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PROCEEDINGS

Numerical Simulation of Proppant Migration in the Non-Uniform Temperature Field during Supercritical CO_2 Fracturing

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ABSTRACT

The temperature gradient between the geological formation and the injected supercritical CO_2 (Sc-CO_2) initiates heat transfer processes, leading to a non-uniform temperature field within the fracture. This spatial thermal variation induces fluctuations in the density and viscosity of Sc-CO_2. Moreover, the non-uniform density distribution of Sc-CO_2 leads to varying degrees of volume expansion or shrinkage, influencing fluid flow velocities within the fractures. This study integrates heat transfer and fluid leak-off models into the Eulerian-Eulerian two-fluid framework to systematically investigate the collective impacts of Sc-CO_2's density, viscosity, and density-induced volumetric alterations on the proppant transport process under varied pumping conditions. The initial sensitivity analysis discerned that fluid viscosity, density, and velocity significantly influenced the formation of the proppant pack, a process intricately linked to the non-uniform temperature distribution within the fracture. The fracture's temperature profile was delineated into four distinct zones, with Zone B emerging as particularly influential on proppant migration due to pronounced temperature fluctuations resulting from ongoing heat transfer processes. Furthermore, the findings underscored the complex interplay between Sc-CO_2's volumetric expansion/shrinkage and its concurrent density and viscosity alterations. The predominance of either effect and the direction of their impact hinged upon specific pumping conditions. In summary, increased formation pressure, higher formation temperature, and lower injection temperature resulted in an extended proppant pack. The proposed coupled model offers valuable insights for the design and optimization of Sc-CO_2 fracturing operations.

KEYWORDS

Heat transfer; compressible fluid; CO_2 utilization; hydraulic fracturing

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