Evaluation and Conversion of Adsorbed-Free Shale Gas in the Fuling Area, China

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Abstract

Shale gas tends to exist in the forms of adsorbed and free gas in reservoirs. Accurate determination of the ratio of adsorbed-free gas becomes an essential part in evaluating shale gas content and making reasonable plan for shale gas exploitation. Fuling shale gas field is the first shale gas field in China, however, fine evaluation of adsorbed-free shale gas content has not been clearly recognized, as well as its conversion rules. Hence, this paper analyzed influencing factors of adsorbed-free gas, chose a preferred micropore filling model to characterize the absolute adsorbed capacity, and the ratio of adsorption-free gas could be determined. In addition, the effect of factors including temperature, TOC, water saturation and porosity, on the mutual conversion of adsorbed-free gas, were also researched and the conversion of adsorbed-free shale gas under different conditions have been discussed. Different methods of quantitative characterization of adsorption-free gas have been established. As for quantitative description of adsorbed gas, Langmuir model, BET model, D-R model and other models have been established, but there are differences on the selection of those models. Moreover, most of previous studies did not take into account the effect of water on shale adsorption, which caused the overestimation of free gas as the pore volume is also occupied by water. By comparison, this paper chose the pore filling model developed from the adsorbed potential theory to calculate the adsorbed gas. In addition, the quantitative description of free gas was based on the evaluation of adsorbed gas. The volume of free gas was obtained by subtracting the volume occupied by the water-containing part and the volume of adsorbed gas from the pore volume, so the free gas content could be further determined by the state equation PV=

znRT. In order to quantitatively describe the conversion of adsorption and free gas, it is necessary to further explore the factors controlling the transformation. Firstly, the changes of temperature and pressure caused by the change of formation depth were considered, while other conditions such as porosity, water saturation, TOC, pressure coefficient et al. were assumed to be fixed. Then, the effects of different factors on the change of adsorbed-free gas were studied by controlling a single variable respectively. The result shows that, the adsorbed gas amount of Wufeng-Longmaxi Formation in Fuling area gradually increases from shallow layer to deep layer, but the absolute adsorbed capacity of shale no longer increases as the depth continues increasing. The total average ratio of adsorbed-free gas is about 34%. In comparing the effects of simple factors on the mutual conversion at a range of 2000-3500m depth, we found that the effect of porosity and TOC is the most important, followed by the water saturation, and that of pressure coefficient has the least effect on the ratio.