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REINTERPRETATION OF FRACTURE CLOSURE DYNAMICS DURING DIAGNOSTIC FRACTURE INJECTION TESTS

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ABSTRACT

A fit-for-purpose, fully coupled stress-pore pressure simulation model (Abaqus®) is used to simulate diagnostic fracture injection tests (DFITs) and generate before closure pressure responses. The simulated responses are used to explain field observations, and to propose a new concept: progressive fracture closure.

The cohesive zone model (CZM) is used to model fracture propagation and closure associated with DFITs. The customized model in Abaqus® is capable of modeling all the physical processes involved in a typical DFIT including: porous media deformation? fluid flow inside the reservoir? hydraulic fracture initiation, propagation and closure? compliance change before and after closure; residual fracture conductivity? and fluid flow inside the fracture and fluid interaction between the fracture and reservoir (leakoff).

A key result obtained is that the previously-introduced fracture compliance method is demonstrated to be the most reliable approach to identify fracture closure. Depending on the pressure distribution around the fracture, the closure pressure is usually found to be higher than the minimum principal stress. Based on the continuity equation, the compliance method is expanded to include the progressive fracture closure (PFC) concept. PFC refers to the scenario where fracture closure occurs gradually along the length of fracture, from the tip of the fracture to near the wellbore. Different estimates of closure pressure will be obtained early and late in this process. Several field cases are presented which exhibit progressive fracture closure. A consistent closure signature can be identified for these cases using the primary pressure derivative. This study further suggests that wellbore storage can mask the closure signature. Therefore, reducing the wellbore storage effect by using downhole shut-in makes it easier to identify fracture closure, in addition to accelerating the test.

A common DFIT fracture closure referred to as "fracture height recession" is reinterpreted to be caused by the PFC phenomenon. This finding has tremendous implications for interpretation of before closure flow regimes and associated reservoir behavior. This study also confirms that the compliance method, which corresponds to fracture tip closure, provides more of a true measure of closure pressure than conventional approaches which correspond to fracture closure near the well.

To order the full paper, visit https://doi.org/10.2118/185649-MS

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