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An Efficient Numerical simulation of Reactive Flow in Fractured Vuggy Carbonate Reservoirs Considering Hydro-Mechanical coupling effects

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Fractured vuggy carbonate reservoirs are one of the most important reserves in the world, which hold great importance for increasing reserves and production. However, fractured vuggy reservoir has greatly different reservoir space and flow patterns challenging low recovery. Three types of reservoir space, including matrix pores, fractures, and vugs, coexist with strong heterogeneity, and the spatial distribution scale varies from millimeter to the meter. Acidizing is a vital stimulation technique to boost production in deep fractured vuggy carbonate reservoirs since it can effectively enhance the connectivity of fractures and vugs. The real-time dynamic alterations in the volume of matrix pores, fractures, and vugs during acidification, coupled with changes in reservoir in-situ stress, signifies a multi-field coupled problem. Currently, research on hydrological-mechanical coupling processes throughout reactive flow in porous media is restricted to single-pore and fracture models, with little consideration given to the influence of pore, fracture, and vug deformation on reactive flow. This paper puts forth a set of mathematical models and numerical simulation techniques for analyzing reactive flow in fractured vuggy carbonate reservoirs while accounting for hydro-mechanical coupling effects. Validation of the model and method is achieved through a numerical example. The results show that fractures and vugs are leading in acid flow through the medium during the acidification of fractured vuggy media. Under stress conditions, fracture closure exhibits the most substantial impact on acid flow in the fracture, followed by vug deformation. Acid fluid preferentially flows via dominant channels connected by fractures and vugs, dissolving the rock.

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