176e Supervisory Control of Process Transitions: Challenges & Opportunities

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Increasingly, most manufacturing facilities operate at a multitude of states and frequently switch between them. The switch from one state to another is termed as a process transition. Plant startup and shutdown are common examples of transitions in the process and allied industries including refining, petrochemicals, paper & pulp, steel, and cement manufacture. Other transitions occur due to feedstock, throughput, or product slate changes as well as maintenance operations such as furnace decoking or absorber regeneration. Transitions are also common in high-value added specialty and pharmaceutical plants which commonly operate in batch and fed-batch phases. Particulate operations such as crystallization, drying, filtration, etc, whose control is becoming increasingly important in the pharmaceutical and formulated product industries, are also operated under transition states.

From a control perspective, transitions often correspond to discontinuities in the plant operation such as change of setpoints, change of equipment configuration, turning on or idling equipment, etc. Hybrid discrete-continuous behavior of the process therefore has to be considered when controlling transitions. Also, transitions often correspond to large changes in one or more process variables and nonlinear process behavior comes to the fore. Multi-time scale effects also become important where some variables change quickly (order of seconds) and others respond over hours. Traditional approaches to process control have been shown to be inadequate in many instances where processes undergo transitions.

A new paradigm for control of transitions is therefore needed. In this paper, using examples from refining, polymer manufacture, pharmaceuticals, fermentation, paper & pulp, and other industries, we describe the general characteristics of process transitions, the economic and operational motivations for closed-loop control of such operations, and the numerous challenges involved therein. We also outline some new research directions that promise to offer practically implementable solutions to the problem of transition control.