COMPUTER MODELLING GROUP LTD.

What's New in GEM

GEM

Compositional & Unconventional Simulator

Version 2022.10

cmgl.ca

#FutureOfSimulation

Simulator Changes

Temperature Dependent Compaction and Dilation Tables

Temperature is introduced as an independent variable in addition to pressure in compaction and dilation modeling. This is intended to model the effect of temperature variation during compaction and dilation, for instance to study potential thermal fracturing in reservoirs with colder/warmer fluid injection.

See template data sets *gmsmo150 and gmsmo161.*

New Imbibition Capillary Pressure Scaling Option

In addition to the existing full-range saturation scaling method (*FULLRANGE) for reading the boundary imbibition curve in oil-water capillary pressure hysteresis, two new methods (*SORMIX and *COMBINED) are implemented. The new options provide flexibility in controlling the curvature of formed scanning curves.

Please refer to the manual page for *PCOWI_SCALE and template data sets *gmsmo162 and gmsmo163.*

Setting up of the initial Trapped Oil Saturation (*SORM)

A new optional sub-keyword *RELAX has been added to *SORM allowing trapped oil data to be modified so as not to exceed specified residual oil saturations from the drainage relative permeability tables or from the user input grid block residual oil saturations.

Please refer to the manual page for *SORM and template data set *gmsmo164.*

GEM-Surface Network Modeling – IPR Correction

An algorithm is added for IPR correction based on average pressure in the well drainage area. Pressure in the drainage area, PDRAIN is written out to the communication file for models using outboard protocol. The surface networks may use PDRAIN to correct the IPR.

For GEM-GAP link, IPR correction based on drainage area pressure is done within GEM itself with command-line option *-ipr_cor*. Use this feature for models where well rates show oscillatory behavior.

New Option for Heat-Loss Calculations

An optional heat-loss model is now available through keyword *HEAT-LOSS *VW-S, which is a modification of traditional Vinsome-Westerveld (*VW) model. We found the heat-loss calculated by the two models to be in close agreement in most cases, but in certain dual-continua models the new *VW-S method was found to be more robust.

Please refer to manual page for *HEAT-LOSS and template data set *gmthr001*.

Aqueous Phase Density

The aqueous density output for sector is now made consistent with the grid-block based output. Additionally, aqueous phase density calculations have been improved for non-isothermal cases.

Surface Complexation

The convergence criterion for surface complexation equations has been simplified and a critical fix has been made to avoid potential failure during surface complexation modeling.

Chemical Equilibrium and Mineral Reactions

The upper limit of damping factors for Chemical Equilibrium and TST Mineral Reactions has been increased to allow validation with the equivalent Mineral Equilibrium Reactions.

Outboard Scanning for CMG Python Editor

GEM now supports scanning of group, sector, and well-completion layer information from the data file for making it available to the CMG's Python Editor.

Output Enhancements

Additional Geomechanics Items including those Related to Fault Modeling

Thirty geomechanics items including those related to fault modeling option have been added that can now be output via *OUTSRF *GRID, and *OUTPRN *GRID. Twenty-seven of these items are also available through *OUTSRF *SPECIAL.

Please refer to manual pages and template data sets *gmgmc90-gmgmc092.*

Geomechanics Changes

Fault Reactivation Modeling

Fault reactivation modeling option is now available in GEM. The feature is used to trigger flow across or along a fault by using geomechanics. Two options are available:

(a) Modeling fault by changing fault transmissibility, TRANSF, when geomechanical slip tendency exceeds a critical value, such that fluid flow across the fault could occur.

(b) Modeling fault by representing the fault plane with thin grid blocks and computing fluid flow within and through them. These fault blocks have all the flow properties like any other reservoir grid block, so the fluid can flow through them when computed slip tendency between the fault grid block and the adjacent reservoir grid block exceeds a user specified threshold. The main advantage of using the fault grid blocks is that fluid can flow to the other over/underlying zones along the fault

Please refer to manual pages and template data sets *gmgmc90-92*.

Grid Section Changes

Planar Fracture Template Input for Propped and Unpropped Zone

The new keywords (*PROPPED_BWHLEN, *PROPPED_HEIGHTUP, *PROPPED_HEIGHTDOWN) are introduced to specify a propped- and unpropped-zone inside the fracture zone.

