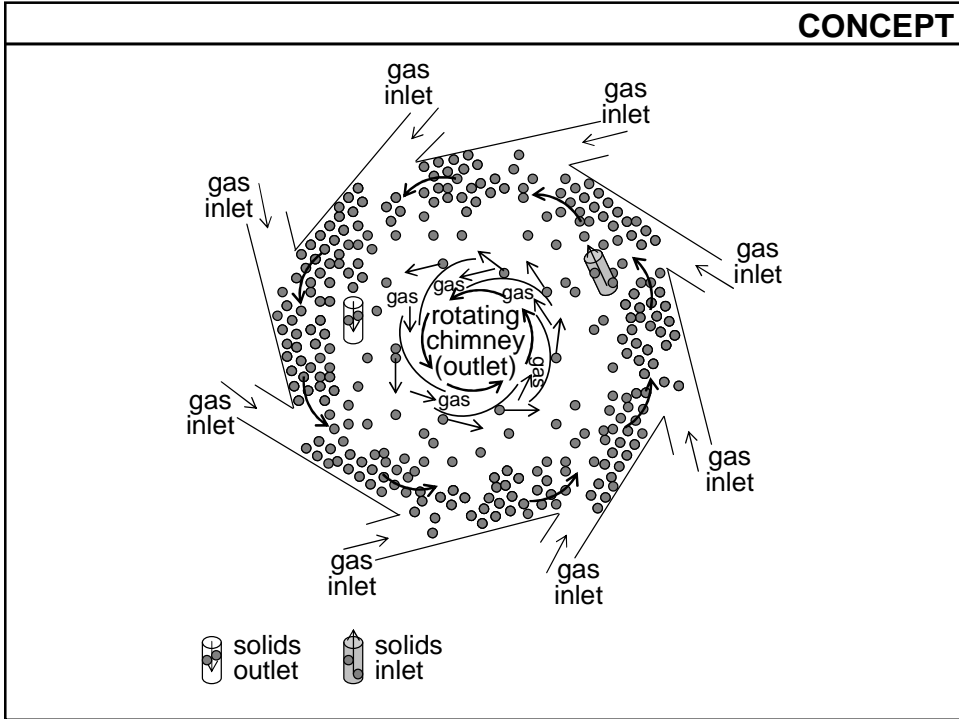
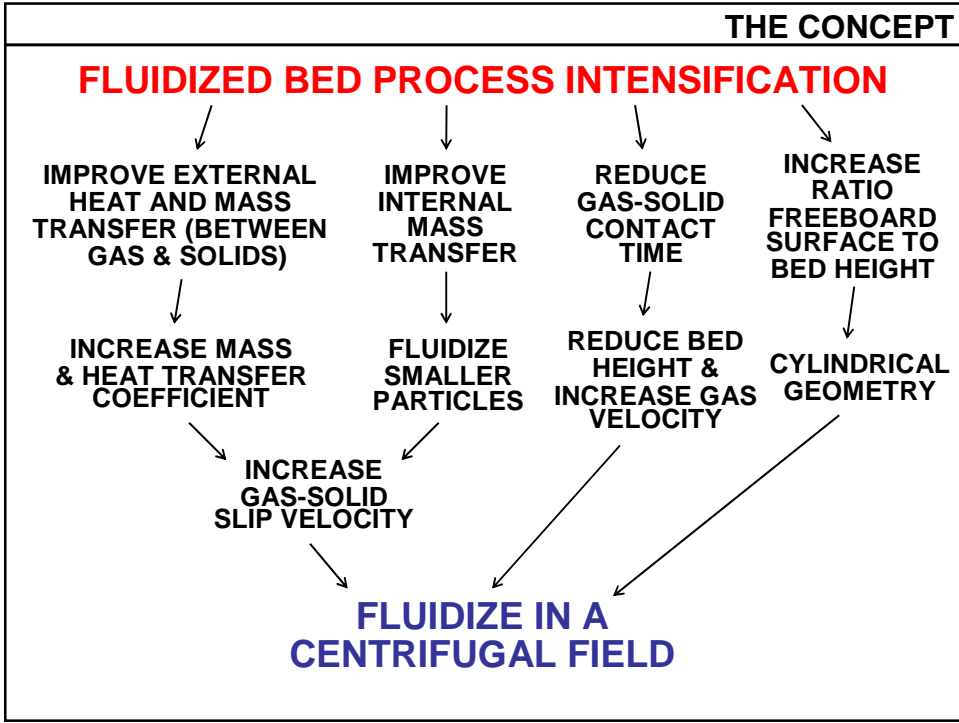


