InterFrost spread sheet for participant's code information

File is code related, if you use more than one code please provide one file per code …

Aims: 1°) provide pieces of information that will probably be essential to understand possible differences in the results or performances, 2°) provide info that will be essential to improve the codes from a "best practice" perspective.

Name of the code

FEFLOW + FTM

Participant laboratory

A) Technische Universität Darmstadt; Institute of Applied Geosciences; Department of Geothermal Science and Technology
B) Technische Universität Darmstadt; Darmstadt Graduate School of Excellence Energy Science and Engineering

Participant name(s)

A) Hauke Anbergen
B) Wolfram Rühaak

Is the code used or developed by the team?

FEFLOW is commercial (DHI-WASY) the used plug-in is developed by us

Numerical scheme, order of the numerical scheme

FEFLOW uses the FEM

Time discretization strategy (fixed time steps / if adaptative, provide further information)

automatic time-step-contro; first order accurate (Forward Euler/Backward Euler)

Spatial discretization

- 2D / 3D
- external/internal mesh generator
- structured or unstructured grids, what kind of polyhedral mesh (tetra ? hexa ?)

2D; triangle mesh generator (Shewchuk, 2005); triangles; unstructured mesh; automatic mesh refinement is used (FEFLOW 6.012), mesh refinement is applied for elements with the freezing range (0 °C - -1 °C), minimum element area is set to $5 \cdot 10^{-6}$ m²

Treatment of non-linearities?

- Method used (Newton, Picard …)
- Convergence criterion expression and threshold value

Newton (heat-transport); error tolerance (Euclidian L2 integral (RMS) norm) $1 \cdot 10^{-3}$

Resolution of linear systems

- Linear solvers
- pre-conditioner

SAMG – Symmetric Algebraic Multi Grid Solver (Fraunhofer SCAI) – Termination Criterion is 1E-8

How is the TH coupling managed?

- Sequential resolution / iterative process / simultaneous inversion?

Sequential; Newton Coupling (maximum 3 iterations per time-step)

List of available boundary conditions options in the code

all commonly used (see below)

Sources of averaging (under relaxation, spatial averaging on variables …)

?

Constitutive laws implemented

- Saturation curve
- Permeability as a function of temperature

different freeze-thaw approaches exist (see below); here the INTERFROST settings for TH3 are applied

What kind of averaging for the properties (depending on water, ice, bulk parameters)?

linear

Is (massively)parallel resolution implemented?

- Which approach (domain decomposition, loop decomposition).
- Indicative number of processors

FEFLOW uses a multi-thread approach; the SAMG solver is OpenMP parallelized (shared memory); here 12 cores were used

Papers / reports / web siteproviding (further) information

doi: 10.1139/cgj-2014-0177 (Anbergen, Rühaak, Frank, Sass, 2015. Numerical simulation of a freeze-thaw-testing procedure for borehole heat exchanger grouts. Canadian Geotechnical Journal)

doi: 10.1007/978-3-642-38739-5 (Diersch, FEFLOW, Springer, 2014)

http://www.feflow.info/html/help/default.htm?turl=HTMLDocuments%2Freference%2Fparameters%2Fmaterialproperties%2Fflow%2Finoutflow_on_topbottom.htm

Further pieces of information?