CFD study of spray drying in a lab scale multi-zone vortex chamber

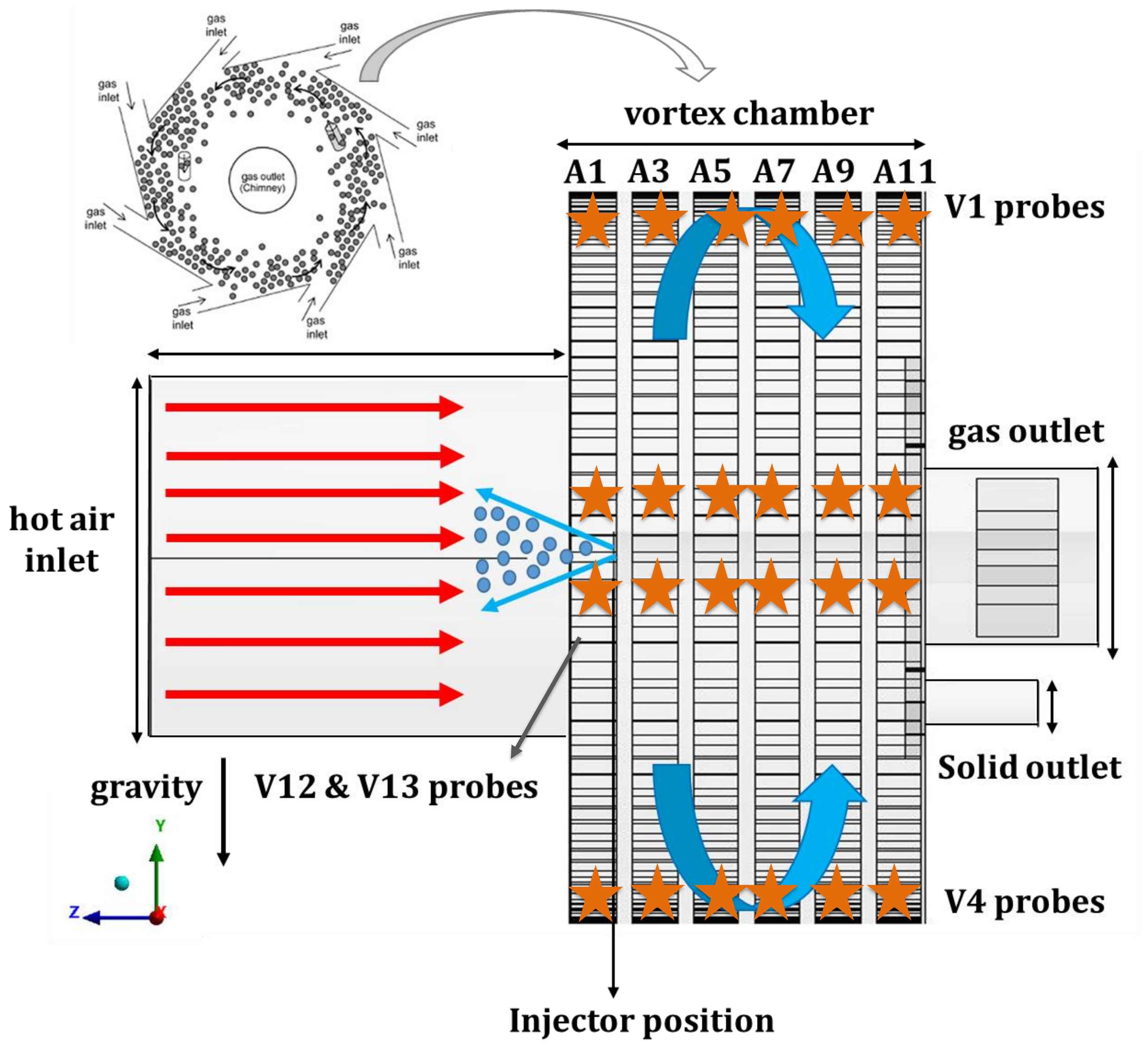
U. Jamil Ur Rahman, I. Baiazitov, A. K. Pozarlik, G. Brem

Chair of Thermal Engineering, Faculty of Engineering Technology, University of Twente, The Netherlands.

