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CFD modeling a fluidized bed large scale reactor with various internal elements near the heated particles feeder

Olga V. Soloveva[a,b], *Sergei A. Solovev*[c,d,*], *Svetlana R. Egorova*[b], *Alexander A. Lamberov*[b], *Alexey V. Antipin*[d], *Emil V. Shamsutdinov*[a]

[a] *Institute of Heat Power Engineering, Kazan State Power Engineering University, Krasnoselskaya St. 51, 420066 Kazan, Russia*

[b] *Institute of Chemistry, Kazan Federal University, Kremlevskaya St. 29, 420111 Kazan, Russia*

[c] *Institute of Mechanics and Engineering — Subdivision of the Federal State Budgetary Institution of Science "Kazan Scientific Center of the Russian Academy of Science", Lobachevskiy St. 2/31, 420111 Kazan, Russia*

[d] *Institute of Mathematics and Mechanics, Kazan Federal University, Kremlevskaya St. 35, 420008 Kazan, Russia*

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ABSTRACT

A numerical study of the fluidized bed industrial reactor in the presence of various internal elements is carried out by CFD methods A simple reactor heating efficiency function of chemical reaction with heat absorption is considered. The main emphasis is placed on the circulation flows of the catalyst particles and heating of the reactor. The analysis of the impact of various design elements on the heating efficiency of the reactor is carried out. Particular attention is paid to the possibility of baffles applying, which allows redirecting the flow. This effect may have an especially important value when the rapid heating of the reactor is required for temperature dependent reactions. The influence of heated catalyst feeder design on the efficiency of whole reactor heating is educed. The influence of the fractional composition of the catalyst, namely the presence of fine particles, on the reactor heating efficiency for different reactor design features is also studied. The results are carried out for a specific reactor example, but contribute to the overall branch of fluidized bed engineering.

1. Introduction

Fluidized bed gas–solid reactors are widely used in the chemical and petroleum industry and gasification of coal and biomass (Kunii and Levenspiel, 1991; Grace et al., 1997; Yang, 2003; Basu, 2006; Sadeghbeigi, 2012) due to the high efficiency of heat and mass transfer between the components. Even though such an apparatus has been used in industry for more than fifty years there is still a high demand in the study of fluidized bed properties and applications.

The investigations on laboratory fluidized bed apparatus do not provide complete results for industrial large-scale reactors. Currently one of the most reliable methods of determining the properties of the large-scale fluidized beds is a tomographic scanning, as presented by the recent works (Chen et al., 1999; Jin et al., 2005; Patel et al., 2008; Heindel et al., 2008; Wang et al., 2012; Mandal et al., 2012; Escudero and Heindel, 2014; Kingston et al., 2015).

One of the possible ways to get the data is a numerical simulation. Computational fluid dynamics (CFD) is a very effective tool for understanding fluidized bed hydrodynamics including heat and mass transfer. CFD is important in optimization and design of industrial large-scale reactors. Solving equations numerically allows carrying out calculations of different possible mechanisms of the fluidization process, both in terms of basic research and practical application. Numerical calculations of fluidization are usually based on

* *Corresponding author at*: Institute of Mathematics and Mechanics, Kazan Federal University, Kremlevskaya St. 35, 420008 Kazan, Russia.
E-mail address: serguei_s349@mail.ru (S.A. Solovev).

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