Evolution-traced Multivariate Statistical Process Control for Batch Processes

By

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Abstract

Batch processes have been widely employed in chemical and other manufacturing industries, due to its capabilities to manufacture high-value-added products and to meet the requirements of fast changing markets. In batch manufacturing, operation safety and product quality consistency are pivotal issues that have attracted attentions of many researchers. To deal with these two problems, many multivariate statistical analysis techniques such as principal component analysis (PCA) and partial least squares (PLS) have been adopted in the field of multivariate statistical process control (MSPC), and have been extended to different forms by taking the nature of batch processes into consideration. The related methods include multiway PCA/PLS (MPCA/MPLS), phase-based PCA and PLS, etc. Along the time direction within each batch, many existing methods assume that the similar characteristics within each phase can be captured by a single statistical model, which ignore the inner-phase process variations. Along the batch direction across the whole process, traditional methods handle process variations by adjusting the monitoring models continuously in a direct way, which leads to increase of chance for introducing disturbances and faults. In fact, process evolution, a typical kind of process characteristic variation caused by process dynamics or long term external factors, should be discriminated from the random variation caused by noises.

In this dissertation, several novel strategies have been proposed to improve both batch process monitoring and quality prediction by tracing both inner-phase and inter-batch evolutions. Using the proposed methods, the specific issues contained in batch process data, such as transitions, uneven durations, time-varying and multi-mode, can be handled.

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Examination Committee:
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