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Geometry Influence of Particles Depositing in Realistic Human Lung Replicas

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Humans are constantly exposed to pollutants in the air. These particles can originate from a variety of sources like pollen, microplastics, fabrics or, as highlighted in the recent pandemic, expiratory events leading to exhaled viruses encapsulated in saliva droplets. Understanding particle deposition in the human lung is of key interest to reduce the impact of harmful particles, or on the contrary, to improve the targeted delivery of drugs to reduce their side effects. A common simplification in the study of particle deposition in human airways is to assume perfectly spherical particles. This is an accepted approach for studies of aerosolized droplets, yet for inhalation of toxic fibres or arbitrarily shaped aerosol particles such as pollens, fibers or volcanic ash, the assumption of spherical shape no longer applies. In this context, shape factors are often used to account for non-sphericity effects, but these are often insufficient to accurately predict particle motion. Therefore, more sophisticated particle models need to be considered. However, there is a glaring lack of research in this area regarding the accurate prediction of inhalation of more complex shaped particles in realistic human airways. In this work, we investigate the effect of different particle geometries on the deposition behaviour in realistic lung models. The study includes spheres and prolate ellipsoids as well as more arbitrary shapes in the scope of superellipsoidal particles, fitted to naturally occurring pollutants, to cover a wide range of particles suspended in the air we breathe. In our study we focus on the deposition efficiency in the mouth-throat and tracheobronchial region as well as the level of bifurcuration of the chosen lung geometry. The computational study is based on Lagrangian particle tracking in RANS resolved turbulent flow in a realistic lung geometry performed using an in-house solver developed in the OpenFOAM framework. Finally, we present the identified key influences on deposition efficiency in the lung models used.

REFERENCES

[1] Wedel, J., Štrakl, M., Steinmann, P., Hriberšek, M., Ravnik, J. Can CFD establish a connection to a milder COVID-19 disease in younger people? *Computational Mechanics* (2021) **67**: 1497–1513.

[2] Wedel, J., Štrakl, M., Steinmann, P., Hriberšek, M., Ravnik, J. Risk Assessment of Infection by Airborne Droplets and Aerosols at Different Levels of Cardiovascular Activity *Archives of Computational Methods in Engineering* (2021) 1–20.