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Impact of Fluid-Driven Subcritical Crack Growth on Hydraulic Fracture Initiation and Growth

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Most approaches to stimulation of horizontal wellbores rely on initiation and growth of more than one hydraulic fracture. In the ideal case, each perforation cluster generates at least one hydraulic fracture, and the fluid and proppant are uniformly partitioned among these entry points. Simulation of this richly-coupled process of multiple fracture growth is an active area of research. But how do these multiple fractures initiate in the first place? A combined experimental and modeling study have recently led to new understanding of the mechanisms leading to the initiation (or not) of multiple hydraulic fractures. Our results demonstrate time-delayed initiation at wellbore pressures insufficient to generate instantaneous hydraulic fracture growth, and we argue this mechanism is essential for initiation of additional hydraulic fractures within a stage once the first one or two fractures begin taking enough fluid that the wellbore pressure plateaus or declines. Understanding the origins and mechanistically modeling this time delay is important because developing strategies to reduce the delay time will lead to successful stimulation from a greater proportion of perforation clusters. Our results show that the time delay can be predicted, with the models relying on characterization of so-called static fatigue properties and/or subcritical crack growth properties of rocks. We will also show experimental evidence that the time delay can be reduced by changing fluid properties. For example, low viscosity fluids generate a shorter time delay in general and use of dilute HCl reduces the time delay in carbonate rocks.

References

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