The Particle Finite Element Method (PFEM) in thermo-mechanical problems

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ABSTRACT

The research in the modelling of industrial and manufacturing processes using the Particle Finite Element Method (PFEM) is presented in this work. It is focussed in problems where the material experiences large deformations due to an external mechanical action and/or an external thermal action. Most of the materials employed in industrial processes are metals with a constitutive behaviour governed by its thermal and mechanical properties. Therefore the work focusses in the treatment of the thermo-plasticity within the PFEM and the incompressibility in fluids and metals with plastic deformation.

Lagrangian mixed displacement-pressure and velocity-pressure formulations are proposed for the modelling of forging, extrusion, cutting and melting problems. Some industrial processes require accounting for the thermo-mechanical contact interaction between solids while others require the modelling of the fluid-structure interaction. The features related to the Lagrangian description of the movement that characterizes the PFEM allow to adapt naturally the domain analysed to the requirements of the manufacturing processes.

Some literature benchmarks have been used to check the accuracy of the method. More realistic problems are presented to show the capabilities of the method and the possible applications of the PFEM for modelling thermo-mechanical problems related to the industry.

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