A batch reactor heat recovery challenge problem

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We present a challenge problem for maximizing the heat recovery in a heat exchanger network connected to a set of batch reactors, which are discharged periodically.

A cold process stream is to be used as a utility, and is split into several parallel branches which each are connected to a heat exchanger. After being heated in the primary sides of the heat exchangers, the streams from the different branches are merged again. The recombined stream is then further heated to a specified target temperature in a fired heater.

During the discharging periods of the batch reactors, the reactor effluents are fed into the secondary sides of the heat exchangers to preheat the branches of the cold process stream.

The optimization objective is to adjust the split of the cold incoming stream such that a maximum amount of heat is recovered from the reactor effluents over a time period of 24h. This is equivalent to minimizing the energy required for the cold stream to reach the target temperature. Due to the batch reactor operation strategy, it is not known a-priori when the batches are emptied. Sometimes only one batch is emptied at a time, at other times several discharges start shortly after each other, such that the discharging processes overlap.

The proposed problem has several interesting and challenging features, the most important ones are:

- Relevant for industrial practice
- Integer character: Either a batch is discharged or not
- Dynamic optimization: A trajectory for a given scenario is to be obtained.
- Nonlinear model equations:
  - Discharge flow rate of the batch reactors depends nonlinearly on the reactor levels
  - Heat transfer depends nonlinearly on the discharge flow rate, which either changes continuously, or is zero.

These features make the proposed problem an interesting benchmark for testing optimization strategies and solution algorithms.

A more detailed problem description can be downloaded at `www.nt.ntnu.no/users/skoge/2012/BatchChallenge`