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Plenary Lectures

Recent Developments in Residence Time Distribution

Roel K. Westerterp

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We use to apply the concepts of Danckwerts to describe residence time distribution (RTD) phenomena, although Danckwerts himself in his original paper warned the reader, that his approach would hardly ever describe the RTD problems adequately. Realistic experiments are known that only may be interpreted with the Danckwerts approach, provided we introduce negative dispersion coefficients. Numerous papers have been written to give a possible physical interpretation of the boundary conditions at the inlet and the outlet of the system; but still they keep puzzling experts. In many experiments never a upstreams dispersion in packed beds could be found despite such predictions by the theory of Danckwerts.
We, therefore, derived a new model to interpret RTD phenomena, which still maintains the ease of a one-dimensional approach. We called the model the "wave model ", because of the analogy with the description of wave problems in hydrodynamics. This model only needs boundary conditions at the inlet of the system, adequately describes dispersion in packed beds and asks for realistic dispersion parameters in the case where the Danckwerts model would need negative dispersion coefficients. The wave model will be explained and applied.
Chaotic temperature fields in running packed bed reactors have been observed which could not be interpreted with the usual models to describe the behaviour of packed bed plug flow reactors. This led to the investigation of the influence of free convection on the RTD in packed bed reactors. The results of this investigation will be explained and the correlation of the dispersion data will be shown to be quite accurate. Extrapolation of the correlated data to industrial equipment warns for very serious consequences in such equipment, which will be explained. Urgent large scale experiments are required.