Optimal Operation of Batch Processes with Multiple Inputs and Constraints

B. Srinivasan, S. Palanki, and D. Bonvin

Optimal operation of batch processes has become increasingly important in recent years in the face of increased competition and also due to the trend towards building small, flexible plants near the markets of consumption. Traditionally, batch processes have been operated with rudimentary control loops, which hinders the implementation of best operating policies in the face of uncertainty. This results in substantial losses in both quality and productivity.

In this paper, a theoretical framework for on-line optimization of batch processes with multiple inputs and constraints is developed. It is shown that the optimal solution consists of several discontinuous input intervals; however, the inputs are analytic in between discontinuities. Some combinations the inputs push the system towards the constraints of the problem, while other combinations exploit the intrinsic compromises present in the system. A procedure is developed to separate these two combinations of inputs. This characterization of the optimal solution can be utilized to develop an efficient numerical procedure for computing the nominal optimal solution. Furthermore, the characterization also helps develop a measurement-based optimization scheme that is highly efficient in the presence of uncertainties. The benefits of this scheme are illustrated via the simulation of a non-isothermal semi-batch reactor.