

Initiation and propagation of wormhole in unconsolidated rock matrix induced by long-term water injection

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Abstract

Water injection and well washing are frequently-used operations for injection wells to maintain reservoir pressure. Cavity or wormhole can form in some unconsolidated and erosional formation after long-term injection. This may result in disastrous safety problems such as wellbore collapse. To describe the problem, a multi-physics coupling model was built. Erosion was coupled with geomechanics and hydromechanics through velocity and porosity. By constructing a reservoir model with stochastic and inhomogeneous porosity we found that the initial porosity plays an important role in the geometry and evolution direction of wormhole. Then we studied the effects of parameters such as flow flux, erosion coefficient and pore pressure on the erosion rate and wormhole area. Results show that the wormhole growth rate is dominated by the flow velocity and these parameters can only influence the area of wormhole. The technology of multi perforations in a plane is a new effective method and has been validated in the JiLin Oilfield of China. Thus, we studied the wellbore with multi-perforations to investigate possible interactions between perforations due to Darcy flow. This work provided a new method to predict wormhole of unconsolidated rock. The results can enhance the understanding of wormhole initiation and propagation and provide an insight to guide the design of perforation pattern.

Keywords: Water injection; Wormhole; Erosion; Multi-physics coupling; Finite element simulation