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Numerical simulation of heat and mass transfer processes in large-scale fluidized bed complex structure apparatus as an example of the reactor of isoparaffins dehydrogenation

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Abstract

In the chemical industry are widely used fluidized bed apparatus. The advantage of them is the high speed of heat and mass transfer between components of the reaction, which are in different aggregation states. Studies of large-scale apparatus are hindered big sizes and plurality of structural elements. Often such apparatus operate at high temperatures (500-900 C), which further complicates the study. In this paper we consider a fluidized bed reactor block intended for the dehydrogenation of isobutane. In numerical simulation of fluidization was extended Eulerian-Eulerian approach. Differential equations that describe the hydrodynamic and thermal processes in the field of computational model of the reactor were solved in ANSYS Fluent CFD for axisymmetric unsteady flow scheme. At full simulation of the unit of the reactor in differential equations for the mass fraction of components of the gas mixture is necessary to consider changes related with chemical reactions. In the model used for this purpose it is necessary to add terms to the equations of mass transfer and absorption of heat depending primarily on the gas temperature and catalyst concentration. In this paper we'll restrict considering the minimum number of components of the reaction (raw materials - isobutane, product - isobutylene). For a given chemical reaction is written User Defined Functions (UDF). The influence of the ambient gas, the catalyst and the time step on the progress of chemical reaction in the volume element is studied. Numerical calculations were carried out, due to them circulating streams in the apparatus, the temperature field distribution of the catalyst and the conversion of the feeding gas-raw were analyzed.

Keywords

Dehydrogenation of isoparaffins, Fluidized bed, Industrial reactor, Mathematical model, Numerical simulation