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CRITICAL VARIETY UNDER PARAMETRIC UNCERTAINTY IN AN INDUSTRIAL REACTOR FOR BENZENE CATALYTIC OXIDATION

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Abstract

Safe operation of highly thermally sensitive industrial reactors is still considered a major issue in chemical engineering practice. The problem becomes even more stringent when highly exothermic reactions are conducted under randomly fluctuating operating variables, and especially when the set-point is located in a close vicinity of the runaway boundaries for increasing the reactor productivity. This study is aiming to derive the runaway boundaries and their associated region of confidence in the operating variable space for such a highly risky fixed-bed catalytic reactor by applying a very effective Morbidelli and Varma generalized criterion. In a subsequent step of the risk assessment, such a critical variety is approximated by adequate simple multi-variate correlations of the control variable safety limits, usually of mixed logarithmic-polynomial form, from bringing together all critical curves separately derived in parametric planes. Such simple correlations allow quickly evaluating the associated variance of the critical limits to be further used in the reactor multi-objective robust optimization step. Exemplification is made for an industrial fixed-bed multi-tubular reactor for benzene catalytic
oxidation to maleic anhydride in vapour-phase by using a more detailed kinetic model.

Key words: catalytic reactor, confidence region, maleic anhydride production, runaway boundaries

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