Matrix acidizing analysis in fractured carbonate formations by using UPNM

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Abstract

Carbonate reservoirs are always treated with matrix acidizing technique after well drilling, completion or production for a period of time. This operation aims to dissolve damage and create dominate wormholes with high conductivity by injecting reactive (acid) fluids into formations. The flow of oil and gas to the wellbore would finally be facilitated. Numerous works have been carried out to simulate this process in continuous carbonate rocks, and several 3D models are proposed to quantitatively evaluate the effects of acidizing treatment by analyzing different engineering parameters. However, carbonate formations are characterized with porous media which contains not only matrix but also fractures. The fracture based acidizing modeling has not been carried out in literature. Therefore, The 3D Unified Pipe Network Method (UPNM) is presented in this study to numerically simulate the acidizing process with HCl in fractured carbonate rock. The fractures and porous media are conceptualized by the equivalence of connected fracture pipes and matrix pipes. This simplification facilitates the modeling of Hydraulic-Chemical (HC) coupled process in fractured media. Meanwhile, UPNM is combined with two-scale continuum model (Darcy scale model and Pore scale model) to describe the acid fluid flows and wormhole development in carbonate rock. The verification of this numerical method is benchmarked against available experiments in literature. And the sensitivity analysis of the dissolution process in continuum porous media is performed to the dissolution rate constant, acid injection rate, rock heterogeneity and rock intrinsic permeability. Then, a fracture with changing geometry and size is considered in the modeling. The influence of its properties (such as dip, strike and conductance) on the wormhole propagation and the amount of reaction fluid per pore volume required to reach breakthrough (PVBT) is analyzed. Finally, the optimal injecting parameters are obtained in matrix acidizing of fractured carbonate rock. This numerical analysis would be employed in the field case with fractured carbonate reservoir to achieve successful matrix treatment.

Keywords: Matrix acidizing, UPNM, Fractured carbonate reservoir, 3D simulation, Two-scale continuum model