# **Numerical proof of the concept of a rotating chimney for Rotating Fluidized Beds**

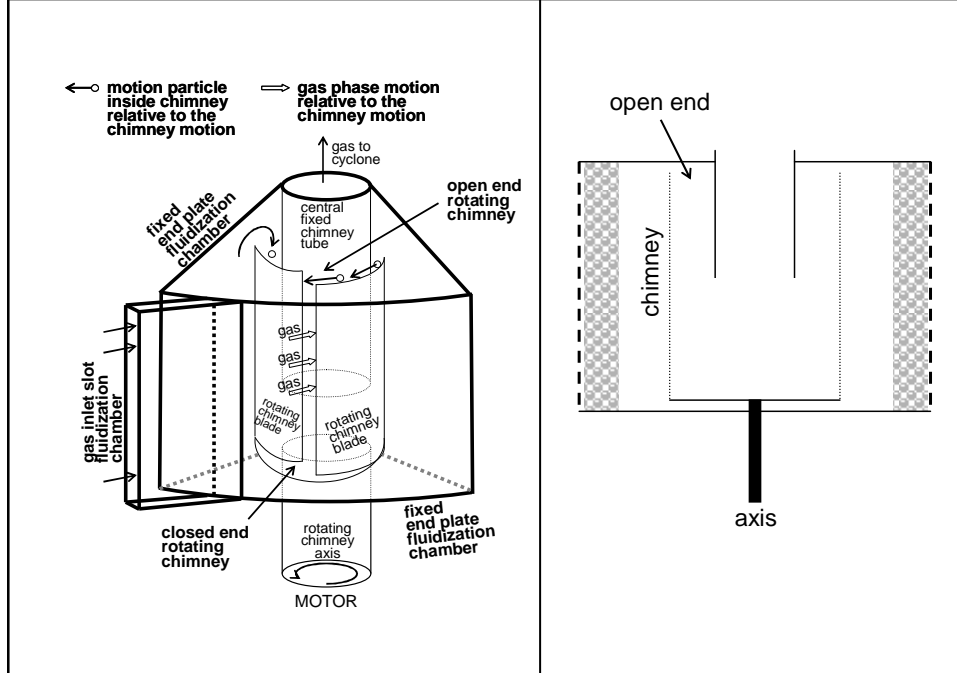
**Nicolas Staudt, Juray De Wilde\***

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1348 Louvain-la-Neuve  
Belgium  
[juray.dewilde@uclouvain.be](mailto:juray.dewilde@uclouvain.be)

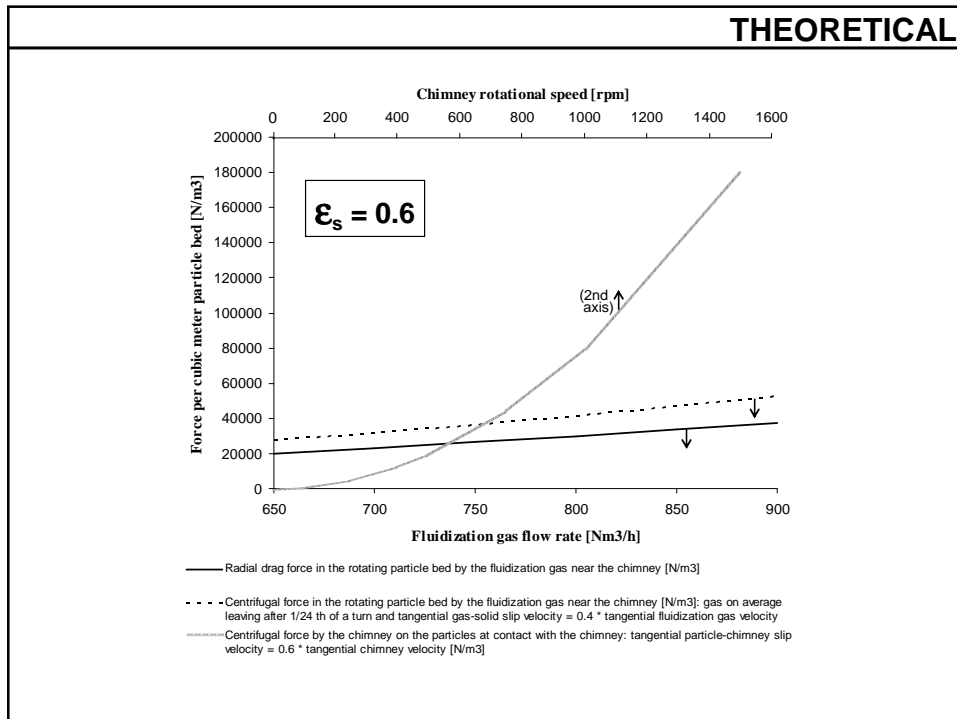
- **THE CONCEPT**
- **THEORETICAL**
- **EXPERIMENTAL**
- **CFD STUDY**
- **CONCLUSIONS**



