In-Situ HTHP Experiment of CO2-Brine-Rock Interaction and Its Implication for Tight Oil EOR and CCUS

Songtao Wu[1], Xiufen Zhai[2], Zhi Yang[3]
[1]RIPED Petro China; [2]Research Institute of Petroleum Exploration and Development; [3]Research Institute of Petroleum Exploration and Development (RIPED)

9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

The application of CO2 in EOR has become a worldwide concern for its significance in environmental protection and its substantial economic returns. As is known to all, the great success of tight oil in North America has changed the global energy landscape, yet how to enhance the low oil recovery (only 5%~8%) is a great challenge. The application of CO2 in tight oil EOR has just commenced, and a large number of scientific problems have to be solved, in which, the reaction between CO2, brine and minerals is one of the PRIORITIES. The Triassic Chang 7 tight sandstones in the Ordos Basin, the most successful tight oil E&P targets in China, have been selected as the focus of the research. CO2-brine-rock interaction is set at in-situ reservoir conditions (78℃, 24MPa). An ionic chemical analysis of the outlet solution, combined with high resolution CT (1.0 micron/pixel), SEM, QEMSCAN and bulk-rock XRD analyses of the core pre- and post-experiment, has been adopted. In-situ 3D porosity-mineral comparison model has been established in the paper. Minerals such as potassium (K) feldspar, albite, NaCl and calcite are variably dissolved after the experiments. The dissolution, migration and reprecipitation of clay minerals are common, which is characterized by chlorite dissolution and the destruction of the original growth framework. Preliminary statistics show that the porosity and permeability of Chang 7 tight sandstones decreased by 60~80% after CO2 water-rock reaction, and that permeability reduction is positively related to the clay mineral content. It is the precipitation and re-migration of clay particles (e.g., kaolinites and smectites) released by the dissolution, which have been transported in the fluid flow path and accumulated at pore throats, that result in the changes of the pore system and the decrease of physical properties. The geological model of long-term CO2 injection-burial in Chang 7 tight sandstone indicated that the effective CO2 reaction was limited to a circle area with radius of about 600m from the location of the injection well. The carbon sequesation minerals included dolomite and siderite. It was estimated that the quantity of carbon storage from mineral sequesation in Chang 7 tight sandstones, Xinanbian area after 200 years, 500 years and 1000 years was 120 million tons, 360 million tons and 480 million tons, respectively. The results provide new insights into CO2 trapping mechanisms in tight oil reservoirs, and into the potential formation damage that may result from massive injections of CO2 into reservoirs during EOR programs and CCUS programs.