Boreskov Institute of Catalysis SB RAS, Novosibirsk
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EUROPACAT XII

XII European Congress on Catalysis
"Catalysis: Balancing the use of fossil and renewable resources"

Kazan (Russia) 30th August - 4th September, 2015

ABSTRACTS

Novosibirsk - 2015

УДК 544.4 + 661.097.3 + 665.6/.7 + 620.9
ББК 24.54 + 35.514 + 31.6
Е91

Е91 EuropaCat XII. Catalysis: Balancing the use of fossil and renewable resources. European Congress on Catalysis. Kazan (Russia) 30th Aug. - 4th Sept., 2015. [Electronic resource] = ЕвропаКат XII. Катализ: сбалансированное использование ископаемых и возобновляемых ресурсов. Европейский конгресс по катализу : abstracts / ed.: V.I. Bukhtiyarov, A.Yu. Stakheev – Novosibirsk : Boreskov Institute of Catalysis, 2015 – 1 USB flash. ISBN 978-5-906376-10-7

В надзаг.: Boreskov Institute of Catalysis SB RAS
Zelinsky Institute of Organic Chemistry RAS
Lomonosov Moscow State University
Arbuzov Institute of Organic and Physical Chemistry KSC RAS

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ISBN 978-5-906376-10-7

I-PP31

A Numerical Investigation of the Catalyst Behaviour in Fluidized Bed Circulating Reactor

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Keywords: fluidized bed, chemical reactor, numerical simulation, structural elements

1 Introduction

Fluidized bed reactors are widely used in the petrochemical industry, in particular for the isobutane dehydrogenation process with fine particles of the chromia-alumina catalyst. An injection of hot catalyst particles is needed for sustenance the temperature of the reaction. The main objective is effective heating of the fluidized bed region with the highest concentration of catalyst. In the large reactors the structural elements (lattice) are used for breaking gas bubbles and active mixing of gas and catalyst. In present paper the motion of solid catalyst particles with a size of 20-200 microns in isobutane dehydrogenation reactor model was investigated. Geometrically reactor is5.1 m in internal diameter and 17.4 m in height, partitioned by ten distributive lattice of angle-type with an area of free section of 30%. A vertical pipe is placed in the center part of reactor for the supplying of heated catalyst. Calculations of hydrodynamic and heat transfer processes in the reactor were carried out by numerical methods using computers with special attention to the flow near the walls in reactor.

2 Formulation of the problem

Currently, one of the ways to determine the properties of large-scale fluidized beds is numerical simulation. In a study of fluidization an Eulerian-Eulerian approach was applied, when carrier phase (gas, liquid) and discrete (solid) phase are continuous. Using kinetic theory of gases, equations (for each discrete phase) which are describing kinetic energy changes of granules in consequence of collisions was added for account of features in a fluidized bed movement.

Presented results of calculations are carried out for mono disperse catalyst (one phase of particles with 90 μm in diameter) and for poly disperse catalyst (two phases of particles with 90 μm and 30 μm in diameter). A steady fast downward flow of catalyst grains along walls of reactor and slow upward movement in the central zone was observed in calculations. This motion is providing the total intensive circulation of catalyst and gas. Any structural elements (e.g. lattice) in reactors can have a significant impact on all circulating field. Parametric calculations for different distances between lattice and reactor walls are performed in this investigation. Namely, in the calculations distance parameters as 9 cm, 5 cm and 3.6 cm were used. The main aim is to analyze catalyst and gas circulation in reactor.

3 Result of calculations

The analysis results of calculations for three cases that were described above of different distance between lattice and walls are shown in figure 1. The arrows on the lattice define the main directions for average upward and downward flows of circulating catalyst and gas in reactor. Reactor about 5 meters in diameter in cases with minor differences in structural elements of apparatus has a significant differences on the overall circulation field as it can be seen from the figure. Catalyst rises in the central zone, and falls down in the areas closer to the external wall and in the thin layer around the central tube in case with distance 9 cm. Catalyst descends in the central zone and in a thin layer near the external wall and rises upwards in the areas closer to the outer wall in case with distance 3.6 cm. Finally, catalyst rises in almost all the reactor zones and descends in thin layers around the central tube and the external wall, but with higher velocity.