## CONCEPT



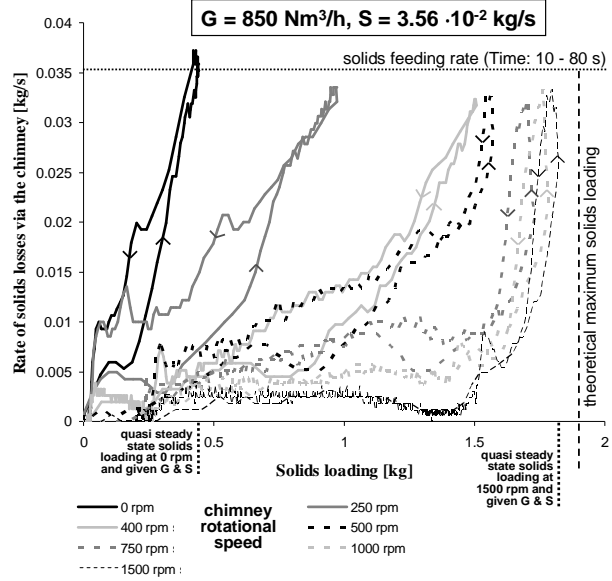
## THEORETICAL



**EXPERIMENTAL**

**REDUCTION OF SOLIDS LOSSES VIA THE CHIMNEY**

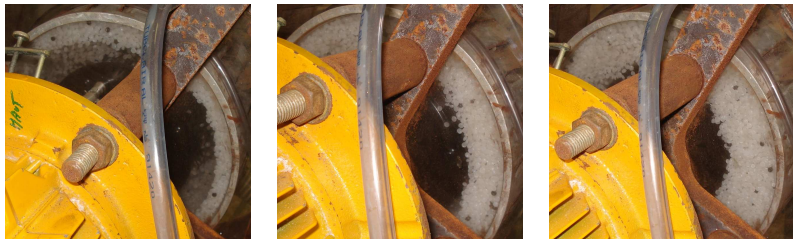
1G Geldart D-type particles, 24-cm diameter fluidization chamber



**EXPERIMENTAL**

**QUASI STEADY STATE SOLIDS LOADING**

24-cm diameter fluidization chamber, given fluidization gas flow and solids feeding rates



