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MUFITS: A Universal Reservoir Simulator for Numerical Modelling, History Matching and Optimization of Multicomponent Flows in Porous Media

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The recent development of the academic reservoir simulator MUFITS aims its transformation to a universal software package that allows for (a) numerical modelling of non-isothermal multicomponent flows in porous media under wide range of pressures and temperatures, including under critical thermodynamic conditions, (b) history matching of non-isothermal reservoir models, and (c) optimization of thermohydrodynamic processes in porous media.

The extended simulator capabilities for modelling of multicomponent flows includes a new fluid properties module for compositional and thermal reservoir simulations using different cubic equations of state (e.g. Peng-Robinson EoS). An extended library of hydrocarbons, carbon dioxide, nitrogen, water, and other components is built into the simulator, and additional components can be characterized and loaded into the library. An arbitrary number of components can be used in particular simulation. In order to simplify the module usage, the corresponding input data are made compatible with the petroleum industry standards. Unlike many other codes, MUFITS allows for compositional modelling of non-isothermal flows of fluids which properties are predicted with a cubic EoS.

For improved history matching and optimization the simulator is supplied with an external Simulation Control Unit (SCU), which automatically changes certain parameters of the digital reservoir model and reads back the results of the simulations. An external control loop is implemented in SCU. At each iteration of the loop non-isothermal flow in a porous medium is simulated, and the simulation results are used for calculation of the objective function being minimized. In order to accelerate the history matching and optimization, the SCU can simultaneously (in parallel) run several reservoir simulations. The simulator is supplied with the build-in capabilities for the calculation of gravity changes and surface uplift/subsidence which measurements can also be automatically used in history matching.

We complement the new developments with several application examples related to gas condensate fields exploration, carbon dioxide injection in depleted oil reservoirs and gas storages, and natural flows in deep geothermal systems.

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