Analysis of forced periodic operations of non-isothermal CSTR with modulation of inlet concentration and temperature

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One way to achieve process intensification is to operate the process in a periodic way, in order to obtain better average performance compared to the optimal steady-state operation. The source of the possible improvement lies in the process nonlinearity. Nevertheless, the improvement is obtained only in some cases, while in some others the periodic operation can be unfavourable.

Testing whether a potential periodic process is favourable or unfavourable generally demands long and tedious experimental and/or numerical work. In our previous work, we have established a method, based on nonlinear frequency response analysis, which gives an approximate value of the average process performance directly, without numerical simulation. In this work, this method is applied for analysis of periodic operations of a non-isothermal CSTR, for the cases of simultaneous periodic modulations of the inlet concentration and inlet temperature and inlet concentration and temperature of the cooling media.

Since the concept of higher-order frequency response functions can be applied only for stable systems, the dynamic stability analysis was performed first, resulting with pre-conditions for application of the frequency response method. Conditions for possible improvements through periodic operation of the non-isothermal reactor have also been established.

Numerical analysis was performed for the reaction of decomposition of hydrogen peroxide in the presence of Fe^{3+}-ions in acidic solution. The results of the nonlinear frequency response method were compared with the results of numerical solution, and good agreement was obtained.