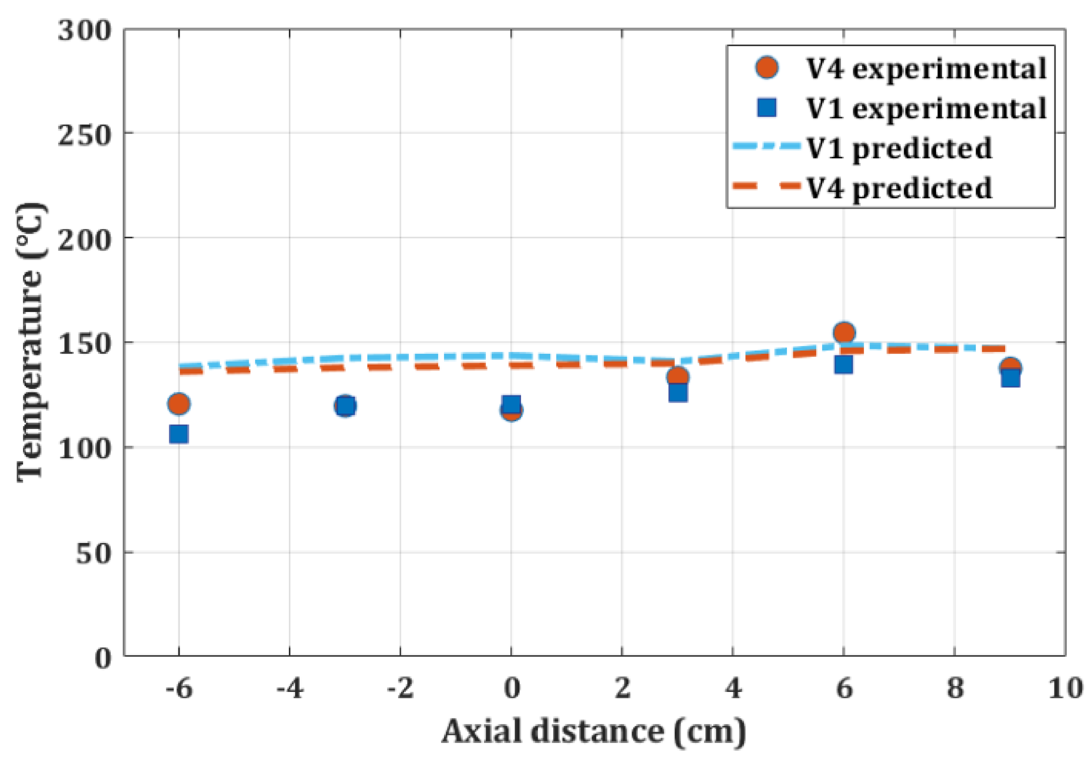
1. MOTIVATION

Conventional spray dryers are known by their high capital and operating costs. Furthermore, low air inlet temperatures and small gas-solid slip velocities limited by gravity leads to low drying rates. In order to develop a commercially viable alternative spray drying technology, a high drying rate in a smaller volume must be achieved. In this study, the possibility of spray drying in a novel multi-zone vortex chamber is investigated using CFD tools. High-G fluidization in vortex chambers leads to intensification of interfacial heat, mass, and momentum transfers [1]. Additionally, due to small particle residence times, higher air inlet temperatures can be employed that further enhances the drying rates.