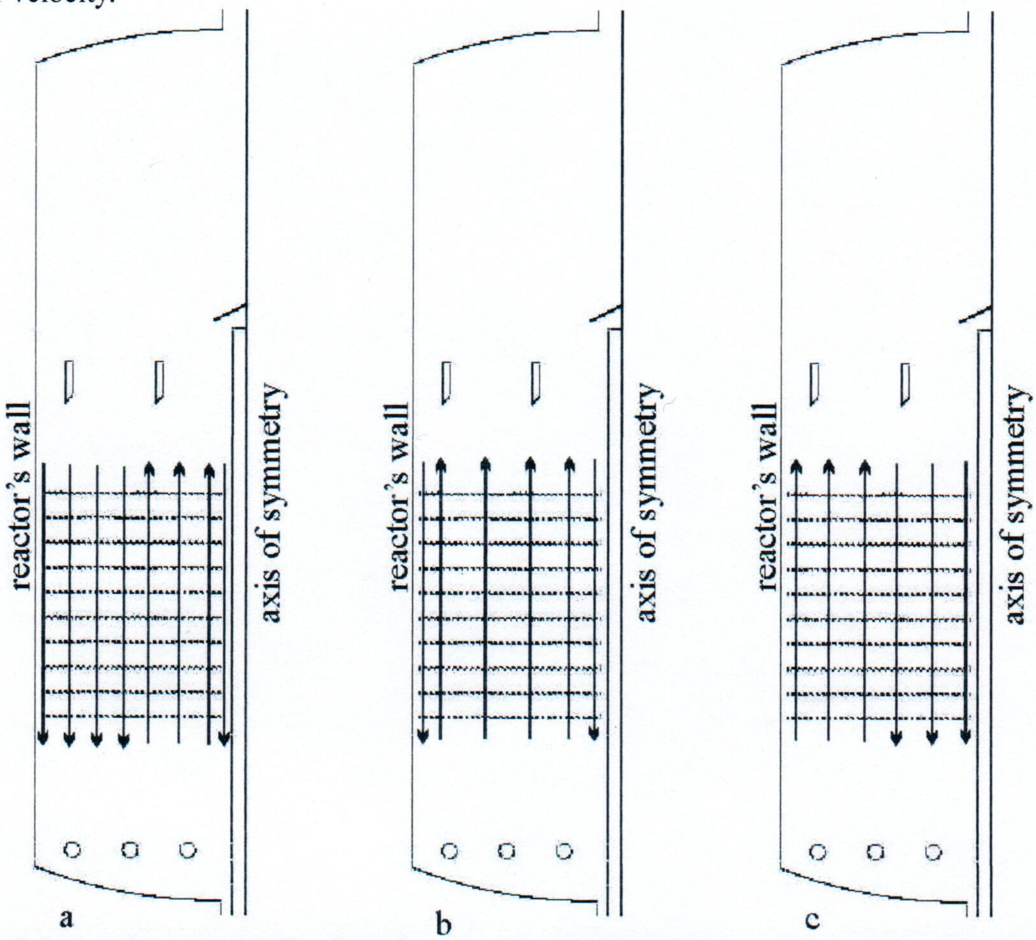

Fig. 1. Scheme of reactor and directions for average upward and downward flows of circulating catalyst and gas for different cases of distance between lattice and walls: a – 9 cm, b – 5 cm, c – 3.6 cm.

4 Conclusion

Any minor changes in the structural elements geometry can have a significant influence for hydrodynamics of the fluidized bed. Application of numerical simulation allows to predict the behavior of bed with using approximations. The researching results can be of interest for industrial applications where it is important to have a proper circulation bed.

Acknowledgements

This work was sponsored by The Ministry of Education and Science of The Russian Federation.