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# NUMERICAL INVESTIGATION ON PARTICLE RESUSPENSION IN TURBULENT DUCT FLOW VIA DNS-DEM: EFFECT OF COLLISIONS

**Hao Zhang[†,‡], F. Xavier Trias[†], Andrey Gorobets[†,§], Dongmin Yang[$], Assensi Oliva[†], Yuanqiang Tan[‡]**

[†]Heat and Mass Transfer Technological Center, Technical University of Catalonia
ETSEIAT, C/Colom 11, 08222 Terrassa, Spain
[‡]School of Mechanical Engineering, Xiangtan University, Hunan 411105, China
[§] Keldysh Institute of Applied Mathematics of RAS, 4A, Miusskaya Sq., Moscow, 125047, Russia
[$] School of Civil Engineering, University of Leeds, Leeds LS2 9JT, UK

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We focus on the numerical prediction of particle-laden turbulent flows in a straight duct at $Re_\tau = 300$ that is defined as $Re_\tau = Hu_\tau/\nu$ based on the duct hydraulic diameter $H = 0.02m$, the mean friction velocity $u_\tau$ and the kinematic viscosity $\nu$. The streamwise length of the duct is $4\pi H$ and the fluid is water. The kinematics and trajectory of the discrete particles as well as the particle-particle interaction are described by the discrete element method (DEM) [1] while the hydrodynamic model of the fluid phase is based on the direct numerical simulation (DNS) [2, 3]. Unlike the particle transportation process in pipes with circular cross section [4, 5], the motion of the particles in square duct can be affected by the secondary vortexes which are known as the secondary flow of Prandtl's second kind. Therefore, the particles show more stochastic motions than those in the homogeneous and iostropic turbulent flows. Moreover, inter-particle collisions play an important role on the particle behavior. In this study, the effect of collisions on the particle resuspension process is investigated with special emphasis.

Initially, 20000 particles of 50 $\mu m$ are randomly generated in the fully developed turbulent flow field, the particles have the same velocities as the fluid flow. The periodic boundary condition is used in the streamwise direction. The collisions between the particles and between the particles and the four bounded walls are treated via a soft-sphere DEM [6]. Numerical simulations are carried out with and without collisions, respectively. Fig. 1 displays the snapshot of the particle and velocity distributions in the duct with collisions. For the sake of presenting better visual, only 20% of the particles are shown without changing the main trend of the distribution characteristic. It is shown that the instantaneous particle distribution is obviously influenced by the secondary flows, the velocities of

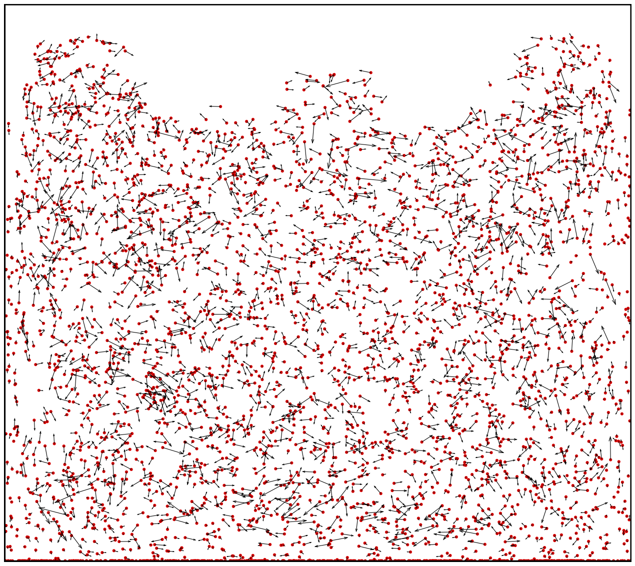

Figure 1: 2D snapshots of particle distribution with velocity vectors at $t = 12s$. Red point for the particle, black arrow for the velocity.

the particles emerge almost random distributions that related to the local fluid structure. However, the intimate motions are decoupled by the gravitational force that leads to a progressive segregation of the particles within the upper half of the duct and accumulation within the lower half. Due to the secondary velocities towards the corners, two arms are lifted within the upper half of the duct that also prevent the particle deposition.

The lower half of the duct is separated into 50 squares, namely five partitions in the $z-$direction and ten partitions in the $y-$direction, each region in the $z-$direction containing ten squares is marked by A, B, C, D, E. The resuspension rate is defined as the ratio of the number of resuspended particles to the total number of particles within each square. Further results will be presented in the final paper and in the conference.

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