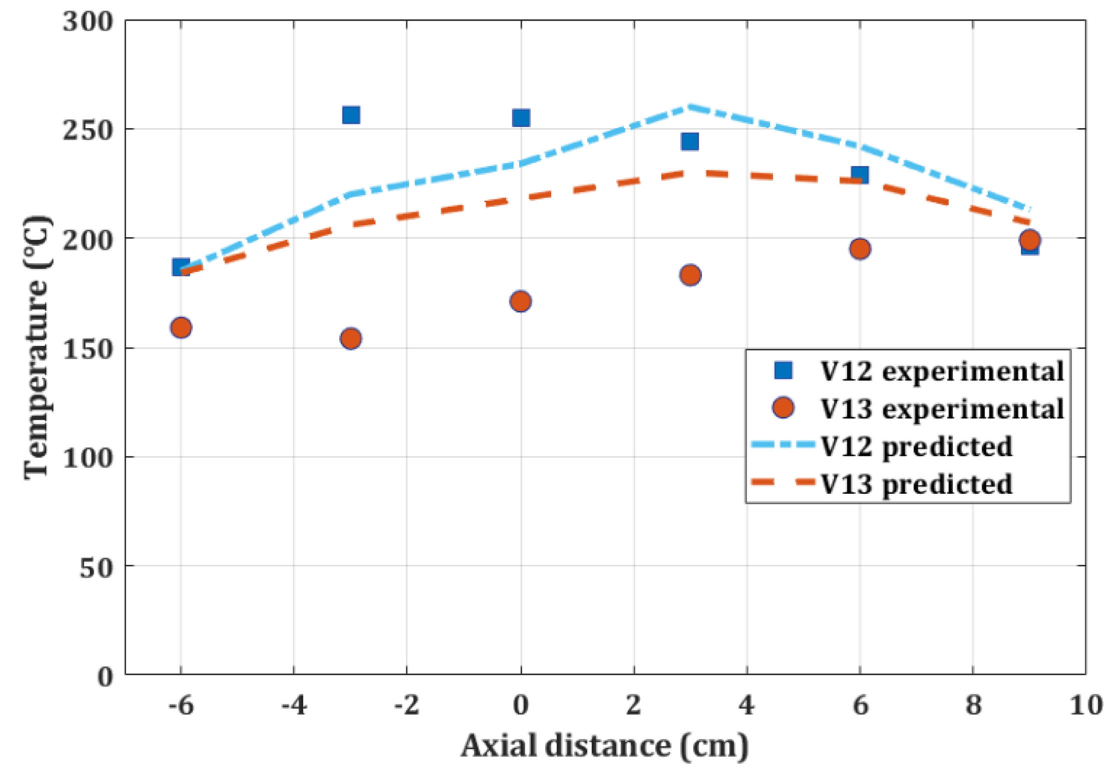
2. CFD MODEL



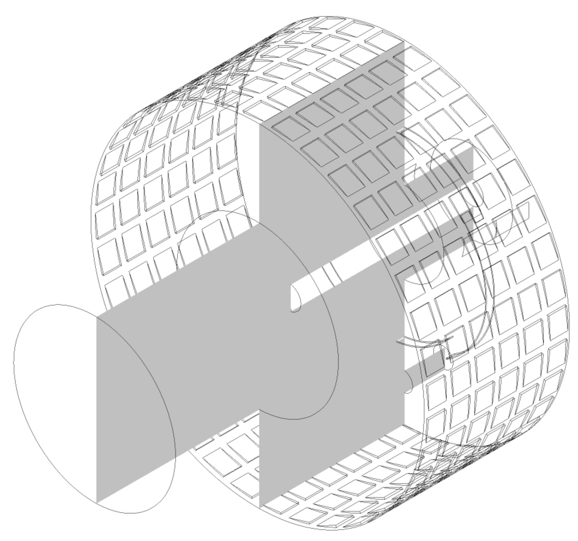
3. EXPERIMENTAL VALIDATION



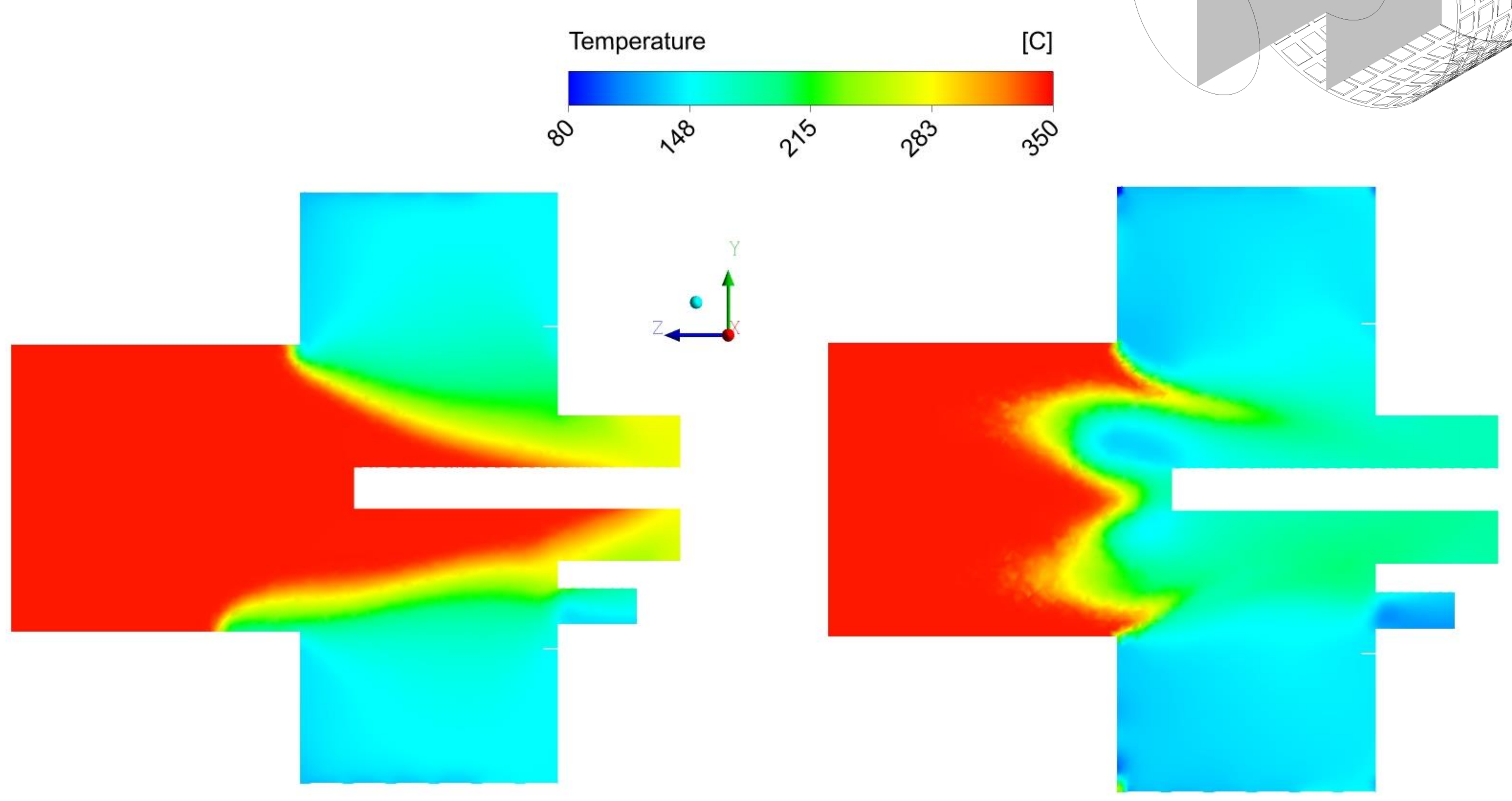
only air



with water spray



4a. RESULTS: Temperature fields

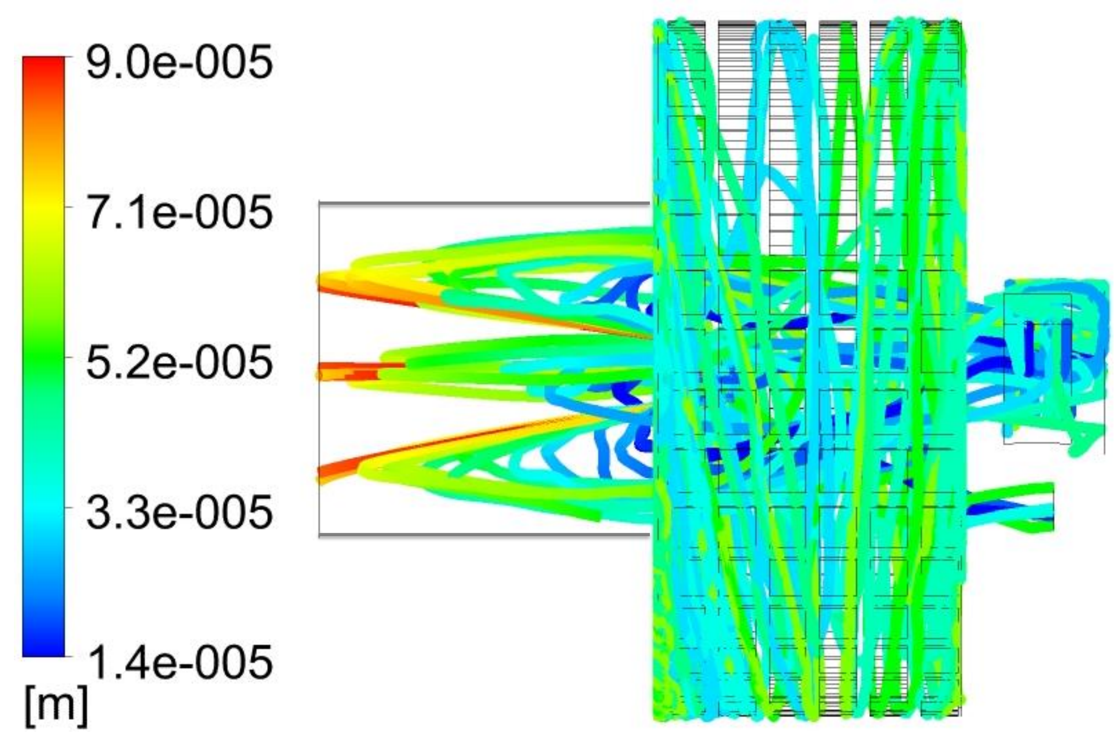


only air

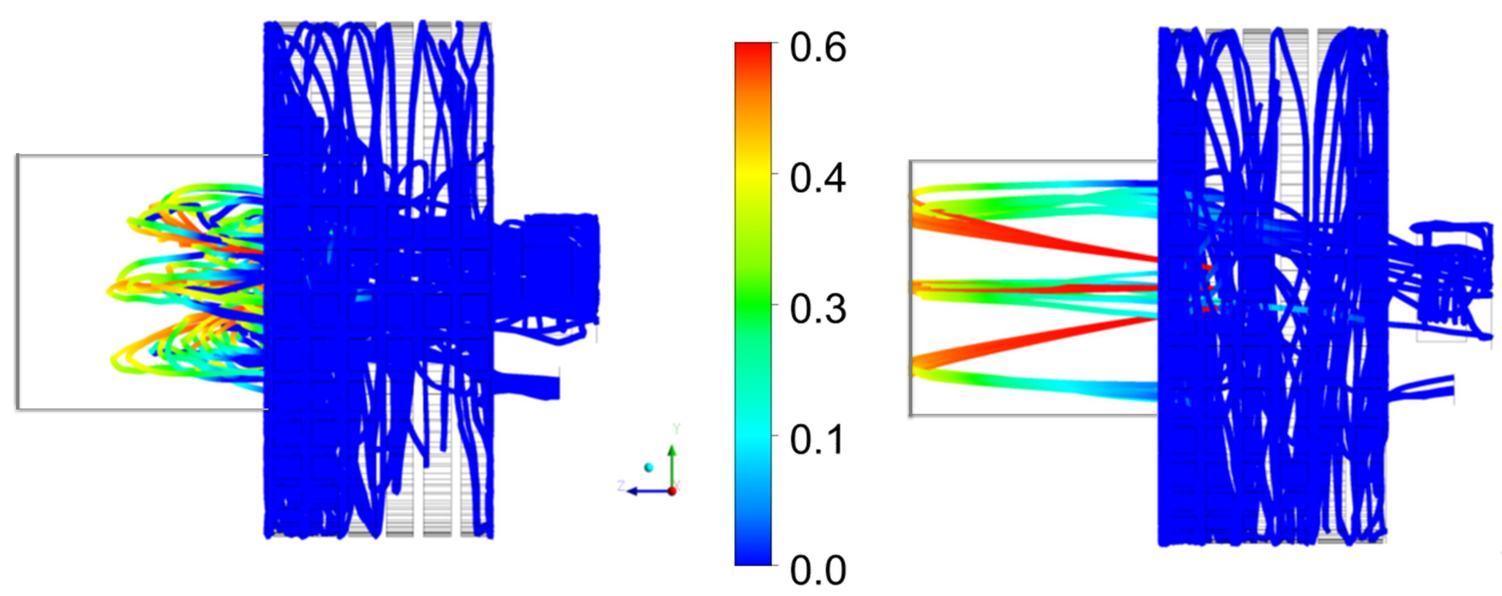
with multicomponent spray

4b. RESULTS: Droplet trajectories

particle diameter



water mass fraction



Particles < 45 µm

Particles > 75 µm

5. CONCLUSIONS

- A 3D CFD model for spray drying in a vortex chamber was developed
- Overall good agreement with the experimental data
- 67 wt.% of product is lost via gas outlets
- Redesign of current vortex chamber is necessary to harvest its full drying potential

6. FUTURE WORK

- Parametric studies on the influence of solid outlet location on air flow patterns and droplet trajectories
- Influence of G-acceleration on separation efficiency

ACKNOWLEDGMENTS

This research is conducted within RVO-Vortex chamber II Project (TEEI115007). Authors would like to express their gratitude to RVO and to all project members for their contributions.

REFERENCES

1. De Wilde, J. and A. de Broqueville (2008). "Experimental investigation of a rotating fluidized bed in a static geometry." Powder Technology **183**(3): 426-435.
2. Tourneur, T. , A. de Broqueville and De Wilde, J (2018). Experimental and CFD study of multi-zone vortex chamber spray dryers. International Symposium on Chemical Reactor Engineering-ISCRE 25.

ISPT Institute for Sustainable Process Technology

FrieslandCampina

Unilever

ECN

UCL Université catholique de Louvain

UNIVERSITY OF TWENTE.