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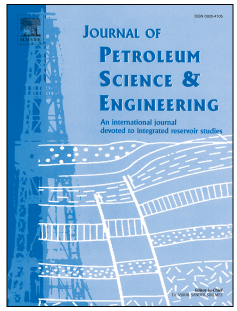

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Experimental investigation of in situ and injection fluid effect on hydraulic fracture mechanism using acoustic emission in Tennessee sandstone

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ABSTRACT

Hydraulic fracture propagation and associated rock failure mechanisms are dependent on multiple factors including the reservoir pore fluid and its interaction with the rock and the fracturing fluid. This dependence of rock failure on in situ pore fluid could affect the stimulated volume and could manifest itself in the hydraulic fracturing diagnostics such as treatment pressure and microseismic. Therefore, it would be beneficial to an engineer designing, planning or interpreting a fracturing treatment to be aware of expected differences in hydraulic fracture responses in formations having different reservoir fluids, i.e. fracturing a gas or oil bearing formation.

We investigate this effect by way of laboratory hydraulic fracturing experiments on triaxially stressed samples of Tennessee sandstone. The acoustic response during rock failure was monitored using 16 P-wave transducers and the waveforms were acquired using a continuous acoustic monitoring system. The effects of pore pressure, water weakening and viscosity of the injection fluids on hydraulic fracture propagation and associated damage are investigated using six experiments on dry, brine saturated and dodecane saturated Tennessee sandstone, fractured with either water (1 cP) or oil (50 cP). Significant rock weakening was observed in fluid saturated samples (breakdown pressures exhibited a reduction of 15-40% from dry sate breakdown pressures); the presence of more polar fluid (water) in the pore space resulted in more weakening (800-900 psi lower breakdown pressures when water saturated vs. dodecane saturated). The effect of injection fluid viscosity is observed to be suppressed for fluid saturated samples as breakdown pressures for samples which were saturated with either fluid (brine and dodecane) were observed to be almost same. Acoustic event distributions, continuous stream monitoring, failure mechanisms and permeability measurements on fractured cores all seem to suggest a more complex fracture network in dry rock and more conventional tensile type failure in brine saturated rock. Continuous acoustic stream energy variation with time offers insight into the induced fracture complexity and should be used along with microseismic cloud distributions to assess the stimulated reservoir volume.

Key words: hydraulic fracturing mechanism, laboratory hydraulic fracturing, acoustic emission, microseismic, SRV, continuous acoustic monitoring

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