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Modeling of Gas Migration in High-Pressure–High-Temperature Fields

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Abstract : Gas migration from pressurized formations is a problem reported in the oil and gas industry. This means increased risks for drilling, production, well integrity, and hydrocarbon escape. Different processes can contribute to the development of pressurized formations, particularly in High-Pressure–High-Temperature (HPHT) gas fields. Over geological time-scales, the different formations of those fields have maintained and/or developed abnormal pressures owing to low permeability and the presence of an impermeable seal. However, if this seal is broken, large volumes of gas could migrate into other less pressurized formations. Three main mechanisms for gas migration have been identified in the literature –molecular diffusion, continuous-phase flow, and continuous-phase flow coupled with mechanical effects. In relation to the latter, gas migration can occur as a consequence of the mechanical effects triggered by reservoir depletion. The compaction of the reservoir can redistribute the in-situ stresses sufficiently to induce deformations that may increase the permeability of rocks and lead to fracture processes or reactivate nearby faults. The understanding of gas flow through discontinuities is still under development. However, some models based on porosity changes and fracture aperture have been developed in order to obtain enhanced permeabilities in numerical simulations. In this work, a simple relationship to integrate fluid flow through rock matrix and discontinuities has been implemented in a fully thermo-hydro-mechanical simulator developed in-house. Numerical simulations of hydrocarbon production in an HPHT field were carried out. Results suggest that rock permeability can be considerably affected by the deformation of the field, creating preferential flow paths for the transport of large volumes of gas.

Keywords : gas migration, pressurized formations, fractured rocks, numerical modeling
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