Economic plantwide control performance benchmarked against economic MPC

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Abstract: The modern globalized market competition drives the necessity for an improved economic operation of chemical plants. The theoretically optimal strategy is to have a dynamic real-time economic optimization and control algorithm that directly regulates the manipulated variables in such way that an economically optimal, safe and stable operation is achieved. But disadvantages such as the current technological and computational limitations or the incompatibility with the existing control infrastructure, have not allowed the adaptation of such solutions as reliable plantwide control strategies. Instead, a conventional approach that is commonly used, hierarchically decomposes the operational decisions into several layers with different time scales, such that the economic and control objectives are clearly separated.
One such approach is the economic plantwide control procedure. This procedure attempts to design a control structure that maintains a close-to-optimal economic operation by means of simple constant set-points policies. In particular, the procedure employs an offline mathematical analysis around the nominal optimal operational point to discover all the different active constraints regions in the entire parametric space. It then identifies for each region a set of controlled variables, such that a close-to-optimal plant operation is maintained in spite of disturbances by keeping these variables at constant set-points.
In this work, we evaluate the economic performance of several control structure candidates designed using the economic plantwide control procedure. Their performance is benchmarked against a state of the art two-layer control scheme, comprised of a fast regulatory layer with SISO controllers and a slower optimization layer with an economic MPC algorithm. A generic chemical plant model that consists of a reactor, a separator and a recycle stream is used as a case study. This particular plant model is used primarily because it incorporates the basic process structure that a lot of chemical plants have. For the evaluation of the economic performance of the selected control structure candidates the process feed flow rate fluctuations is considered as the main disturbance.

Keywords: Economic plantwide control, self-optimizing control, control structure selection, economic model predictive control

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