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Method for predicting a reasonable water injection pressure for a fractured low-permeability sandstone reservoir

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In the process of fractured reservoir development, fracture opening pressure, opening sequence, and reservoir fracture pressure are the factors that must be considered when formulating oil and gas development plans. Particularly in fracturing, refracturing, and water injection development measures for a low-permeability reservoir, accurate prediction of structural fracture development law and reservoir fracture pressure is an important guarantee of improved oil and gas recovery and economic benefits. A reasonable injection pressure for oil and gas wells cannot exceed the fracture pressure of oil and gas reservoirs. Under this pressure condition, the structural fractures should be fully opened to maximize the oil and gas recovery efficiency. Through structural evolution analysis, combined with rock fracture criteria, the occurrence of fractures is predicted; based on the theory of fracture surface energy and rock strain energy in fracture mechanics, the linear fracture density is predicted. Using a core sound velocity experiment and microseismic monitoring technology, the in situ stress direction is determined. Combined with the fracturing data, the in situ stress of each well is calculated; by determining the rock mechanics parameters and a finite element model, the three-dimensional distribution of the in situ stress can be predicted; with the aid of the fracture occurrence and the stress field numerical simulation results, the reservoir fracture pressure and the opening sequence of natural fractures in the reservoir are determined. We used the Paleogene Funing Formation in the T96 fault block of the Jinhu Sag in eastern China as an example to predict the reasonable water injection pressure of fractured low-permeability reservoirs. Observations of core fractures in the Funing Formation in the T96 fault block show that the predominant orientation of fracture strikes is ENE and WNW conjugate fractures; the dip consists of mainly vertical fractures and high-angle oblique fractures (87%). The simulation results of the stress field show that the horizontal minimum principal stress is between 21 MPa and 28 MPa, and the maximum horizontal principal stress is between 30 MPa and 40 MPa. The horizontal maximum principal stress of the T96 fault block is in the ENE direction; near the fault, the direction of the horizontal principal stress changes by 5° to 10°. During water injection, the fractures in the ENE direction open first, and the fractures in the SE direction open subsequently. The opening pressure of the fracture increases as the angle between the fracture strike and the horizontal maximum principal stress becomes larger; the depth of the fracture and the opening pressure are also positively well correlated. In the high part of the structure (1650 m-2000 m), the fracture opening pressure is between 22 MPa and 42 MPa at the opening and between 41 MPa and 69 MPa in the lower portion of the structure (3150 m-3800 m). By calculating the actual fracture pressure of the reservoir, it is proposed to use different water injection pressures in different blocks to ensure high and stable oil and gas well production.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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