

# Hierarchical State Estimation for Dynamic Real-Time Optimization for a Reactor, Separator and Recycle Process

J. Klemets \* M. Hovd \*

*\* Department of Engineering Cybernetics, Norwegian University of Science and Technology, Norway, 7491 (e-mail: jonatan.klemets;morten.hovd@itk.ntnu.no)*

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**Abstract:** The control structure for chemical plants are normally divided into different layers operating at different time scales. The higher layer computes the reference values for the layer below using some optimization strategy (i.e. Model Predictive Control, Real-Time Optimization) based on their steady state values. This has the consequence of not allowing the plant to operate optimally, because the disturbances affecting the plant in the transient stage will not be considered in the optimization layer. This has led to an increasing interest in Dynamic Real-Time optimization (DRTO) and Nonlinear Model Predictive Controller (NMPC). To successfully be able to implement such techniques, more frequent information of the current states of the system is required. Measuring all the important states and disturbances is generally not possible and therefore needs to be estimated, using appropriate state estimators. For chemical process plants and other large-scale systems, using centralized state estimators are in general not favourable due to the high computational complexity. Instead it is preferable to decompose the problem into several sub-systems or local estimators, that each uses a set of measurements that is available locally. In this work, a hierarchical state estimator is investigated, where the process is divided into several local estimators for different sub-systems. Each of the local estimator uses only a local model and the measurements that are available locally. The states and covariance matrix computed by the local estimators are represented in their canonical-form, consisting of an information matrix and information vector. Combining all the estimates received from the local estimators results in a large but sparse information matrix and a information vector, from which a global mean of the states can be recovered. This approach was implemented for a reactor, separator and recycle process together with a DRTO, resulting in a reduction of the economic operating cost when subjected to disturbances.

*Keywords:* Hierarchical State Estimation, Dynamic Real-Time Optimization, Reactor, Separator and Recycle Process

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