Effects of slick water fracturing fluid on pore structure and adsorption characteristics of shale reservoir rocks

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The shale-fracturing fluid interaction and its effects on the pore structures and adsorption characteristics of shale are the key factors affecting shale gas exploration. To address this problem, the black shale samples obtained from the Lower Silurian Longmaxi Formation in Sichuan Basin, China were exposed to slick water fracturing fluid at the simulation conditions of 100 °C and 50 MPa for 72 h through a fluid-rock interaction simulation instrument (Fig.1). The slick water fracturing fluid contained 0.2 wt.% friction reducer, 1 wt.% clay control agent, 0.15 wt.% cleanup agent and 0.05 wt.% demulsifier. The mineral composition, pore structure and methane adsorption capacity of shale samples before and after slick water fracturing fluid treatment were measured by Xray diffraction (XRD), field emission scanning electron microscope (FE-SEM), low-pressure nitrogen adsorption and methane isothermal adsorption experiments using the gravimetric method. The results showed that the carbonate minerals were dissolved during treatment, and as a result, the samples developed many dissolution pores measuring 2–5 μm in diameter, while the other minerals remained relatively undisturbed. The specific surface area and total pore volume of shale sample were reduced after the reaction, and the shale-fracturing fluid interaction exhibited a stronger influence on the mesopores. However, the average pore diameter of nanopore was enlarged after the reaction, increasing from 4.29 nm to 4.78 nm. The changes of fractal dimensions suggested an increase in the roughness of pore surfaces, and the pore structure became more regular. The methane adsorption capacity in shale treated with fracturing fluid was reduced from 1.23 mmol/g to 0.95 mmol/g. The changes in the pore structure and adsorption characteristics of shale could affect the gas flow and gas adsorption capacity. These results indicated that the slick water fracturing fluid may play an important role in shale matrix stimulation.