Modeling of fault reactivation through uncoupled and fully coupled HM models using zero-thickness interface elements

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ABSTRACT

The interaction between fluid flow and mechanical deformation in fault zones can lead to processes of fault reactivation, triggering potential geomechanical problems such as seismicity, well collapse, fluid migration to shallower layers and aggravated surface subsidence. During the production phase, the stress state near a geological fault is modified by the fluid injection/production, which may compromise the integrity of initially sealed faults. Different numerical approaches have been used to forecast phenomena of opening/reactivation of the geological faults. Focusing on the Finite Element Method, two main approaches have been considered. While some represent the faults by damage regions through continuum elements, others try to represent the faults in a discrete way through zero-thickness interface elements. The first approach is easier in terms of implementation because it only requieres the use of different properties in damage zones. However, the mesh in such regions must be well discretized to represent the fault behavior. Unfortunatelly, damage regions are negligible compared to field scales. In such situations, zero-thickness interface elements are more appropriate. Furthermore, such approach can include the modeling of large fault planes and intersections among them. Simulations with interface elements for analyses of fault reactivation have been presented in previous studies considering uncoupled strategies. On the other hand, fully coupled hydro-mechanical simulations considering such approach are not common due to several computational challenges. Thus, studies taking into account comparisons between uncoupled and fully coupled strategies are limited. This paper foccus on the modeling of fault reactivation phenomenon considering uncoupled and fully coupled solution strategies. For such purpose, interface and solid elements with mechanical and hydraulic constitutive relationships were implemented into an in-house simulator. Numerical simulations of hydrocarbon production into a compartmentalized reservoir were performed and compared with those obtained through uncoupled strategies. According to the results, the later lead to lower pressure gradients along the fault planes. Consequently, fault reactivation and fluid migration can be underestimated through uncoupled simulations.

REFERENCES

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