Quantitative Characterization of Pore-Throat Structure of the Tight Sand-Conglomerate Condensate Gas Reservoir in Bohai Bay Basin Based on Multi-Scale Digital Core

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Abstract

A major breakthrough in condensate gas exploration has been made in the tight sand-conglomerate reservoir of the Paleogene Kongdian formation in the southwest of Bozhong Depression in Bohai Bay Basin. The pore throat scale of tight sand-conglomerate reservoir is wide, the network system is complex, and the heterogeneity is strong. Conventional experimental techniques such as casting sheet and mercury injection method can only qualitatively characterize the pore type and shape, but lack of multi-scale quantitative and fine characterization of pore-throat structure, which limits the exploration and development effect of deep reservoir. Based on dual-energy CT scanning of full-diameter cores, micrometer CT plunger scanning, micron CT subsample fine scanning, SEM large-field imaging and QEMSCAN mineral scanning analysis, we obtained multi-scale digital scanning images of cores, microscopic pore structure and mineral distribution. The pore-throat structure characteristics of tight sand-conglomerate reservoir are characterized at different scales, and the micropore shape, size, spatial distribution, connectivity and other structural characteristics are clarified. A digital core research platform is established based on 3D image extraction corresponding 3D pore network model.The pore throat radius of the plunger sample is between 10 μm and 200 μm, the average coordination number is 4.0, the average shape factor is 0.056, the critical connectivity radius is 25 μm. The pore throat radius of the subsample is between 1 ~ 22 μm, the average coordination number is 3.73, the

average shape factor is 0.0522, and the critical connectivity radius is 2.32 μm. The different scale structure characteristics of micropore throat of tight sandy gravel rock in Paleogene system are as follows: the micropore is distributed unevenly in three dimensional space, it is isolated, and strip micropore is developed locally. The pore throat is a bundle tubular shape in three dimensional space and has good connectivity. It is the main channel to communicate larger micropores. The pore throat is superimposed on each other, and the geometry of the pore throat is tubular, spherical, nanoscale short tubular micropore with certain connectivity with micron-sized tubular micropore and adjacent isolated spherical nano-pore. It has dual functions of throat and pore. Multi-scale digital core technology provides a basis for accurate understanding of microscopic pore throat characteristics of dense reservoirs and provides a new method for the study of pore throat structure of micro-nano oil and gas reservoirs.

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