameter changes. Once you implemented the recursive LSQ, estimate the parameter values (possibly using different forgetting factors) and visualize your results in terms of the obtained time-dependent parameter estimates and plots depicting simulation results of the obtained predictive model (using the discretized model).