6-month internship offer, 2013

Development of a 3D code for the non-Newtonian pressure equation

Total

Total is an international Energy Company operating in 130 countries with nearly 100,000 employees. The Company is a global oil and gas producer and supplier, covering all aspects of the petroleum industry: oil and natural gas exploration and production, renewable energy development, refining, distribution and trading. Total is also a major player in the petrochemical industry.
The 'New Reservoir Simulator' Project offers to host an internship in Total Exploration and Production main Research & Technical Center in Pau, Southern France, to work on the numerics of non-Newtonian flows in porous media.

Position of the problem

Oil companies use reservoir simulators to simulate the flow of gas, oil and water in underground porous media (reservoirs), and their link to surface facilities through injectors and producer wells. Reservoir fluids naturally count up to thousands of components, in addition to additives injected for the purpose of enhancing oil recovery (alcalines, surfactants, polymers, flue gas, …).

Water-polymer solutions typically exhibit non-Newtonian behavior, i.e. their viscosity depends on their shear-rate, whose local average in a porous medium is proportional to the superficial velocity. This causes the solution mobility to be velocity-dependent, inducing complications in the numerical discretizations of the flow equations. In particular, the stencil required for fully implicit schemes is larger than for the Newtonian case (in 3D, at least a 19pt stencil vs a 7pt stencil). To circumvent this problem, many chemical flooding simulators use a semi-implicit mobility treatment.

Attempted internship roadmap

We have developed a prototype Matlab code solving the fully implicit non-Newtonian monophasic flow equation in 1D and 2D, using different types of discretization. The first purpose of this internship will either be to port the code to fortran, or to optimize it in Matlab as well as extend it to 3D.

Depending on the remaining time, the intern will use the developed code to perform a selection of tests and comparisons with existing commercial or academic simulators.

Required qualifications and skills

1. MSc or PhD student in physics or mathematics, with good knowledge of
   - Numerical analysis (in particular finite volumes) ;
   - Programming (fortran, as well as a scripting language such as Matlab).

2. Prior knowledge of porous media flows is not required, but would be a plus.
3. Fluent in English.

Contact

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