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A PARALLEL FEM-DEM APPROACH FOR ANALYSIS OF CUTTINGS TRANSPORT IN WELLBORES

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Cuttings transport (hole-cleaning) process is a challenging issue associated with efficiency of wellbore drilling process. Cuttings transport process involves complex interaction between cuttings, drill pipe, wellbore and drilling mud. To understand the cuttings transport in a wellbore the combination of advanced computational techniques such as the discrete element method (DEM) and the finite element methods (FEM) are essential.

In this work we present recent advances in the coupling of the DEM and the FEM for modelling and analyzing the transport of the cuttings in critical sections of a wellbore.

Cuttings are modelled as discrete spherical particles with the DEM. These particles are embedded in a finite element mesh of linear tetrahedra discretizing the domain containing the liquid inside the wellbore. The equations for a non-Newtonian fluid are solved with a stabilized FEM and a mixed velocity-pressure formulation. The interaction between the particles and the fluid is modelled via an immersed technology.

The solution of the resulting FEM-DEM coupled equations has been implemented to work in parallel computers compatible with both OpenMP and MPI architectures. The parallel computing implementation has been carried out within the Kratos multiphysics environment developed at CIMNE [1]. The computational efficiency, accuracy and scalability of the resulting parallel DEM-FEM code has been validated in the study of the motion of several hundred thousand particles in cylindrical pipes of a few hundred meters containing mud.

The paper describes the FEM-DEM approach developed and several applications of the resulting parallel code to the transport of drill-cuttings in annuli of different lengths and inclinations.

REFERENCES

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