CFD-DEM Modelling of Residence Time Distributions of Particles in a Two-Zone Fluidized Bed Reactor (TZFBR)

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ABSTRACT

In many processes chemical products are generated in fluidized beds of catalyst particles. Often, the particles have to be regenerated in a second reactor. A cost efficient and highly promising way is to use a Two-Zone Fluidized Bed Reactor (TZFBR), where these processes take place in one single reactor. Subject of the work is the modelling of a TZFBR to produce the basic chemical 1,3-butadiene from n-butane (Fig. 1). The T-junction for the n-butane inlet separates the fluidized bed in two zones. In the reaction zone n-butane is converted to butadiene with the lattice oxygen inside the Mo-V-MgO catalyst. In the regeneration zone, coke depositions on the particles are burned and the lattice oxygen of the catalyst is filled up.

One major aspect for the fundamental understanding and optimization of the residence time of the particles in the two zones, which should ideally be the same for each particle. Using a modified CFDEM-code, the residence times of the particles are calculated and analyzed for different conditions (isothermal flow). The number of particles is ca. 80.000 (diameter 800 µm). It was found, that the residence time (RTD) of the particles is spacially strongly inhomogeneous (Fig. 2). For some conditions the frequency distribution FD (spectra of the RTD) shows the characteristics of the residence time distribution of a well stirred reactor in each of the two zones and can fitted with the function $FD=1/\tau \cdot \exp(-t/\tau)$, where τ is an average time (Fig. 3).

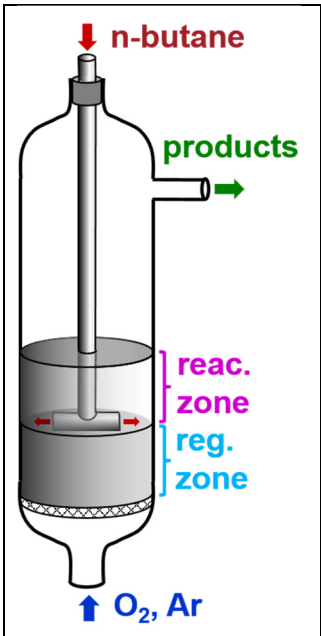

Fig. 1: Reactor design. Diameter = 28 mm.

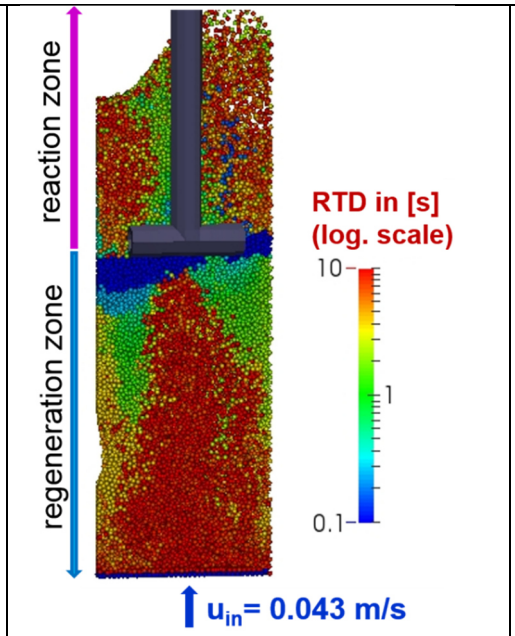

Fig 2: Momentary RDT of particles in the two zones of the TZFBR.

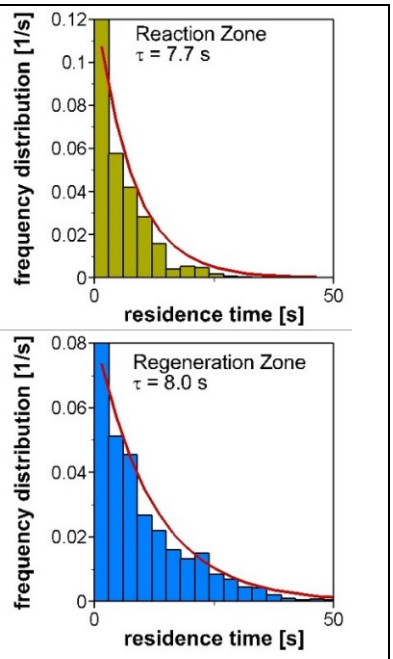

Fig. 3: FD with fit and average residence time τ.

REFERENCES

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