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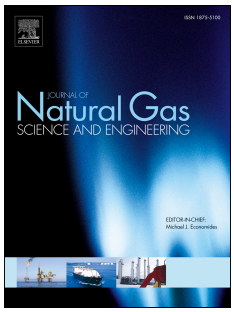

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Experimental Investigation on Fracture Surface Strength Softening induced by Fracturing Fluid Imbibition and Its Impacts on Flow Conductivity in Shale Reservoirs

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Abstract

The economic development of shale gas reservoir requires not only the large-scale complex fracture network, but also the sufficient fracture conductivity. Field operations have demonstrated that large amounts of fracturing fluids are retained in shale formations due to low flow-back efficiency. The fluids can enter into the surrounding reservoir matrix through hydraulic fractures. A series of microcosmic physical and chemical reaction can lead to fracture surface softening. In this paper, comparative imbibition experiments are conducted on 9 core samples from different shale formations. Nuclear magnetic resonance technique is used to evaluate the water-rock interaction range. Then, a large number of gird indentation tests for surface hardness with spontaneous imbibition time are designed to investigate change rules of fracture surface mechanical properties in the interaction between fluid and shale. Furthermore, the long-term fracture conductivity experiments, which are performed by gas and water alternately, are carried out to analyze the influence of water-rock interaction and fracture surface softening on fracture conductivity. The results show that the main affected area of water-rock interaction (water saturation＞ 50%) during the seven-day water imbibition in the tight shales is located several millimeters inward near the imbibition surface. The first 1 hour of the imbibition in the fracture surface is the beginning stage when mesoscopic damages to rock surface hardness occur, which results in gentle hardness decline. In the following 24 hours, damages intensify, leading to considerable hardness decline, which accounts for 50%~ 75% of the total. After that, damages continue to increase slowly. The fracture surface strength softening has no direct relation with the water imbibition rate and the imbibed volume per unit volume of rocks. The intensity of such kind of physical and chemical reaction can be reflected by the pore volume multiple of imbibed water and the effective driving force coefficient, whose higher values indicates stronger water-rock effects and more serious fracture conductivity damages. This study preliminarily explores the interior relation between the spontaneous imbibition capacity and the fracture surface softening. It can also provide new methods for the evaluation and analysis of proppant