Book review

MODELING OF COLUMN APPARATUS PROCESSES

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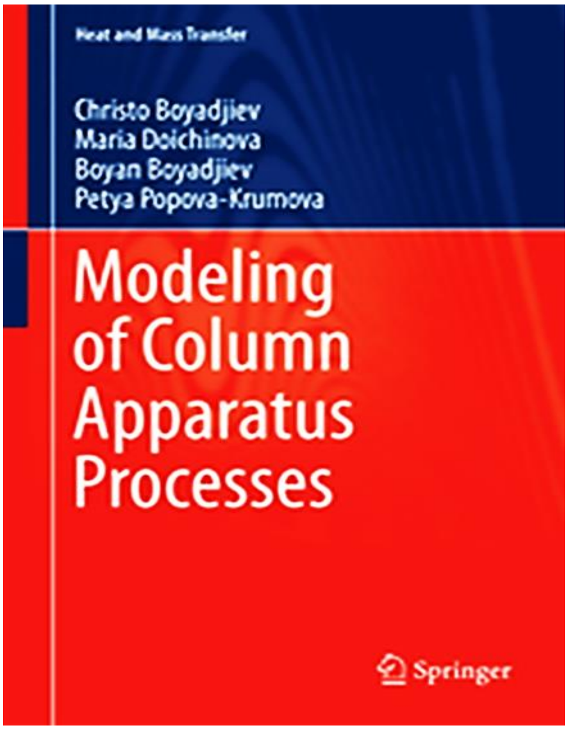

The complex processes in the column apparatuses have a combination of hydrodynamic processes, convective and diffusive mass (heat) transfer processes and chemical reactions between the reagents (components of the phases).

In the book is presented a new physically motivated approach for the modeling of column apparatus processes in industrial conditions, using the mechanics of continua. In the *Introduction* was showed that the presented mass transfer theory is not applicable for the modeling of column apparatus processes in industrial conditions, because the velocities in each phase and the phase surfaces in columns are unknown and practically cannot be determined.

The modeling of column apparatus processes is made, using two type models as convection-diffusion and average concentration models, where as an innovation is the process mechanism identification on the base of the Guhman's generalized analysis. In the book are presented these models of one, two, and three phase processes.

In the first part of the book are presented the convection-diffusion models which permit to be made qualitative analysis of the processes.

The one-phase processes are analyzed in the cases of complex chemical reaction kinetics, second and pseudo-first-order reactions. It is shown the influence of the velocity radial non-uniformity on the conversion degree. As an innovation is a new explanation of the *back mixing* effect as a reducing of the average residence time of the flow in the column.

The two-phase processes in column apparatuses are analyzed in the cases of physical and chemical absorption and adsorption, catalytic processes. The absorption processes are presented in co-current and counter-current gas-liquid flows.

The adsorption processes are presented in the cases of non-stationary process in the solid phase and quasi stationary process in the gas (liquid) phase.

The catalytic processes are presented as stationary processes in gas-solid systems, where the adsorption of the first reagent is physically or chemically.

As innovations are the presentation of interphase mass transfer, adsorption, and catalytic reaction as a volume reaction.

In the second part of the book are presented the average concentration models and quantitative analysis of the chemical, absorption, adsorption, and catalytic processes. The innovations in this part are:

The ability to be used this model for modeling of the processes at an unknown velocity distribution in the column, which is introduced in the model by two parameters, which can be determined from experimental data.

The explanation of the conversion degree decrease as a result of the radial non-uniformity of the velocity distribution.

The experimental data, obtained in a short column with real diameter, are useful for the model parameters identification.

In the third part of the book are presented calculation algorithms as innovations.

Practically, the new type models are characterized by the presence of small parameters at the highest derivatives. As a result, the use of the conventional software for solving the model differential equations is difficult. This difficulty may be eliminated by an appropriate combination of MATLAB and perturbations method.

In the cases of counter-current gas-liquid or liquid-liquid processes the mass transfer models are presented in two co-ordinate systems. Thus, a combination of an iterative algorithm and MATLAB has to be used for solving the equations set in different co-ordinate systems.

In the practical cases of non-stationary adsorption in gas-solid systems, the presence of mobile (gas) and immobile (solid) phases in the conditions of lengthy processes leads to a non-stationary process in the immobile phase and a stationary process in the mobile phase. A combination of a multi-step algorithm and MATLAB has to be used for the solutions of the equations set in a gas and solid phases.

The fourth part concerns the models of the processes, which participate in different patents, related with the waste gas purification from sulfur dioxide in column apparatuses.

In the cases of comparable interphase mass transfer resistances in the gas and liquid phases, an intensification of the mass transfer should be realized in two phases. In these conditions a new patent is proposed, where the process optimization is realized in a two-zone column, where the upper zone the process is physical absorption in a gas-liquid drops system, while in the lower zone it is a physical absorption in liquid-gas bubbles system and the chemical reaction takes place in the column tank.

In a new patent, using a two-step process – physical absorption of SO_2 by water and adsorption of SO_2 from the water solution by synthetic anionite particles. The adsorbent regeneration is made by NH_4OH solution. The obtained $(NH_4)_2SO_3$ (NH_4HSO_3) is used (after reaction with HNO_3) for production of concentrated solutions of SO_2 and NH_4NO_3.

The decrease of the column diameter is realized in a new patent, where a co-current SO_2 absorption is used.

The created methods for modeling of column apparatus processes are a base for solution of many industrial problems.

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