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Thermogravitational segregation in a North Sea petroleum reservoir

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In many petroleum reservoirs, the fluid properties are not the same through the reservoir thickness. Variation of the composition, i.e. compositional grading, can affect reserve estimation, production and EOR strategies. Apart from gravity, the geothermal gradient may also contribute to the fluid distribution. Thermodiffusion is the governing phenomenon determining contribution of the geothermal gradient.

Compositional grading in reservoirs at initial state can be obtained from data analysis, but in many cases, the quality of the data is poor and the number of representative samples from a given reservoir is scarce. Therefore, non-equilibrium thermodynamic models are used for the calculation of the compositional gradients. This computation provides valuable information on the connectivity between the different sampling points [1].

In order to determine the variations in pressure and composition with depth and to be able to indicate if/where a gas-oil contact exists, we have developed a model based on the principles of irreversible thermodynamics, within the approach to thermodiffusion in porous media proposed by Montel et al. [2]. Based on the relationships where pressure, chemical potentials, and thermal gradient are linked, the distribution of hydrocarbons in a petroleum reservoir is described. A computational algorithm accounting for non-ideality of the mixture, characterization and phase transitions has been developed. We validate our model and calculation procedure for the compositional grading by comparison with the case studies reported in the literature for a North Sea reservoir, and with sample component distributions produced by application of the molecular dynamics.

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