Chimney: 250 rpm      500 rpm      1000 rpm

**1G Geldart D-type particles**



Chimney: 0 rpm      500 rpm      1000 rpm

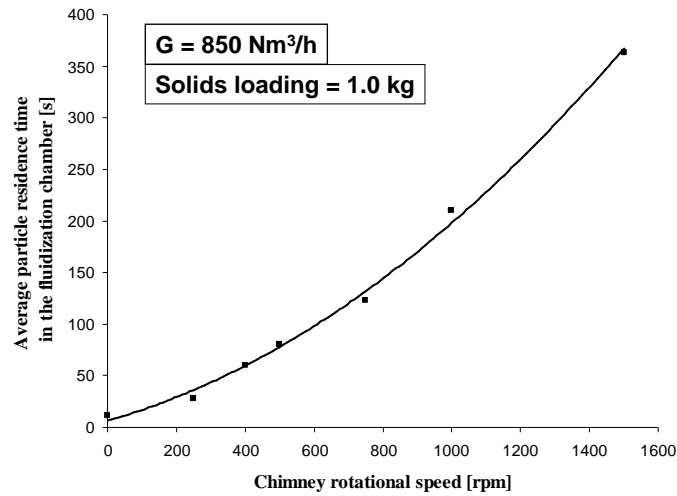
**1G Geldart B-type particles**

**SUPPRESSION OF BUBBLING**

## EXPERIMENTAL

### AVERAGE PARTICLE RESIDENCE TIME CONTROL

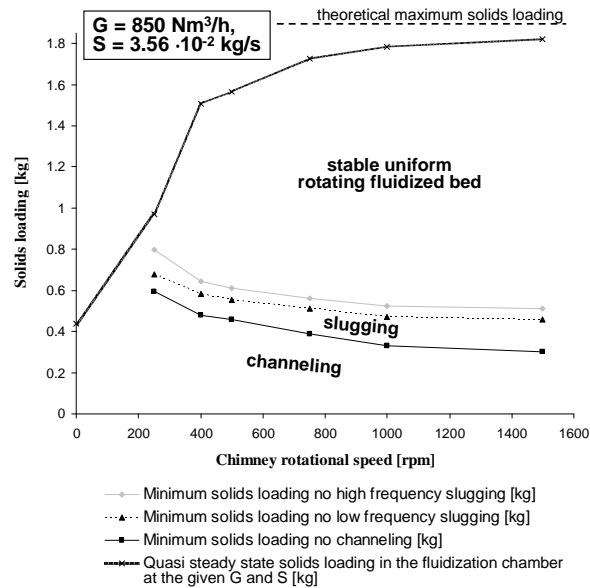
1G Geldart D-type particles, 24-cm diameter fluidization chamber  
 Given fluidization gas flow rate and solids loading in the fluidization chamber



## EXPERIMENTAL

### CRITERIA FOR STABLE AND UNIFORM OPERATION

1G Geldart D-type particles, 24-cm diameter fluidization chamber

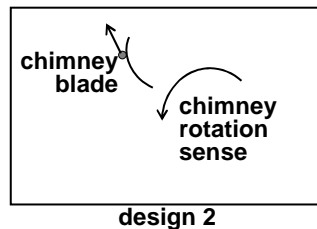
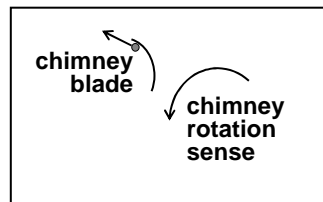


