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Aerosol deposition in bends: sensitivity studies of various parameters in a lagrangian stochastic model

Indoor air is a topic of interest for the safety and health of industrial workers as well as more recently for the population, enhanced by pollution concerns and the Covid pandemic. Many applied studies have investigated the risk assessment of aerosol dispersion and its consequences on air quality using CFD commercial codes, which are easy to handle and produce fast results in complex geometries (ventilated rooms, buildings, schools, hospitals, ...) For the particle phase, the easiest and fastest way to implement a two-phase flow in such codes is to use the one-way coupling lagrangian approach. As a result, many applied papers have been written on aerosol dispersion. In the dispersion of aerosol, wall deposition is one important component and over the past 20 years, many studies ([1.], [3.], [4.], [6.], [7.], [9.]) have been performed with different versions of commercial codes to investigate this phenomenon, on the basis of test-cases. For aerosol deposition studies, the Pui's experiments on deposition in bends have been widely used. The Pui correlation has been revisited recently [8.] leading to a new correlation obtained over a wider range of parameters. The objective of this work is to simulate this test case with the Fluent code and compare it with the original and the newest correlation, including a sensitivity study on several parameters, including the so-called Cl stochastic constant, that has, to our knowledge, never been explicitly mentioned in previous studies.

The Pui case [5.] concerns the deposition of 900 kg/m^3 aerosol in a bend for two duct radii, two curvature ratios and two Reynolds numbers. The method used is a fluorescence method where particles collected on the walls are washed to determine the deposited amount. Results are given in terms of deposited fractions and Stokes numbers. We will consider here 10% uncertainty on the Stokes number and the deposition efficiency, i.e. much higher than the announced 3% uncertainty of the original paper, a realistic assumption considering our experience on fluorescent aerosols.

All calculations are performed up to $y^+=1$ at walls, with 10 to 20 cells in the refinement zone and double precision. The sensitivity study concerns the bulk mesh density (M1, M2, M3), the type of mesh (tetra/hexa), the turbulence model (RSM-based on epsilon, SST-k- ω without Matida [2.]'s correction of the kinetic energy near the wall), the drag coefficient and the Cl constant of the lagrangian stochastic model. Example of results are presented in Figure 1 **Erreur ! Source du renvoi introuvable.**

None of the studied parameters recover the new Wang correlation [8.]. The type of mesh, hexa or tetra has no influence when a refined mesh is used. The turbulence model has an influence over all the size range. The mesh density and the Cl parameter have mainly an influence on the smallest particles (1 to 3 μm). There is a need of discussions on the modelling choices of Cl in commercial codes especially since the 1-3 μm particles are the ones considered in a lot of aerosol dispersion studies linked to COVID applications. One step before is also to verify if flows in bends, especially the secondary flows and the recirculation zone, are well recovered with the choices performed. Detailed best-practice guidelines including flow and particle validations steps and sensitivity studies for the use of aerosol stochastic modelling for dispersion studies need to be enhanced.

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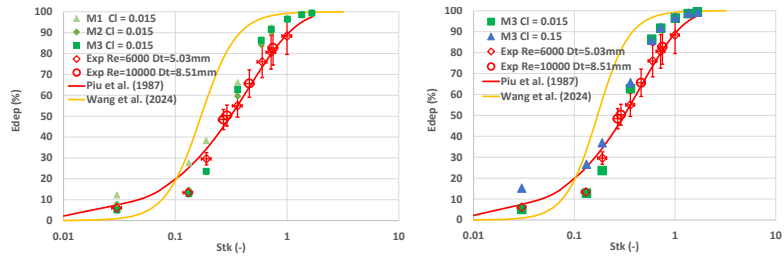


Figure 1 : Sensitivity analysis: mesh density influence(left) and stochastic model constant CI influence (right).