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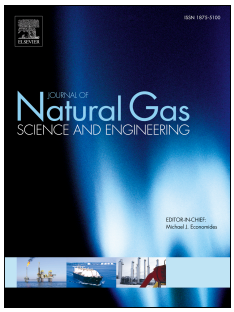

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A numerical investigation on the effects of rock brittleness on the hydraulic fractures in the shale reservoir

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Abstract: Hydraulic fracturing is an extensively used technique for development of oil and gas resources. In the shale reservoir, rock brittleness plays an important role during hydraulic fracturing. In this paper, a numerical code known as RFPA (Rock Failure Process Analysis) is introduced and the embedded digital-image-based (DIB) technique is illustrated in detail. Based on this integration, the effects of rock brittleness on the failure mode and stress-strain characteristic of the shale specimens are numerically investigated. It is found that the brittle shale specimen is more likely to rupture with multi crossed failure planes while the ductile specimen is more likely to rupture with a penetrating failure plane, from which we deduce the brittle shale is easier to develop more natural fractures than the ductile shale. The influence of natural fractures on complex hydraulic fracture network is further investigated through numerical simulation and the positive effect of rock brittleness is indirectly verified. It is found that hydraulic fractures are preferable to propagate in brittle minerals, i.e. the hydraulic fractures always choose the brittle minerals as the favorite path to propagate or choose a thin or weak part of ductile minerals to penetrate and is blocked by the ductile minerals. Moreover, the hydraulic fractures generated in the brittle shale are tortuous and appear with multi branches, which is much beneficial to form hydraulic fracture network in contrast to the smooth hydraulic fracture generated in the ductile shale. This is probably one of the causes of that the required treatment pressure in ductile shale layer is higher than that in brittle shale layer.

Keywords: brittleness; shale; hydraulic fracture; numerical simulation; ductile