The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

A Scalable Block Preconditioner for Coupled Thermo-Hydro-Mechanics Problems

Ana Ordonez[1], Nicolas Tardieu[2*], Carola Kruse[3] and Daniel Ruiz[4]

[1] EDF/R&D, IMSIA UMR EDF-CNRS-CEA-ENSTA 9219, France,
ana-clara.ordonez-egas@edf.fr
[2] EDF/R&D, IMSIA UMR EDF-CNRS-CEA-ENSTA 9219, France,
nicolas.tardieu@edf.fr
[3] Cerfacs, Toulouse, France, carola.kruse@cerfacs.fr
[4] INP, Toulouse, France, daniel.ruiz@toulouse-inp.f

Key Words: *Preconditioning, Multiphysics, Biot's Problem, Finite Elements, HPC*

We are interested in the modelling of coupled thermo-hydro-mechanical (THM) problems that describe the behaviour of a soil in which a weakly compressible fluid evolves. The soil is modelled as a porous medium and the fluid is subjected to various mechanical, thermal and hydraulic loadings [1]. This model is used for the evaluation of the THM impact of high-level activity radioactive waste exothermicity within a deep geological disposal facility build in a clay-based host rock. The parallel and scalable solution of the linearized equation system is the objective of this work.

Academic work has been carried out on models involving solid mechanics and hydraulics [2] [3] or involving THM but with no special concern on linear solvers [4]. In this talk, we shall present the definition of a block preconditioner for the fully coupled THM equations based on parameter-robust preconditioners [5]. A block Gauss-Seidel preconditioner is set up, in which a multigrid method is used to precondition each block. The method is implemented in code_aster, the massively parallel open source general purpose finite element solver developed at EDF R&D [6].

Numerical results for linear THM tests reflect the good performance of the proposed preconditioner that shows to be weakly scalable until more than 2000 cores and more than 1 billion degrees of freedom. Furthermore, the iteration count of the iterative solver is independent of the mesh size and robust parameter-wise.

REFERENCES

[1] O. Coussy. Poromechanics, *John Wiley & Sons*, 2004.
[2] J.B. Haga, H. P. Langtangen and H. Osnes. Efficient block preconditioners for the coupled equations of pressure and deformation in highly discontinuous media, *Int. J. Numer. Anal. Meth. Geomech.*, 2011.
[3] N. Castelletto, H. A. Tchelepi and J. A. White. Block-partitioned solvers for coupled poromechanics: A unified framework, *Computer Methods in Applied Mechanics and Engineering*, 2016.
[4] M. Cacace and A. B. Jacquey. Flexible parallel implicit modelling of coupled thermal–hydraulic–mechanical processes in fractured rocks, *Solid Earth*, 2017.
[5] J. Lee, K.-A. Mardal and R. Winther. Parameter-robust discretization and preconditioning of Biot's consolidation model, *SIAM Journal on Scientific Computing*, 2017.
[6] www.code_aster.org