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COMPUTATIONAL STUDY OF GAS-SOLID HEAT TRANSFER IN ROTATING FLUIDIZED BEDS IN A STATIC GEOMETRY

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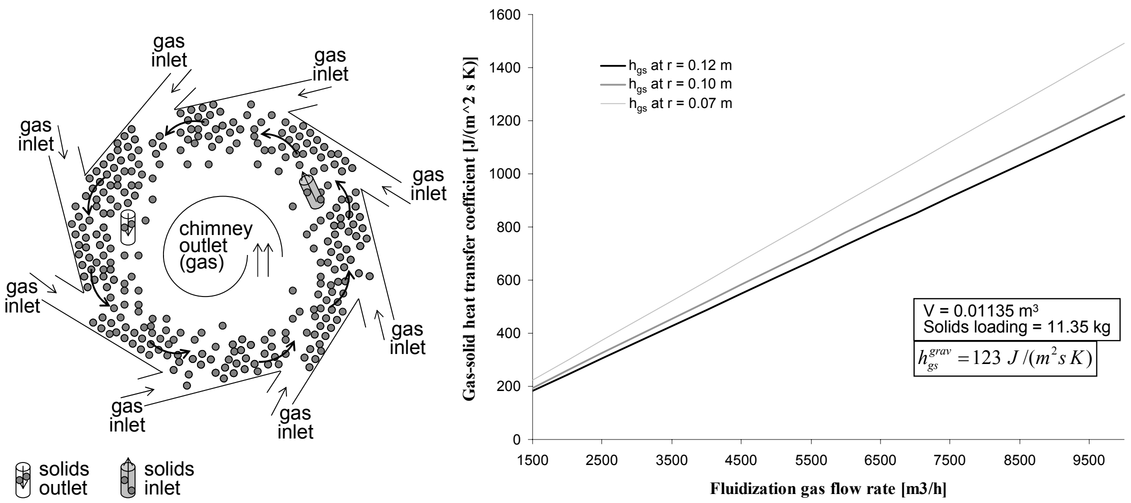
ABSTRACT

Gas-solid heat transfer in rotating fluidized beds in a static geometry [1] is theoretically and computationally investigated. In rotating fluidized beds in a static geometry (Figure 1(a)), both the centrifugal force and the radial gas-solid drag force are influenced by the fluidization gas flow rate in a similar way, allowing operation over a very broad fluidization gas flow rate range and offering increased flexibility with respect to cooling or heating via the fluidization gas. In particular, rotating fluidized beds in a static geometry can be operated in dense regime at fluidization gas velocities and, hence, gas-solid slip velocities much higher than those in conventional fluidized beds, resulting in a significant increase of the gas-solid heat transfer coefficient (Figure 1(b)). Compared to



(a) (b)

Figure 1: A rotating fluidized bed in a static geometry. (a) Schematic representation; (b) Typical behavior of the gas-solid heat transfer coefficient as a function of the fluidization gas flow rate at different radial positions *r* in the fluidization chamber (*r* = 0.07 m: chimney, *r* = 0.18 m: outer wall).

conventional fluidized beds, an intensification of the gas-solid heat transfer by one order of magnitude can be easily achieved.

2D CFD simulations of the response of the particle bed temperature to a step change in the fluidization gas temperature (Figures 2 and 3) confirm the theoretically predicted significantly higher allowable fluidization gas velocities and resulting gas-solid heat transfer coefficients in rotating fluidized beds in a static geometry compared to conventional fluidized beds. Furthermore, as a result of the rotational motion of the particle bed and the combined radial-tangential fluidization, the particle bed temperature is shown to be much more uniform in rotating fluidized beds in a static geometry than in conventional fluidized beds.

The combination of increased fluidization gas velocities and increased gas-solid heat transfer coefficients make rotating fluidized beds in a static geometry potentially interesting for use with fast and highly endothermic or exothermic reactions.

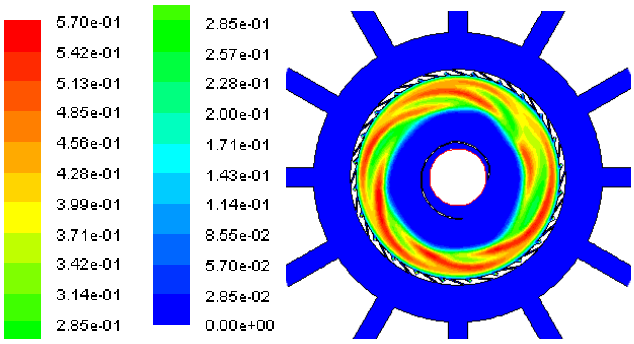


Figure 2: Simulated solids volume fraction in a rotating fluidized bed in a static geometry.

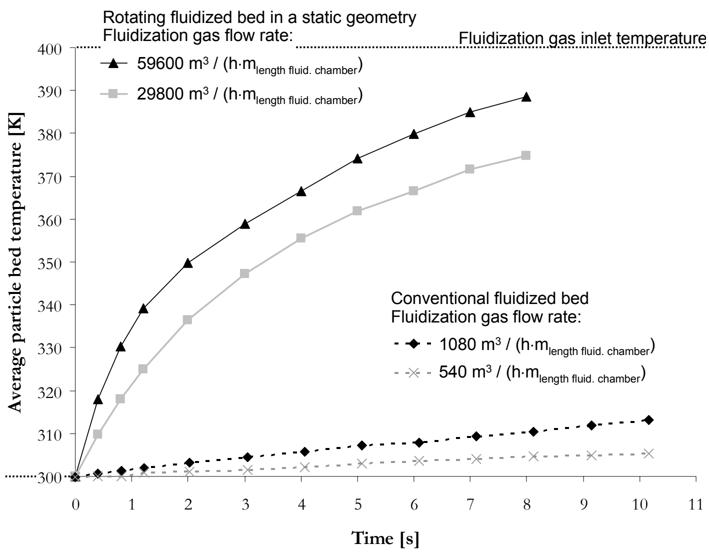


Figure 3: Simulated response of the average particle bed temperature to a step change in the fluidization gas temperature from 300 K to 400 K at time $t_0 = 0$ s. Comparison of a conventional fluidized bed and a rotating fluidized bed in a static geometry.

REFERENCES

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