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Experimental investigation on the mechanical properties of shale soaked in supercritical CO□ / water at dynamic pressures

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As shale gas exploitation proceeds, reservoir pressure progressively decreases. While using CO_2 or water to enhance shale gas recovery, it is important to investigate their effects on the mechanical properties of shale under dynamic pressure conditions. In this study, we have investigated the effects of supercritical CO_2 and water immersion on the mechanical properties of shale under different dynamic pressures (pressure change 1: decreasing from 20 MPa to 8 MPa; pressure change 2: decreasing from 42 MPa to 30 MPa). The testing results indicate that, after soaking in supercritical CO_2 and water, the uniaxial compressive strength (UCS) of shale is decreased by 51.05% and 58.36% (pressure change 1), and by 35.98% and 36.84% (pressure change 2), respectively. The strength and Young's modulus of shale are decreased more significantly after water immersion compared to supercritical CO_2 immersion. Due to the matrix compression effects, the mechanical properties of shale are changed more significantly under lower imbibition pressures. Supercritical CO_2 immersion leads to an increase in the Poisson's ratio along with more complex fracture patterns, whereas water immersion results in a slight decrease in the Poisson's ratio associated only with shear fracture formation. The acoustic emission (AE) signals display obvious stage characteristics during the compressional deformation of the samples, and the AE energy is mainly generated in during the unstable crack propagation stage. Supercritical CO_2 immersion plays an important role in crack generation, whereas water immersion is dominated by the alteration of the pore structure. Compared with the constant pressure imbibition, the dynamic pressure imbibition changes the microstructure of shale and weakens its mechanical properties more significantly. The results of this study provide a clearer understanding of the effects of CO_2 and water on the mechanical properties of shale during exploitation of shale gas.