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Coupled Fluid Flow and Geomechanics with Continuum Damage Mechanics in Dual-Porosity Modeling of Fractured Reservoirs

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The purpose of this work is to build a coupled geomechanics-flow model to accurately simulate the in-situ stress and fluid flow in fractured reservoir. The model is developed by iteratively coupling a geomechanics model that uses the Continuum Damage Mechanics as its basis to investigate relationships between fracture dynamic change and pore pressure vary. The coupled model also reveals some important coupling effects between stress and fluid flow.

In-situ stress condition is instable after hydraulic fracturing, and fractures are highly sensitive to the change of in-situ stress. Oil production causes the decrease of pore pressure and then leads to the change in subsurface stress. Re-open or closure of these fractures bears significant influence on the water-oil flow process. To evaluated fracture's role during production, a poro-elastoplastic damage model is introduced, and a numerical solution for the distribution of continuum damage variables is obtained by using the finite element method (FEM).Volumetric density and conductivity of fractures are related with a set of damage variables. Therefore, the stress sensitivity of fractures is quantified and modeled.

In order to avoid instability and inefficiency of numerical solution, a fully implicit and sequential iterative algorithm is used in the coupled geomechanics-flow simulation. A 3D model involving water-oil flow and fracture deformation is built to verify the coupled geomechanics-flow model and illustrate the nature of flow in a dynamic fractured formation. Result is compared to that of a traditional model that not considers the geomechanical coupling effect. The change of fractures permeability with time is also calculated. Result suggests that fractures closure, caused by in-situ stress change during production, makes a significant difference in production rate. Eventually, this coupled model with continuum damage mechanics could improve the forecast accuracy for oil production.

References

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Primary author: Mr CAI, Xin (China University of Petroleum)

Co-authors: Prof. LIU, Wei (China University of Petroleum); Prof. SHEN, Xinpu (China University of Petroleum)

Presenter: Mr CAI, Xin (China University of Petroleum)

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