Coupled CFD-DEM simulation of particle-laden flows in slot die coating system with presence of free surfaces

Vajiheh Akbarzadeh* , Andrew N. Hrymak **

* Department of Chemical Engineering, McMaster University,

Hamilton, ON, Canada, akbarzv@mcmaster.ca

** Chemical and Biochemical Engineering, University of Western Ontario,

London, ON, Canada, ahrymak@uwo.ca

Key words: coupled CFD-DEM, Multiphase flow, parallel computing

Coupled CFD-DEM is employed for evaluation the motion of individual suspended particles near moving surfaces in a complex 3-D flow field, motivated by the flow of particle laden fluid in slot die coating system. The geometry of slot die coating system is complex with presence of moving web, free surfaces and suspended particles. Charge carbon black particles are suspended in ionic solution with vol. Fraction of 5%. Laminar flow field in a slot die coating geometry (Fig.1) that is fully coupled with motion of

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particles is simulated using a new multiphase solver compiled in parallel CFDEM open source code.
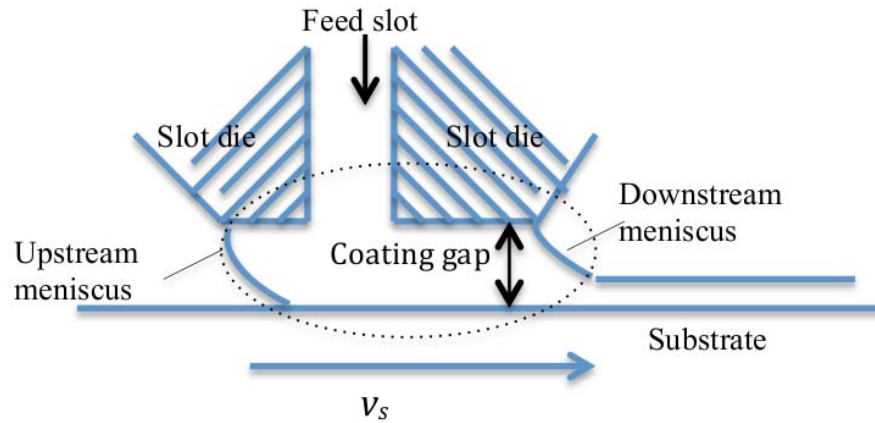

Figure 1. Slot die coating geometry

The geometry dimensions are in orders of 100 mm, where the particles have diameters as small as 100 μm.   Collision, colloidal, and hydrodynamic forces are taken into account in motion of particles. Collisions between particles with each other and the walls are assumed to be Hookean and soft-sphere. Particles interact with each other and the walls through DLVO forces, which include short range Wan der Waals attraction and long range electrostatic repulsion. Hydrodynamic forces are applied from the fluid (drag, lift, an buoyancy forces). Particles have densities of (1800 kg/m3) slightly higher than the fluid density (1000 kg/m3). In a numerical modeling [1] the flow of sub-micron particles in the viscous flow of a simplified slot die coating geometry was studied, where they did not consider the fully coupling of flow between particles and the fluid phase, and presence of free surfaces. In this work the effect of particles charge, density, and concentration is studied on flow field. Preliminary results show that particles concentrate in regions with lower velocities, and flow in the domain in clusters. This is consistent

with previous experimental observations of slot die coating system **[2]** . presence of a free surface affects the flow field and particle behavior.

References

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