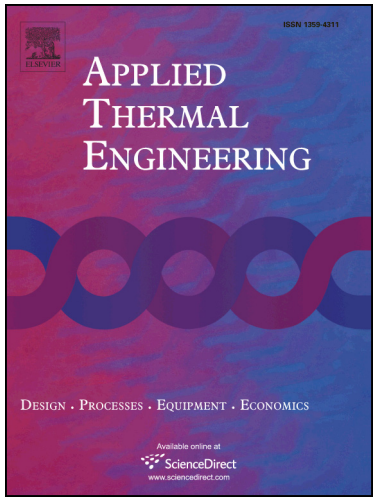

Research Paper

Simplified Modeling of Liquid-Liquid Heat Exchangers for Use in Control Systems

Piotr Laszczyk

PII: S1359-4311(16)33732-2
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2017.03.033
Reference: ATE 10037

To appear in: *Applied Thermal Engineering*

Received Date: 3 December 2016
Revised Date: 10 February 2017
Accepted Date: 9 March 2017

Please cite this article as: P. Laszczyk, Simplified Modeling of Liquid-Liquid Heat Exchangers for Use in Control Systems, *Applied Thermal Engineering* (2017), doi: http://dx.doi.org/10.1016/j.applthermaleng.2017.03.033

Simplified Modeling of Liquid-Liquid Heat Exchangers for Use in Control Systems

Piotr Laszczyk

Institute of Automatic Control
Faculty of Automatic Control, Electronics and Computer Science
Silesian University of Technology
ul. Akademicka 16, 44-100 Gliwice, Poland
tel. 48 (32) 2371473 Fax: 48 (32) 2372127
e-mail: Piotr.Laszczyk@polsl.pl

Abstract:

For last decades various models of heat exchange processes have been developed to capture their specific dynamic nature. These models have different degrees of complexity depending on modelling assumptions and simplifications. Complexity of mathematical model can be very critical when the model is to be a basis for deriving the control law because it directly affects the complexity of mathematical transformations and complexity of final control algorithm. In this paper, the simplified cross convection model for wide class of heat exchangers is suggested. Apart from very few reports so far, the properties of this modeling approach have never been investigated in detail. The concept for this model is derived from the fundamental principle of energy conservation and combined with a simple dynamical approximation in the form of ordinary differential equations. Within this framework, the simplified tuning procedure of the proposed model is suggested and verified for plate and spiral tube heat exchangers based on experimental data. The dynamical properties and stability of the suggested model are addressed and sensitivity analysis is also presented. It is shown that such a modeling approach preserves high modeling accuracy at very low numerical complexity. The validation results show that the suggested modeling and tuning method is useful for practical applications.

Keywords:

heat exchangers; simplified dynamical modeling; tuning procedure; practical validation

1. Introduction

Improvement in energy efficiency is one of the main goals in designing control strategies for the vast majority of industrial processes. At the same time, over 80% of the worldwide energy utilization involves heat transfer processes [1]. Therefore, heat exchange and distribution phenomena should be very intensively investigated when process efficiency is considered, because its proper design provides potential possibilities for optimization [2,3,4,5,6]. However, optimal energy consumption requires not only proper process design but also its efficient control.