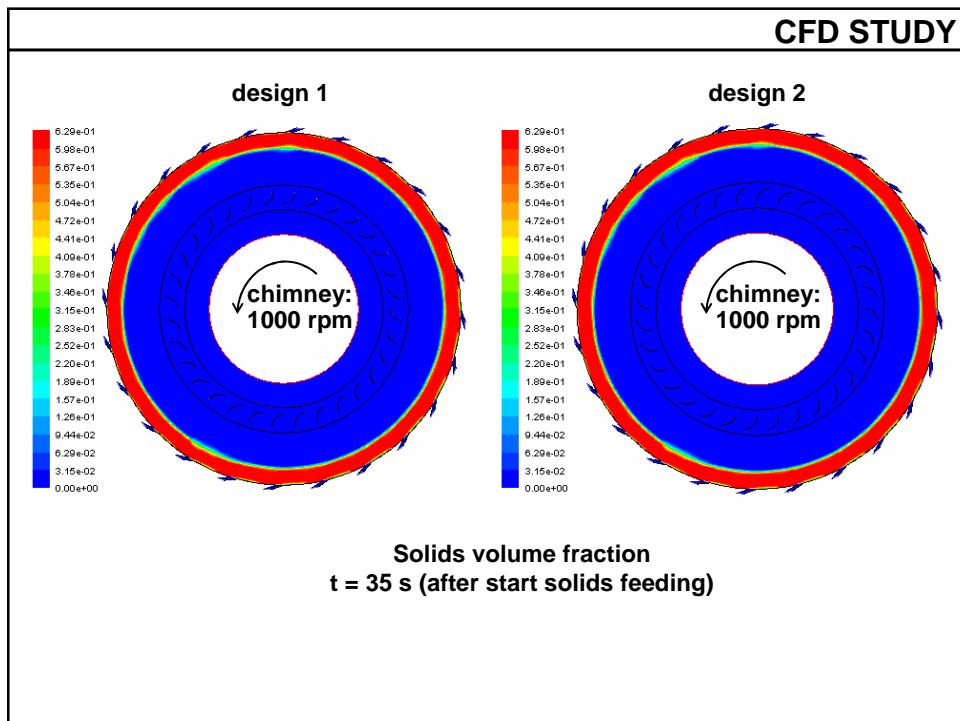
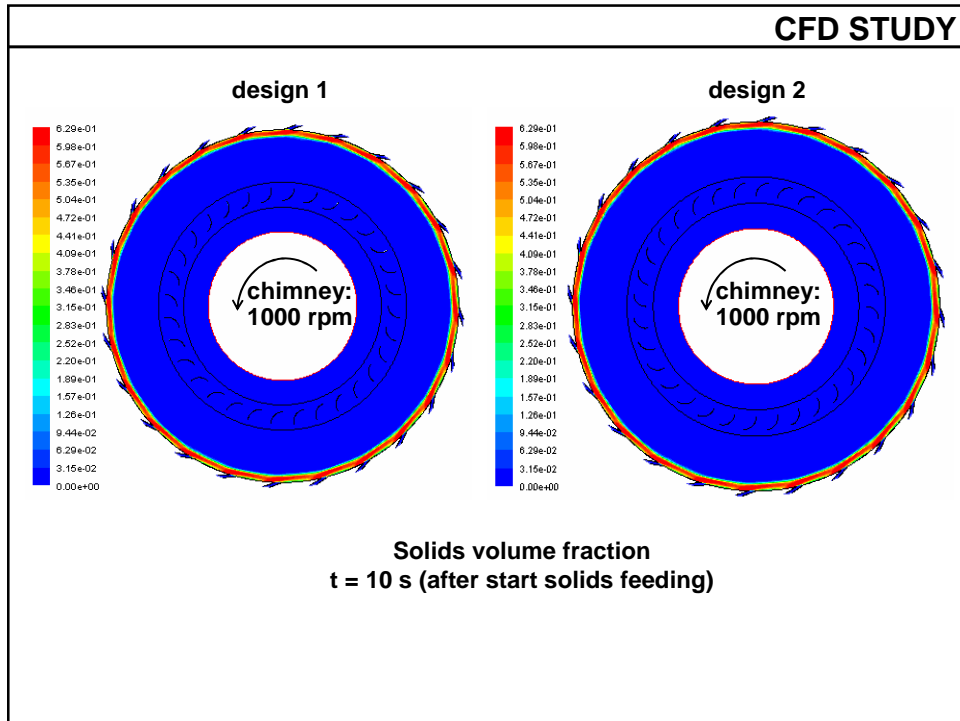
## CFD STUDY

- EFFECT ON ROTATING FLUIDIZED BEDS
- INFLUENCE CHIMNEY DESIGN
- IMPROVED UNDERSTANDING FLOW PATTERNS
- BEHAVIOR WITH MICRO-SCALE PARTICLES ?

