Cleaner chemicals manufacture through efficient scheduling

A recent Bulgarian study has proposed a more environmentally friendly approach to manufacturing chemicals and biochemicals in multipurpose batch plants, which carefully considers how the production process is scheduled.

A multipurpose batch plant is a manufacturing plant designed to be flexible enough to produce a variety of similar types of products at the same time, for example, different types of milk products processed from raw milk. It contains many sets of equipment of different types, each used for a distinct step in processing the product. Alternative processing recipes (i.e. type of raw material used, processing times, suitable processing units, quantity of materials used to make the product) can be used to make the products by sharing available equipment. The plant processes raw materials according to a schedule to meet the demand for the different products. This might mean the product is made in batches to make best use of the available resources.

Scheduling production involves finding the best way to assign key raw materials and other inputs to particular pieces of equipment in the right processing sequence in order to maximise the use of the plant’s equipment (as idle equipment is a waste of resources) whilst achieving certain objectives: typically the lowest cost, highest quality and least time. Increasingly, one of the scheduling objectives is to minimise the overall impact on the environment from the production process.

Partly funded by the European Commission’s European Social Fund¹, this study used a Life Cycle Analysis (LCA) and a process systems engineering approach to include the environmental considerations as an integral part of scheduling. Optimal or near optimal solutions to scheduling would then include the least possible impact on the environment. The researchers analysed the waste generated by each processing recipe, including wastes introduced by the raw materials, and the tasks that generate pollution.

This approach produced optimal, or near optimal, solutions for scheduling which detail the composition of the key raw material inputs, the production routes and units and times at each piece of equipment that enable the demand to be met at minimal environmental cost.

A case study of a multipurpose batch plant that processes two types of raw milk into curds was used to illustrate the method. In dairies, the most important environmental indicator for waste analysis is the Biochemical Oxygen Demand (BOD), used to measure the strength of organic pollutants in the discharged wastewater. This gives a measure of waste produced from the raw materials, the processing tasks, and losses of by-products and final products. The BOD load depends on the composition of the milk, which would be different, for example, for whole milk or condensed skimmed milk, both of which are used as raw material inputs in the plant.

In this case study, the analysis used waste production data to reveal that two pollutants were responsible for more than 40 per cent of the BOD: milk deposits on walls of pasteurising vessels and the whey acidification and drainage processes. The researchers applied their modelling approach and suggested that the environmental impact of the wastewater from the manufacture of curds could be reduced by targeting losses from whey acidification and drainage tasks, possibly by reusing the discharged whey in the dairy or in farms.


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Theme(s): Chemicals, Sustainable consumption and production