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Coupled CFD-DEM modelling to assess settlement velocity and drag coefficient of microplastics

Robin Jérémy[1], Latessa Pablo Gaston[2], and Manousos Valyrakis[2]
[1]CESI La Rochelle, Ecole d'ingénieur CESI, France (jeremy.robin@viacesi.fr)
[2]university of Glasgow, School of Engineering

Several studies have documented high concentration of microplastics on fresh water sources, oceans and even on treated tap and bottled water. Understanding the physics behind these particles in the water environment has become one of the key research needs identified in the World Health Organization Report (2019). In order to develop novel and efficient methodologies for sampling, treating and removing microplastics from water bodies, a thorough understanding of the sources and transportation and storage mechanisms of these particles is required.

In this article, the settlement velocity affecting the transport [1, 2] of low-density particles (1<r<1.4 g.cm^{-3}) and drag coefficients is assessed through numerical modelling. The effects of fluid and particle relative densities and media temperatures are analysed, as well as the impact of the particle size and shapes [3].

Computational Fluid Dynamics (CFD) techniques are applied to solve the fluid dynamics while the Discrete Element Method (DEM) approach is used to model the particle trajectories [4]. These two modules are coupled under the CFDEM module, which transmits the forces from the fluid into the particle and from the particle into the surrounding water through the Fictitious Boundary Method approach.

Several tests are run under the same particle conditions in order to estimate the influence of turbulent flows on these experiments. The influence from different particle densities and diameters on settling velocities and drag coefficients is assessed. The numerical results are validated against a wide range of experimental data [2, 3] and compared against empirical predictions.

There is an urge for gaining a better understanding of the sources and transport of microplastics through fresh water bodies. In this sense, sampling and quantification of microplastics in a drinking water source is key to evaluate the environment status and to design the most appropriate techniques to reduce or remove the microplastics from the aquatic environments. The implementation of coupled CFD-DEM models provides a very powerful tool for the understanding and prediction of the transport processes and the accumulation of microplastics along the fluvial vectors.

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