NUMERICAL SIMULATION OF SLURRY FLOWS IN HETEROGENEOUS AND SALTATION REGIMES IN HORIZONTAL PIPELINES

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Introduction. In this work, the simulation of a two-phase liquid-particles flow is performed using an Eulerian-Eulerian model to predict the complex flow behavior where both particle concentration and particle velocity profile are shown and compared with experimental data. One of the main concerns during implementation of pipeline transportation of multiphase mixtures the is assurance of the flow, where the formation of particle fixed beds should be strongly avoided due to its disadvantageous and damaging effects on the flow, which mostly occur at the bottom sides of the pipeline walls.

Materials and methods. CFD has become a powerful tool to model fluid flows, heat and mass transfer, chemical reactions and related phenomena by solving the mathematical differential equations that govern the physics of these processes using numerical algorithms on a typically multi-processor or muti-core computer. Slurry flows are one of the most complex challenges to model using CFD techniques since the presence of particles inside a continuous phase of liquid, requires the consideration of particle-particle, particle-wall and particle-fluid-particle interactions. These mixture flows are typically considered as a two-phase flow. In general, two different categories of CFD models are used for modeling two-phase flow. The Eulerian-Lagrangian model solves equations of motion for each individual particle, considering particle-particle collisions and the forces acting on each individual particle, whereas Eulerian-Eulerian models solve equations of motion for each phase considering both of them as fully interpenetrating continua.

Results. The complexity of the analysis of slurry flows is associated to the large number of variables that influence these type of flows in pipelines; e.g., pipeline inclination, cross section shape, wall roughness, particle size, particle size distribution, particle density, particle shape, local solid concentration, fluid density, fluid velocity, fluid rheology and the properties of the fluid-particle interface. In this study, the Granular Kinetic Theory (GKT), is used to model the pseudo-viscosity of the particles thought as a continuum fluidized medium. Special attention is given to the effects caused by each of the three terms of the GKT viscosity (kinetic, collisional and frictional) inside the stress tensor of the solid phase (granular flow) to the particles concentration. These results show consistency and concordance with experimental data.

Conclusion. A CFD study using an Eulerian/Eulerian framework has been presented to model particle-liquid flows. The particles are treated as a continuum fluid medium with viscosity described according to the Granular Kinetic Theory. The predicting capability of the model is assessed under different flow regimes for mono-disperse and bi-disperse bulk particles injected in the inflow liquid-particle flow stream. The mixture velocity and bulk solid concentration present an excellent agreement with experimental data.

References.

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