Contribution ID: **500**   Type: **Poster + 3 Minute Pitch**

Direct numerical simulations of solid particle interactions in suspensions using Smoothed Particle Hydrodynamics

Thursday, 17 May 2018 12:02 (2 minutes)

Suspensions and their applications can be found in many fields of mechanical, civil and environmental engineering. The rheological behavior of suspensions strongly depends on the concentration of suspended particles. To consider the flow behavior as well as fluid-solid interactions in dilute suspensions, we present 3D Direct Numerical Simulations (DNS) of a single-phase fluid with discrete embedded solid particles. We therefore present an implementation using the general-purpose particle simulation toolkit HOOMD-blue [1, 3] extended for the usage of Smoothed Particle Hydrodynamics (SPH) [2, 5]. Since both the fluid and the solid phase is discretized by particles, SPH as a Lagrangian particle method presents a good choice to model this particular non-linear problem. The advantages of DNS with SPH compared to often used coupled SPH-DEM approaches are the fully resolved solid-fluid interfaces and the here acting hydrodynamical forces.
Solid-solid contact and resulting interaction forces are included into the model by using a simplified Hertz-Mindlin contact model [4]. The model is applied on all solid particles representing the solid phase in the suspension. Thus, in case of contact, an additional particle force is added to the prescribed forces in the local momentum conservation equation.
We are aiming for a discussion about the validity of the implementation. Thus numerical investigations include simulations with fully elastic collisions with and without a surrounding solvent as well as free falling of a solid grain with and without a surrounding fluid.
To review the results of the approach, we finally discuss an example with multiple spherical solid grains in a single-phase fluid in different configurations as for example gravity or parallel flow. Resulting local particle properties as velocity and shear stresses are considered and compared to known analytical solutions. We focus on particle scale effects as for example the mobilization forces acting on a bed of solid grains and the resulting transport of single particles as well as the transformation of flow behavior, for example the evolution of shear flow, dependent on the number of suspended particles.

References

[1] J. A. Anderson and C. D. Lorenz, and A. Travesset. General purpose molecular dynamics simulations fully implemented on graphics processing units. Journal of Computational Physics, 227:5342–5359, 2008. doi:10.1017/S0022112067001375.
[2] R. A. Gingold and J. J. Monaghan. Smoothed particle hydrodynamics - Theory and application to non-spherical stars. Mon Not R Ast Soc, 181:375–389. 1977. doi:10.1093/mnras/181.3.375.
[3] J. Glaser and T. D. Nguyen and J. A. Anderson and P. Liu, F. Spiga and J. A. Millan and D. C. Morse and S. C. Glotzer. Strong scaling of general-purpose molecular dynamics simulations on GPUs. Comput Phys Com, 192:97–107, 2015. doi:10.1016/j.cpc.2015.02.028.
[4] R. D. Mindlin and H. Deresiewicz. Elastic spheres in contact under varying oblique forces. J Appl Mech, 20:
327–344. 1953.
[5] R. Sivanesapillai, H. Steeb, and A. Hartmaier. Transition of effective hydraulic properties from low to high

Reynolds number flow in porous media. Geophys Res Letters, 41:4920–4928, 2014. doi:10.1002/2014GL060232.

Acceptance of Terms and Conditions

Click here to agree

Primary author: Mrs KIJANSKI, Nadine (University Stuttgart)

Co-author: Prof. STEEB, Holger (University of Stuttgart)

Presenter: Mrs KIJANSKI, Nadine (University Stuttgart)

Session Classification: Parallel 10-B

Track Classification: MS 3.02: Fluid Interactions with Thin, Fibrous Porous Media