8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

# A CFD STUDY OF NOVEL TECHNOLOGIES FOR FLUIDIZATION IN A CENTRIFUGAL FIELD

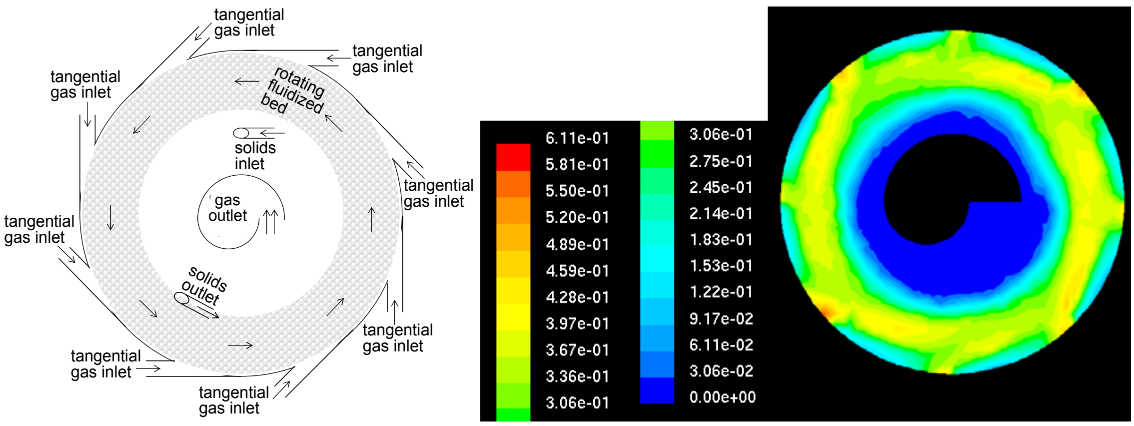
*** Axel de Broqueville[1], Juray De Wilde[1]**

[1] Dept. Materials & Process Engineering,
Université catholique de Louvain,
Réaumur, Place Sainte Barbe 2,
1348, Louvain-la-Neuve, Belgium,
E-mail: Juray.DeWilde@UCLouvain.be

**Key Words:** *Fluidization, Centrifugal force, Process Intensification, Computational Fluid Dynamics (CFD).*

## ABSTRACT

The operating conditions in conventional fluidized bed reactors are limited by the role of earth gravity. On the one hand, internal mass and heat transfer limitations may be encountered, a too strong reduction of the particle size resulting in poor fluidization. On the other hand, external mass and heat transfer limitations may be encountered, the gas-solid slip velocity being limited by the terminal velocity of the particles in the earth gravitational field. Fluidization in a centrifugal field allows overcoming the above mentioned limitations and allows, as such, fluidized bed process intensification. Two novel technologies for fluidization in a centrifugal field are investigated using computational fluid dynamics (CFD). A Eulerian-Eulerian approach is taken and the Kinetic Theory of Granular Flow is applied.
In rotating fluidized beds in a static geometry (Figure 1(a)), the centrifugal field is generated by injecting the fluidization gas tangentially in the fluidization chamber via multiple gas inlet slots in its outer cylindrical wall [1]. A combined tangential-radial

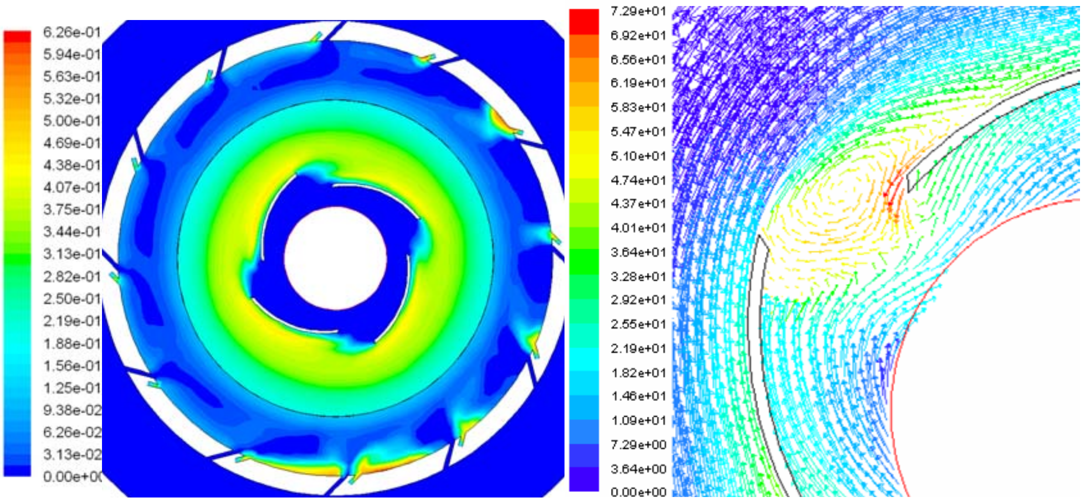



(a) (b)

Figure 1: Rotating fluidized bed in a static geometry. (a) Concept; (b) Simulated solids volume fraction profile.

fluidization of the particle bed is obtained by forcing the fluidization gas to leave the fluidization chamber via a central chimney. The fluidization gas flow rate influencing both the centrifugal force and the counteracting radial gas-solid drag force in a similar way renders rotating fluidized beds in a static geometry extremely flexible with respect to the fluidization gas flow rate and the gas-solid contact time. In particular, dense operation at high fluidization gas velocities is possible.

In rotating fluidized beds around a rotating chimney [2], the centrifugal field is generated by a rotating chimney consisting of multiple blades and positioned centrally in the fluidization chamber (Figure 2). The fluidization gas being forced to leave the fluidization chamber via the chimney, a radial gas-solid drag force counteracting the centrifugal force is generated. Furthermore, both the fluidization gas and the particles obtain a tangential velocity by the action of the rotating chimney. This results in a combined tangential-radial fluidization.




(a) (b)

Figure 2: Simulation of a rotating fluidized bed around a rotating chimney. (a) Solids volume fraction; (b) Solids velocity vectors relative to the chimney rotational motion, colored by the absolute solids velocity magnitude (focus: zone between two blades).

The two novel technologies for fluidization in a centrifugal field can eventually be combined to obtain extremely flexible fluidization technology. In such case, the rotating chimney allows to increase locally, that is, in the vicinity of the chimney, the centrifugal force and to reduce drastically the solids losses via the chimney.

Numerical data on the fluidization behavior, the pressure drop over the particle bed and the rotating chimney, the gas-solid heat transfer characteristics and the solids losses via the chimney are presented, discussed and compared to experimental data.

## REFERENCES

[1] Juray De Wilde, Axel de Broqueville, "Rotating Fluidized Beds in a Static Geometry: Experimental Proof of Concept", AIChE Journal, 53:(4), p. 793-810, 2007 (DOI: 10.1002/aic.11139).

[2] Juray De Wilde, Axel de Broqueville, "Experimental Study of Fluidization of 1G-Geldart D-Type Particles in a Rotating Fluidized Bed with a Rotating Chimney", submitted for publication in the AIChE Journal, 2007.