

A mathematical technique for the design of near-zero-effluent batch processes

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Abstract

Wastewater minimisation in chemical processes has always been the privilege of continuous rather than batch plants. However, this situation is steadily changing, since batch plants have a tendency to generate much more toxic effluent compared to their continuous counterparts which are usually encountered in bulk manufacturing.

Past methodologies for wastewater minimisation in batch processes have focused on operations based on mass transfer. They do not take into consideration the reuse of wastewater as part of product formulation. Reusing wastewater in product formulation has the major advantage of negating much of the effluent produced, thereby enabling a process to operate in an almost zero-effluent manner.

Presented in this paper is a mathematical technique for the simultaneous design and scheduling of batch operations operating in a near-zero-effluent manner. The technique determines the number and size of the processing vessels, while ensuring maximum water reuse in product. The technique was applied to an illustrative example, and an 80% savings in wastewater was achieved, with a corresponding plant design that achieves the required production.

Keywords: zero-effluent, batch process, wastewater minimisation