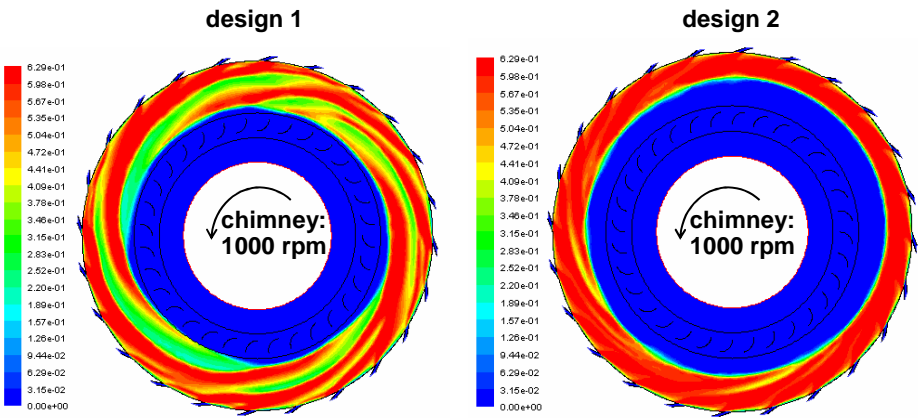
## CFD STUDY

- Fluidization chamber: 24-cm diameter (2D)
- Gas inlet slots: 24, 2.3 mm width tangential (30°)
- Gas injection velocity: 35 m/s
- Rotating chimney: 16-cm diameter, 32 blades, 1000 rpm
- Rotating chimney: two different designs
- Operating pressure (outlet): 101300 Pa
- Particles: 350  $\mu\text{m}$ , 2100  $\text{kg}/\text{m}^3$
- Particles: continuously fed





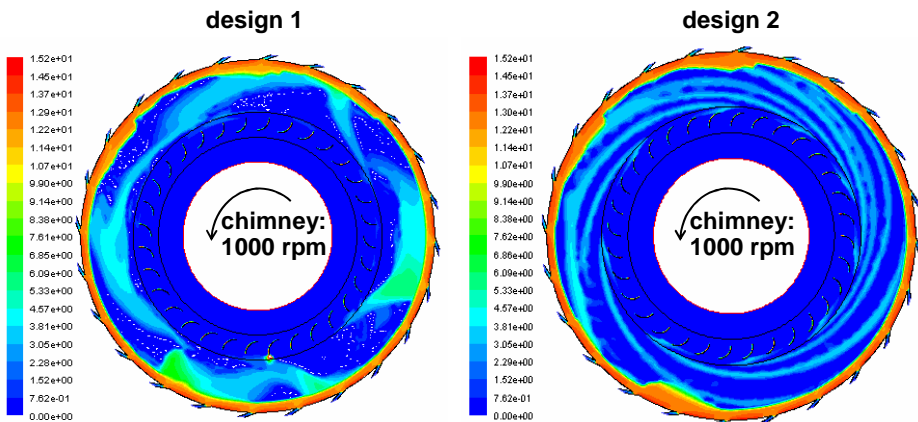
**CFD STUDY**



**Solids volume fraction**  
**t = 70 s (after start solids feeding)**

- No solids losses via the chimney, despite high solids loading
- Design 2 results in improved particle bed uniformity and reduced radial bed expansion

