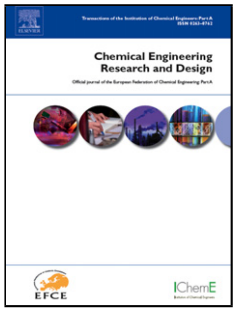

Title: Grey-box model identification of temperature dynamics in a photobioreactor

Author: A. Jiménez-González M. Adam-Medina M.A. Franco-Nava G.V. Guerrero-Ramírez

PII: S0263-8762(17)30137-5
DOI: http://dx.doi.org/doi:10.1016/j.cherd.2017.03.004
Reference: CHERD 2602

To appear in:

Received date: 24-11-2016
Revised date: 2-3-2017
Accepted date: 7-3-2017

Please cite this article as: A. Jiménez-González, M. Adam-Medina, M.A. Franco-Nava, G.V. Guerrero-Ramírez, Grey-box model identification of temperature dynamics in a photobioreactor, <*![CDATA[Chemical Engineering Research and Design]]*> (2017), http://dx.doi.org/10.1016/j.cherd.2017.03.004

Grey-box model identification of temperature dynamics in a photobioreactor

A. Jiménez-González[a,*], M. Adam-Medina[a], M.A. Franco-Nava[b], G.V. Guerrero–Ramírez[a]

[a]*Interior Internado Palmira s/n, Col. Palmira, C.P. 62490, Cuernavaca, Morelos, México.*

[b]*Corsario I 203, Col. Urías, C.P. 82070, Mazatlán, Sinaloa, México.*

Abstract

This article presents a general strategy for grey-box model identification and deals with some issues that might be present in real life applications. An Unscented Kalman Filter (UKF) is used to train a grey-box temperature model with experimental data from an internally illuminated photobioreactor. The model structure is derived by means of heat balance analysis with the aid of a heat flow diagram. Then, the model is discretized and given an alternative state space representation in such a way that parameters can be readily estimated with an UKF. In order to avoid performance degradation and to improve the stability of the UKF algorithm, the prediction error covariance matrix is estimated and the state covariance matrix square root is calculated with a method based on Schur spectral decomposition to ensure positive semi-definiteness.

Keywords: Heat balance, grey-box model, parameter estimation, Unscented Kalman Filter, covariance matrix, internally illuminated photobioreactor.

1. Introduction

Process model development and parameter estimation usually conform a previous step to other tasks such as model based control design, process optimization or fault diagnosis. The most common approach to determine the dynamical model of certain process consists in applying material and energy balances to obtain a set of differential equations (Dochain, 2013, [5]). In many cases, the parameters of the process model are unknown. However, process data that can be used for parameter estimation is usually available.

Direct and sensitivity methods are among the most common approaches for continuous model parameter estimation. The direct method intends to directly minimize the quadratic error between the model function and the state derivative. In practice, the state derivative is not available, and thus it must be reconstructed from noisy measurements. Experimental results show that this approach is not very robust and tends to fail (Oliveira, 2004, [15]). On the other hand, the sensitivity

*Corresponding author
Email address: abraham.jimenezg11e@cenidet.edu.mx (A. Jiménez-González)