5 Conclusions

The intention of this work is to extend Lage's 2D formulation (21) to 3D. It does it, however the software is much slower. In 2D, the problem is much smaller compared to 3D. The size of the Jacobian matrix in 3D is one of the bottlenecks.

Our main objectives were accomplished. To formulate and implement the flow of one fluid phase in 3D and also the 3D flow with particles. The validation of the non particulate flow was done, but we could not run the problem for Reynolds numbers higher than 60. The Newton Method would not converge for higher values. This made us think about the radius of convergence of the Newton Method. The 3D problem is more unstable than the 2D in terms of convergence. Mainly due to the ill-conditioning the Jacobian matrix.

The implementation of the particulate flow was, by far, the hardest part. Using Fictitious Domain Method we could save time in mesh generation, however it brought up a new milestone: to solve a larger system of equations. Just to use this method, one must create the $\overrightarrow{\lambda}$ field. It almost doubles the amount of unknowns as the reader may have noticed.

This work may be parallelized in the Jacobian assembly. This was not done in this M.Sc. dissertation as it was not as costly as the solver. In future works, we strongly suggest the search for better solvers and parallelization of the code. We recommend the seek for an iterative solver, as the band of the Jacobian matrix is very high. As the Newton Method does not always converge, another method can be interesting to study flows with higher velocities.

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