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A COUPLED PERIDYNAMICS AND DEM-IB-CLBM METHOD FOR EROSION CAUSED BY PARTICLE-WALL COLLISION IN A VISCOUS FLUID

Ya Zhang[1], Sina Haeri[2*], Yonghao Zhang[3] and Guang Pan[4]

[1] Key Laboratory for Unmanned Underwater Vehicle,
Northwestern Polytechnical University, Xi'an, Shaanxi 710072, China,
zhangya_1@mail.nwpu.edu.cn
[2] James Weir Fluid Laboratory, University of Strathclyde, UK, G1 1XJ,
sina.haeri@strath.ac.uk
[3] James Weir Fluid Laboratory, University of Strathclyde, UK, G1 1XJ,
yonghao.zhang@strath.ac.uk
[4] Key Laboratory for Unmanned Underwater Vehicle,
Northwestern Polytechnical University, Xi'an, Shaanxi 710072, China,
panguang@nwpu.edu.cn

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The presence of solid particles - as small as 0.01w% - in pipelines in many industrial processes leads to major erosion problems such as degradation of pipelines and production equipment including pumps and valves. The impinging particles will cause excessive damage to the surface layer, which will also reduce the effectiveness of corrosion inhibitors resulting in material degradation. Meanwhile, corrosion will in return accelerate the erosion rate resulting in severe and rapid loss of surface metal (washout). A lack of predictive design tools makes prevention of catastrophic failure difficult.

In this paper a recently developed coupled Discrete Element, Immersed Boundary, Cascaded Lattice Boltzmann Method (DEM-IB-CLBM) is further extended and coupled with the Peridynamics theory, to directly measure the damage due to particle impacts. Material properties can directly be incorporated into the simulations to predict the damage using the Peridynamics theory. Meanwhile, the fully resolved particle-fluid coupling (DEM-IB-CLBM) provides the accurate trajectories of the particles and their rotational and translational kinetic energies just before the impact to accurately predict the damage (the Peridynamics theory).

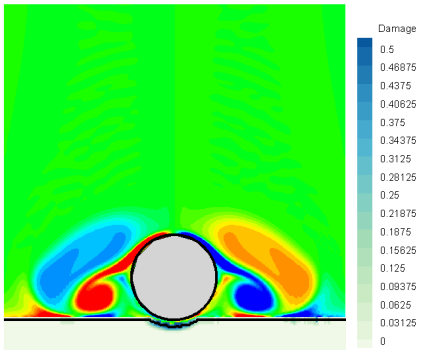

Figure 1: Damage caused by a single particle impact.

The damage caused by a collision event on the bottom wall of a viscous fluid is fully studied (Figure1). The new approach has also been implemented to exploit the graphics coprocessor technology and the feasibility and efficiency of the code for the simulation of a large number of particles is demonstrated on a NVIDIA K20M GPU.