Investigation of Shale Gas Adsorption Mechanism

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Fuling shale gas field, with the annual output of over 5 billion m^3, is the most successful shale gas field in China at present. Even so, there are still many issues, which are important for better exploration and development in the future, need to be further investigated. The adsorption behaviour and mechanism is one of them, because it is of great significance for evaluating shale gas resource potential and predicting the productivity curve.

The adsorption capability of shale gas is mainly investigated by adsorption experiment at present, from which one can only obtain the excess adsorption amount, making it impossible to reveal the adsorption behaviour and mechanism. Unlike adsorption experiment, grand canonical Monte Carlo (GCMC) simulation can provide not only the excess adsorption amount, but also the interaction energy, adsorption site, density distribution and so on, which are important for revealing the adsorption mechanism. However, the experimental measurements and simulation results are of different order of magnitude according to the publications, arousing the suspicion on the feasibility of molecular simulation method, even though it is feasible and reliable in theory.

Point at these problems, we investigated the shale gas adsorption behaviour and mechanism by both experiment and GCMC simulation. We uncovered the essential reason that causes the difference between experimental measurement and simulation results. Thereafter, we built up the reasonable expression method of excess adsorption amount to span the scale difference between experiment and simulation, making it possible to test the feasibility of simulation results by the experimental measurements.

Based on the cross-scale expression, we investigated the adsorption behavior of CH_4, CO_2 and the mixed gas in montmorillonite, illite, kaolinite and kerogen by GCMC method. We demonstrated the difference on adsorption behavior between CH_4 and CO_2, which is caused by the difference of their polarity. Then we illuminated the difference on adsorption capacity among different minerals by comparing the capacity of single adsorption site, the density of adsorption site, and the specific surface area. We confirmed theoretically the practicability of improving shale gas productivity by injecting CO_2. We finally combined the simulation results with the geological condition of Fuling shale gas field and revealed the shale gas bearing mechanism.

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[3]EP. Fan (2014) Energy Exploration & Exploitation, 32, (6), 927-942.