Feed optimization using kinetic model and scale-down approach

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Abstract

Chemical incidents are typically caused by loss of control, resulting in runaway reactions or process deviations in different units of production. In case of fed-batch reactors, the main problem generally encountered is the accumulation of heat [1]. In fact, understanding and controlling this aspect is one of the most important and challenging process safety tasks. One solution, for fed batch reactors, would be to control precisely the feed rate to avoid rapid heat accumulation.

The main aim of presented study is to provide a first insight into a way of investigating reaction kinetics using non-linear model fitting and scale-down approach. In order to acquire information about the reaction behavior and develop a reaction model, several calorimetric experiments at different scales (mg, g, kg) are necessary [2]. In each scale the reaction conditions in terms of temperature and heat transfer are different what results in significant differences of the relevant parameters influencing the reaction rate [3].

Using the defined reaction model, it is possible to predict the reaction behavior under very different conditions. Nevertheless, from a scale-up point of view, the behavior of an industrial system is completely different from that one at the laboratory scale. Consequently, some measurements should be performed at industrial scale in order to fill this lack of information required for the correct up-scaling. This task is often long and arduous. Fortunately, Zufferey [4] proposed a method allowing to simulate conditions approaching industrial ones at laboratory scale which helps in avoiding large scale experiments.

Once all these steps are performed, a large scale dynamic model can be postulated and used to simulate the industrial process. These simulations will allow defining the safety constraints and optimizing the feed profile in order to maintain the process safe and productive.

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