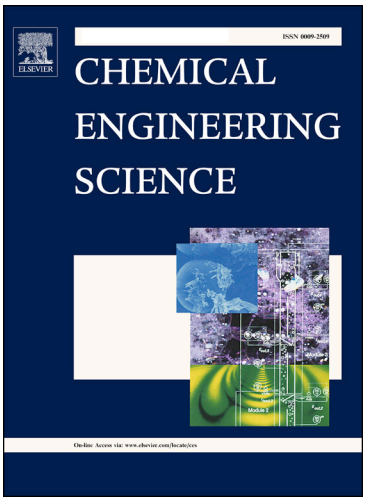

Multi-rate state estimation applied to a pilot-scale reactive distillation process

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Multi-rate state estimation applied to a pilot-scale reactive distillation process*

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***Abstract*— In this paper, we use a variant of the Extended Kalman filtering (EKF) state estimation technique which is specifically adapted to handle models that are described by differential-algebraic equations (DAE) to estimate the full state vector of a reactive distillation process in a pilot plant. The process model employed in this work is a MESH model (Material, Equilibrium, Summation, Enthalpy or Heat balance) that incorporates several hundred state variables. At the pilot-scale process, the concentration measurements of each product stream of the column (distillate, bottom) can be accessed at a slower sampling rate compared to the temperature and holdup measurements. We have designed and tested the state estimator in simulation studies for a realistic setting and present the results. The state estimator is run online at the column using an OPC-DA (OLE (Object Linking and Embedding) for Process Control for Data Access) server for an efficient data exchange between the process control system (PCS), the concentration measurement device based on the near-infrared (NIR) spectroscopy and the state estimator. Both in theory and in practice, we evaluate the statistical properties of the innovations in order to draw conclusions on the performance of the state estimator. At the pilot-scale reactive distillation process, we tested different operating conditions to demonstrate the reliability of the state estimator.**

Keywords: Extended Kalman Filter for DAE systems, multi-rate state estimation, nonlinear DAE-systems, reactive distillation, transesterification

I. INTRODUCTION

Process intensification and process integration are general trends in chemical engineering. In process integration, different unit operations, e.g. a reaction step and a separation step are combined in a single apparatus which is usually less expensive and significantly smaller [1,2]. Reactive distillation (RD) as the most popular example of an intensified process has been

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