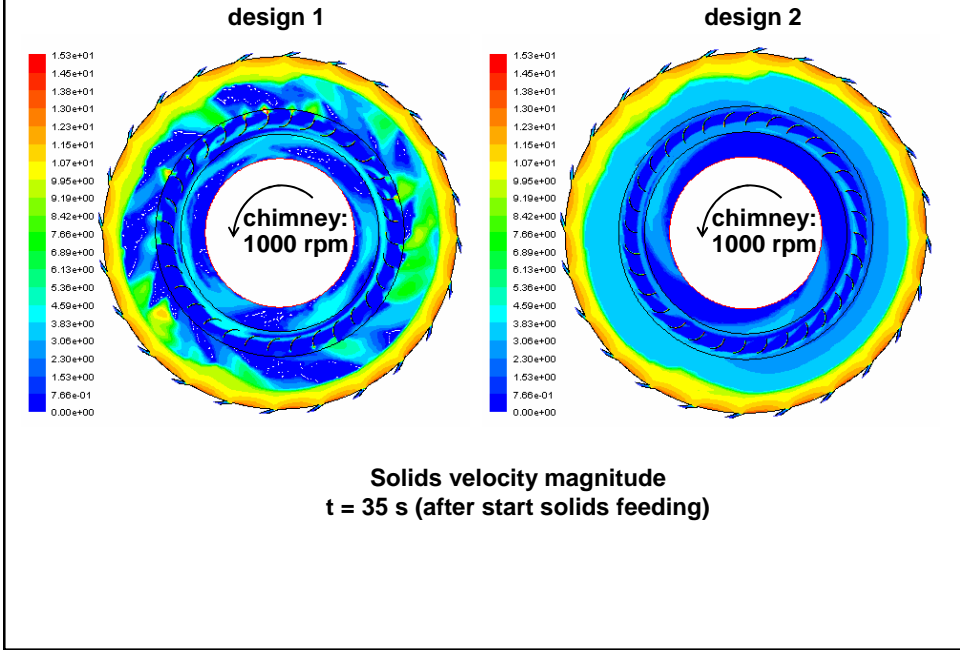
**CFD STUDY**



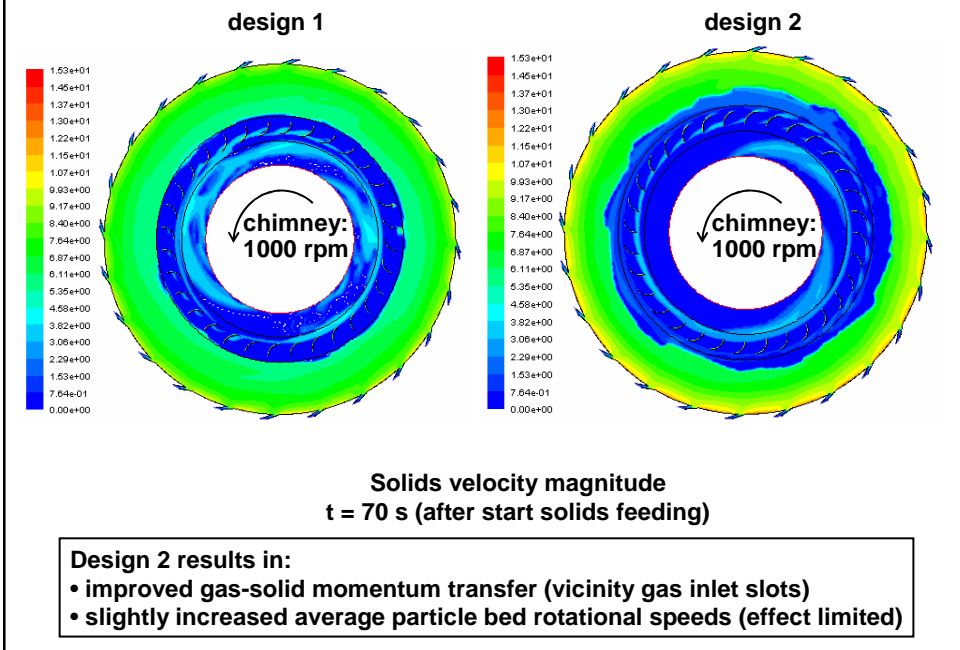
**Solids velocity magnitude**  
**t = 10 s (after start solids feeding)**



