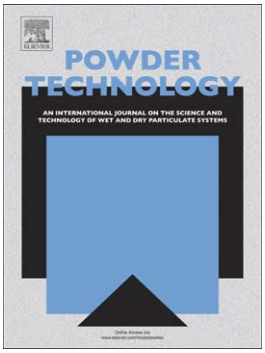

Computational Fluid Dynamics Study of the CREC Riser Simulator: Mixing Patterns

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PII: S0032-5910(16)30898-1
DOI: doi:10.1016/j.powtec.2016.12.030
Reference: PTEC 12178

To appear in: *Powder Technology*

Received date: 20 May 2016
Revised date: 29 October 2016
Accepted date: 6 December 2016

Please cite this article as: I. Ahmed, S. Rostom, A. Lanza, H. de Lasa, Computational Fluid Dynamics Study of the CREC Riser Simulator: Mixing Patterns, *Powder Technology* (2016), doi:10.1016/j.powtec.2016.12.030

Computational Fluid Dynamics Study of the CREC Riser Simulator: Mixing Patterns.

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Abstract

The CREC Riser Simulator Reactor is a novel mini-Riser unit. This study considers a laminar-turbulent CFD (Computational Fluid Dynamics) simulation using the COMSOL Multiphysics® module to establish gas-solid mixing patterns. The proposed CFD calculations are verified using both experimental data (<10-15% difference) and mass balance errors (< 0.1%). Results show the significant detrimental effect of basket vertical baffles implemented in earlier designs of the CREC Riser Simulator Reactor. On the basis of this, it is demonstrated that a double vortex flow leading to high gas mixing is favored in a new reactor configuration "without" basket vertical baffles. For instance, at 4200 rpm, in a basket unit loaded with 0.8 gm of catalyst, close to ~69 cm/s gas axial velocities were observed. This shows turbulent or fast fluidization conditions with smaller than 0.51s mixing times. In addition, this new suggested design with enhanced mixing places the CREC Riser Simulator in a new class of laboratory scale fluidized catalytic units.

Keywords: *CREC Riser Simulator, Fluidization, CFD modeling, Mixing patterns*

1 Introduction

The CREC Riser Simulator is a novel bench scale reactor unit especially designed to determine catalyst performance under very short contact times (2-20s). This novel device has been invented [1] and initially developed to determine the kinetic parameters of the catalytic cracking of hydrocarbons [2]. In the last 10 years, it has been applied to study a diversity of catalytic reactions including: a) the steam reforming of methane, b) the dry reforming of methane, c) the catalytic and thermal gasification of biomass, d) chemical looping combustion, e) the oxydehydrogenation of light gases, f) the catalytic desulfurization of gasoline; among others [3–15].

In the CREC Riser Simulator, a rotating impeller is placed in the upper unit section. This impeller, creates a downward gas flow and an upward gas flow, in the periphery and center, respectively. Under the adequate upflow gas conditions, particles contained in a centrally placed basket, are fluidized. The special engineering of this unit provides both fluidized particles and high gas mixing. Under typical 6000 rpm speed, the high gas recirculation yields a quasi-constant reactant concentration for all gas phase species.

As a result of the intensive gas and particle mixing, the CREC Riser Simulator can be considered as a "fluidized batch reactor".