A new version of the PFEM for the free-surface and multi-fluid flows problems.

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ABSTRACT

In this paper we present a new version of the Particle Finite Element Method (PFEM) applied to free surface and multi-fluid flows problems. In the previous works, the PFEM was applied to this kind of problems taking advantage of the fact that Lagrangian methods are specially well suited for tracking free surfaces and interfaces[1]. Note that in the Lagrangian approaches the problem becomes separated into a geometrical part(tracking the motion of the nodes) and a physical part(calculating how the flow variables evolve in time at each node). The numerical schemes used in the previous versions of PFEM, were able to deal with free-surface and multi-fluid flows. However its main disadvantage consisted in the need of remeshing at every time step due the mesh distortion. This increased the computational cost of the method particularly due to the fact that the time step size had to be small enough in order to avoid the element inversion (which is equivalent to the non-negativity of the Jacobian). In spite of using implicit time integration schemes, this condition required severe time step reduction.

The method presented here intends to avoid the limit on the time step due to execesive deformations of the mesh. For this propose the new position of the particles is evaluated using the X-IVS method(has been already tested on fixed grids)[2]. This approach allows particles to surpass several elements independent of the spatial discretization. Once the nodes obtain their final position, a new mesh is generated in order to solve the physical part of the problem in the classical PFEM manner. The paper concludes with challenging examples.

REFERENCES

[1] S. Idelsohn, M. Mier-Torrecilla, N. Nigro and E. Oñate, On the analysis of heterogeneous fluids with jumps in the viscosity using discontinuous pressure field. Comput. Mech., (2010).

[2] S. Idelsohn, N. Nigro, A. Limache and E. Oñate, “Large time-step explicit integration method for solving problems with dominant convection”, Comput. Methods Appl.Mech.Engrg.,(2012).