The two new keywords (*PROP, *UNPROP) are used to assign properties to propped and unpropped zone, respectively.

The existing keyword *ELLIPTICAL_DISTRIBUTION was previously applied only to the permeability distribution. Now it will also be applied to other spatial property as well if propped zone is defined.

To use the propped/unpropped feature, *PROPPED_BWHLEN must be non-zero and either *PROPPED_HEIGHTUP or *PROPPED_HEIGHTDOWN must also be non-zero. If *ELLIPTICAL_DISTRIBUTION is *ON, both *PROPPED_HEIGHTUP and *PROPPED_HEIGHTDOWN must be non-zero.

Cutoff and Modification of Property Distribution Data

The *CUTOFF option after *PDD specifies a minimum conductivity below which the conductivity values will be filtered out. The *MOD option after *PDD modifies the original PDD data. The new keyword *PDD_NAME in a Planar Fracture Template is to associate a PDD with planar fractures created by the template. The PDD names support wildcarding (? and *) so that the CUTOFF / MOD option can be applied to a group of PDDs. The fracture size (i.e., bi-wing lengths and heights) will be determined by the associated PDD and the cutoff operation will be applied to it.

New Option *FG for *LAYERSUP/*LAYERSDOWN

A new option *FG is added to bring consistency in treatment for the fracture in the local grid refinement.

Cut-off for Discrete Fracture Segment Volume

New keyword *DFSCUTOFF *vol* nulls out discrete fracture grid blocks whose volume is less than *vol*. The keyword is like *PVCUTOFF but applies to discrete fracture grid-blocks. It can be useful in improving the simulator performance by nulling-out small volume discrete fracture segments in the model.

Improvement in Array Reading Filters

A replacement value can be given after *MINVAL / *MAXVAL. The new syntax is *MINVAL / *MAXVAL *val*1 *val*2 (while the old syntax is *MINVAL / *MAXVAL *val*1). If the candidate value is beyond the threshold *val*1 and the second value *val*2 has been specified, the candidate value will be replaced by *val*2 alternatively.

Managing of Connection Array Working Space

The algorithm is improved to manage connection array space for handling large number of grid-blocks especially for models using parallel processing.

Well Management Changes

New Constraints for Group Control

New constraints for group production control, *BHO, *BHG and *BHW, have been added for *GCONP *MAX and *GCONP *GTARGET. These controls were previously available only for injection groups.

Handle Models with a Large Number of Triggers

The upper limit of triggers in a dataset has been relaxed to allow use of a large number of triggers, if necessary.

Template Dataset Changes

The following Table lists new or modified template data files.

GMGRO037	Demonstrate use of keyword *PINCHVGAP *SKIP
GMGMC090	Fault Reactivation through fault grid blocks -- dual continua Case
GMGMC090	Fault Reactivation Modeling fault grid blocks -- single porosity Case
GMGMC092	Fault Reactivation Modeling without fault grid blocks
GMSMO160	Use of Temperature Dependent Rock Compaction Tables
GMSMO161	Use of Temperature Dependent Rock Dilation Tables
GMSMO162	Capillary Pressure Scaling Option *PCOWI_SCALE *COMBINED
GMSMO163	Capillary Pressure Scaling Option *PCOWI_SCALE *SORMIX
GMSMO164	Use of *SORM *RELAX in a 2-D Miscible Flood model
GMTHR001	Use *VW-S Model for Heat-Loss Calculation
GMTHR012	Model with varying thermal properties

Miscellaneous Changes / Bug Fixes

Bug-Fixes/Improvements

- Fixed assignment of *BG without *FZ or *NFZ.
- Fixed reading of DFN data in FAB format.
- Fixed parallel execution of models with tracers that use total variation diminishing (TVD) scheme.
- Improved Log (saturation Index) plotting.
- Fixed pressure entries in IPR tables for wells with backflow.
- Fixed initialization of component array being passed to surface network.
- Fixed thermal conduction in models with variable thermal conductivity.
- Fixed an error in connectivity of grid blocks through pinched out blocks.

Data Incompatibilities with Previous Versions of GEM

Restarts generated from previous versions are not compatible with this version of GEM due to additional reading/writing of data.