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A Conceptual Analysis for Resource Optimization in Variable Time Multipurpose Batch plants

by

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Abstract

Batch processing has been embraced by numerous chemical industries, such as the food, beverage, specialty chemical, and pharmaceutical industries because of its flexibility of accommodating changes in demand and responding effectively to uncertainties in market and supply chains. On the other hand, wastewater generated by batch processes depends on the specific tasks. Thus, the methods of wastewater minimization developed for continuous processes do not apply to batch processes. Few studies based on insight-based techniques have been reported to address wastewater recovery issues for flexible batch processes. The flexible batch process refers to that in which the durations of batch operations are treated as variables, not parameters. Therefore, a conceptual analysis was performed in this work to address the wastewater minimization in batch plants with flexible scheduling.

A dynamic programming approach was first proposed to design a batch water network based on predefined scheduling. Insight from these results could assist the designer in rescheduling operations to maximize water recovery through direct water reuse. However, the extent of performance improvement is limited because the rescheduling process only involves a few operations, not all of the water operations. Thus, the dynamic programming method was extended to flexible batch processes in which only durations of batch operations are given. The difference is that in the former method, the stage is determined by the timings of water operations, while for the latter approach, the stages are identified based on the inlet concentration of water operations.

Although dynamic programing approach, as an algebraic method, could provide a graphical representation of the targeting process, it is difficult to find the optimal

solution when faced with complex problems. A match ranking matrix approach was proposed to prioritize matches between water sources and sinks. Batch water network could be synthesized by choosing optimal matches between water sources and sinks. Besides, a hybrid method of combing water pinch analysis and match ranking matrix method was presented to design batch water network, which takes advantages of graphical representation of pinch analysis and insight for the design of batch water network from match ranking matrix method.

Finally, the main conclusions and future work are summarized. These conceptual methods in this work could be used to address the wastewater minimization in flexible batch plants.