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Liquid Nitrogen as Fracturing Method for Hot Dry Rocks in Kazakhstan

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Abstract : Hot, dry rock (HDR) has substantial potential as a thermal energy source. It has been exploited by hydraulic fracturing to extract heat and generate electricity, which is a well-developed technique known for creating the enhanced geothermal systems (EGS). These days, LN2 is being tested as an environmental friendly fracturing fluid to generate densely interconnected crevices to augment heat exchange efficiency and production. This study examines experimentally the efficacy of LN2 cryogenic fracturing for granite samples in Kazakhstan with immersion method. A comparison of two different experimental models is carried out. The first mode is rock heating along with liquid nitrogen treatment (heating with freezing time), and the second mode is multiple times of heating along with liquid nitrogen treatment (heating with LN2 freezing-thawing cycles). The experimental results indicated that with multiple heating and LN2-treatment cycles, the permeability of granite first ameliorates with increasing number of cycles and later reaches a plateau after a certain number of cycles. On the other hand, density, P-wave velocity, uniaxial compressive strength, elastic modulus, and tensile strength indicate a downward trend with increasing heating and treatment cycles. The thermal treatment cycles do not seem to have an obvious effect on the Poisson's ratio. The changing rate of granite rock properties decreases as the number of cycles increases. The deterioration of granite primarily happens within the early few cycles. The heating temperature during the cycles shows an important influence on the deterioration of granite. More specifically, mechanical deterioration and permeability amelioration become more remarkable as the heating temperature increases.LN2 fracturing generates many positives compared to conventional fracturing methods such as little water consumption, requirement of zero chemical additives, lessening of reservoir damage, and so forth. Based on the experimental observations, LN2 can work as a promising waterless fracturing fluid to stimulate hot, dry rock reservoirs.

Keywords : granite, hydraulic fracturing, liquid nitrogen, Kazakhstan
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