Exit Velocity of a Sphere Falling in Narrow Tubes

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Understanding the hydrodynamic forces occurring during particle-particle collisions in viscous fluids furthers knowledge in areas such as industrial fluidized beds and bedload sediment transportation. A fluidized bed reactor can convert solid fuels such as biomass or coal into gas or other liquid fuels, providing a better environment for processes such as combustion, and resulting in less pollution and waste. Modeling the hydrodynamics of bedload sediment transport has applications in dredging shipping channels, building harbors, and predicting erosion. The particle-laden flows of commercial and geophysical significance are generally turbulent. A Direct Numerical Simulation collision model can account for the hydrodynamic forces in a turbulent particle-laden flow, but it is very expensive, exceeding the capacity of super-computers. One method to reduce the computational cost is to use theoretical equations for the forces occurring when the gap between two colliding particles is very small. To determine the best laboratory setup for experiments to validate these theoretical equations, a method for controlling particle trajectories and minimizing particle rotation was tested. Two spheres of different diameters were released through tubes of various inner diameters (ID) submerged in a tank of water. The exit and terminal falling velocities were tracked with an algorithm. Water, a fluid with low viscosity, was found to be unsuitable for collision experiments. It is recommended that a fluid with a higher viscosity, such as glycerol, be used for future particle collision experiments.