

TriboFoam – An open-source solver for the electrification of particles in turbulent flow

Christoph Wilms^{1,2}, Gizem Ozler^{1,2}, Simon Jantač¹, Wenchao Xu¹, Holger Grosshans^{1,2}

¹ Physikalisch-Technische Bundesanstalt, 38116 Braunschweig/Germany

² Otto-von-Guericke-Universität Magdeburg, Universitätsplatz 2
39106 Magdeburg/Germany

Abstract:

Up to now, we have used the specialized computational fluid dynamics (CFD) code pafiX to develop new charge transfer models and investigate the electrification of particles in a turbulent flow. However, in pafiX, the simulations are limited to generic geometries like ducts and channels. To address this limitation, we have incorporated the models from pafiX into the OpenFOAM framework, a general-purpose and widely used computational tool. This enables simulations of triboelectric charging by flows through complex geometries, as found in industrial facilities. In addition to the standard OpenFOAM forces acting on the particles, such as drag, lift, and gravity, Coulomb forces due to the electric charge is now implemented. Moreover, a hard sphere model has been incorporated for the expeditious calculation of particle-particle and particle-wall collisions, during which the charge transfer occurs. In this contribution, the solver is first validated by simulating a particle-laden turbulent duct flow with pafiX and the new solver triboFoam. In a second step, simulation results will be presented that go beyond the capabilities of pafiX, e.g. a bend pipe case or a T-junction. Finally, we examine the impact of physical properties, including particle size, particle density, and fluid velocity, on the accumulation of triboelectric charge, thereby offering new insights into the triboelectric behavior of particles in complex geometries. As a result, we provide an open source CFD solver that calculates triboelectric charge accumulation. In industry, it can be used for example to prevent explosions caused by spark discharges triggered by excessive accumulation of charge or to simulate the coating of surfaces which is strongly influenced by the particle charge.

Keywords: triboelectric charging, simulation, DEM-CFD, OpenFOAM, CFD

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Corresponding author: Christoph Wilms

E-mail: Christoph.Wilms@ptb.de