CFD STUDY



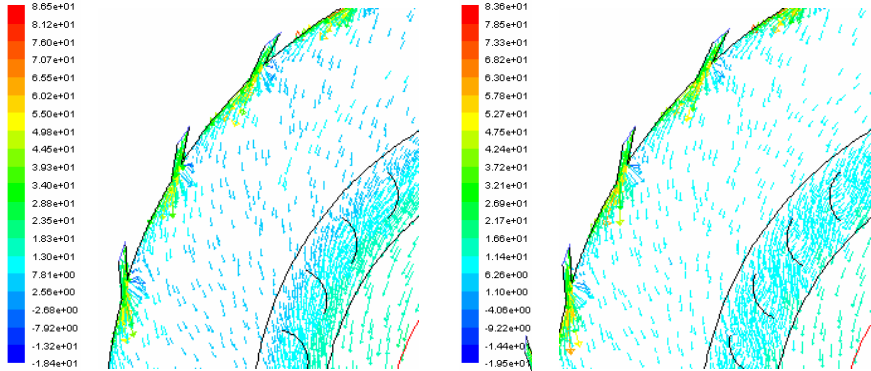
CFD STUDY



**CFD STUDY**

**design 1**

**design 2**



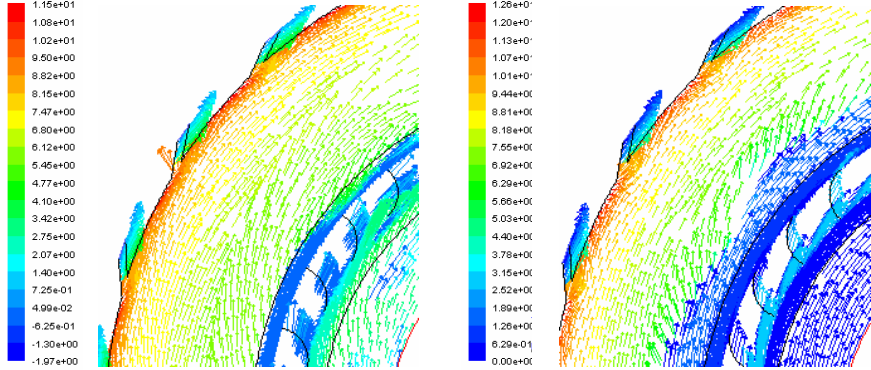
**Gas velocity,  
colored by tangential gas velocity  
t = 70 s (after start solids feeding)**

**Effect chimney design limited**

**CFD STUDY**

**design 1**

**design 2**

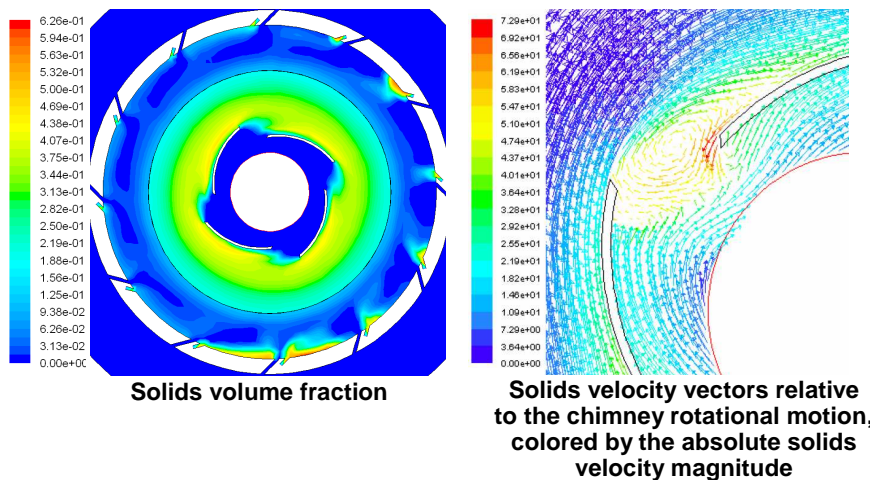


**Solids velocity relative to the chimney,  
colored by the tangential solids velocity  
t = 70 s (after start solids feeding)**

**Effect chimney design limited**

## Behavior with micro-scale particles ?

- Fluidization chamber: 36-cm diameter (2D)
- Gas inlet slots: 12, 4.0 mm width tangential (35°)
- Gas injection velocity: 20 m/s
- Rotating chimney: 14-cm diameter, 4 blades, 1500 rpm
- Operating pressure (outlet): 101300 Pa
- Particles: 10  $\mu\text{m}$ , 2100 kg/m<sup>3</sup>
- Particles: continuously fed



- Rotating fluidized bed around a rotating chimney
- Solids entrained into the chimney can be re-fed to the fluidization chamber via the opening of the next blade

## CONCLUSIONS

- **CONCEPT OF ROTATING CHIMNEY FOR ROTATING FLUIDIZED BEDS STUDIED**
- **CFD CONFIRMS EXPERIMENTALLY OBSERVED FEATURES**
  - **REDUCTION OF THE SOLIDS LOSSES VIA THE CHIMNEY**
  - **INCREASED SOLIDS LOADING IN THE FLUIDIZATION CHAMBER**
- **CFD ALLOWS TO STUDY CHIMNEY DESIGN**
- **CFD DEMONSTRATES USE WITH MICRO-SCALE PARTICLES**
  - ⇒ **ROTATING FLUIDIZED BED AROUND A ROTATING CHIMNEY**