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Investigation on pore structure and imbibition characteristic of tight sandstone by nuclear magnetic resonance

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Abstract: Tight sandstone reservoir, as unconventional oil and gas resource with abundant quantity, plays a significant role in supporting the growing global demand of energy consumption. However, tight sandstone has complex pore structure and strong heterogeneity, which brings challenges to the development of unconventional hydrocarbon resource. In recent years, the nuclear magnetic resonance method has been widely applied in porous media with the advantages of nondestructive, fast and wider range of pore size characterization in investigating pore structure. But pore size distribution curve cannot be obtained directly by nuclear magnetic resonance method. The transverse relaxation time spectrum from nuclear magnetic resonance could be converted into the pore size distribution curve by appropriate surface relaxivity, which can be affect by paramagnetic minerals and varies with lithology. Using low temperature nitrogen adsorption method, high-speed centrifugation method, and nuclear magnetic resonance, the surface relaxivity of five tight sandstone samples from different depths of Dongying depression was measured in this study. And then the influence of mineral composition from experimental samples on surface relaxivity was discussed. In addition, the pore size distribution curve from mercury intrusion porosimetry is utilized to verify the accuracy of the pore size distribution curve inversed by the surface relaxivity. Based on the obtained surface relaxivity, imbibition experiments under high temperature and high pressure conditions were conducted combined with nuclear magnetic resonance technique. Then the flow characteristics of whole cores and different pore size types (micropores, mesopores and macropores) influenced by temperature and pressure was analyzed, and the imbibition mechanism of tight sandstones resource was revealed.
Keywords: NMR, Surface relaxivity, Pore size distribution, Imbibition

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