Turbulent sediment transport through a horizontal pipe

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Slurries, i.e. dense suspensions of solids, are commonplace in process industry and usually transported through pipes under turbulent flow conditions. Dependent on the flow rate and sediment characteristics, the flow is either in the fixed-bed regime, the sliding-bed regime or the fully-suspended regime as illustrated in Fig. 1.
The complex nature of turbulent slurry pipe flow is not well understood such as for example the transition between flow regimes and the principal mechanisms and coherent structures by which turbulence is maintained. Our objective is therefore to gain fundamental insight in the flow physics, which is much needed for improving currently used prediction models for slurry pipe transport in practice [1].

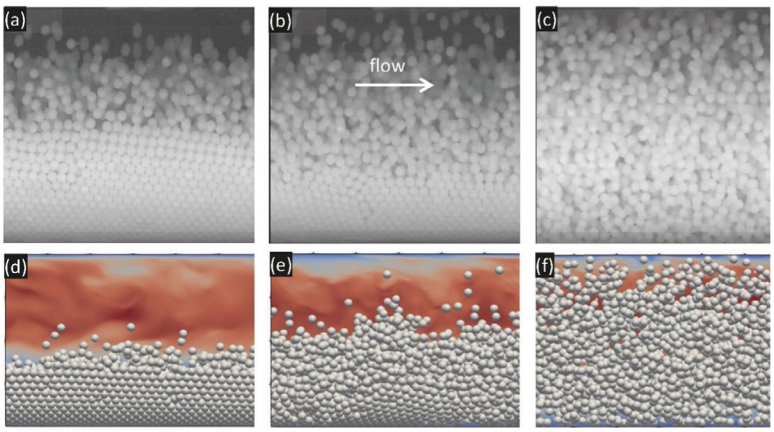

Figure 1: Experimental (top panels) and preliminary DNS results (bottom panels) of turbulent slurry pipe flow. The flow rate increases from left to right.

We have conducted Direct Numerical Simulations (DNS) and experiments of turbulent slurry pipe flow of a monodisperse suspension of 2mm-diameter polystyrene spheres in water in a 4cm-diameter pipe at a solid volume fraction of 20%. The DNS is based on an Immersed Boundary Method for the fluid/solid coupling [2] and equipped with a frictional soft-sphere collision model [3]. Preliminary DNS results are in qualitative agreement with the experiments as shown in Fig. 1.

References

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