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Evaluation of Waterflooded Grade in the Framework of Hydraulic Flow Units in Ultra Low Permeability Reservoir, Ansai Oilfield, Ordos Basin, China

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Most oilfields in China are continental deposits, which show great heterogeneity and the deficiency of natural water energy. Nearly all these kinds of reservoirs have to be injected water to keep formation pressure and enhance recovery efficiency. The distribution of remaining oil in reservoir is extremely complicated after years of water injection. The accurate evaluation of waterflooded grade can be used to determine the distribution of remaining oil. It also can effectively guide the work of stabilizing the oil-producing and exploitation of potential remaining oil in the later period. Ansai Oilfield, which is an ultra-low permeability reservoir, in Ordos Basin, central China, has been developed by injecting water since 1991. Nowdays, due to the strong lateral and vertical heterogeneity, some wells in this area have entered the high-water-cut stage, while the other part are in low-water-cut stage.

This paper presents a method to evaluate waterflooded grade based on hydraulic flow unit (HFU) method and mercury injection capillary pressure (MICP) data in Ansai oilfied. Core data of 4 wells (WR-1, WR-2, WR-3, WR-4) distributed on both sides of the same fracture zone are used for reservoir characterization. Firstly, the flow unit parameters including Reservoir Quality Index (RQI), Flow Zone Indicator (FZI) and normalized porosity(φz) are calculated with porosity and permeability. Meanwhile, the throat size distributions are obtained using MICP data. The r35, which is the calculated throat radius when the mercury saturation equals to 35% is selected to indicate the complexity of pore structure. Then, from high to low quality, the reservoirs are divided into 3 HFUs, i.e. HFU1, HFU2 and HFU3 by the combination of the flow unit parameters with pore structure and other physical parameters. Different HFUs represent different physical facies and different pore structure. HFU1 reservoir has higher lagre-pore proportion. When water injected, it is easy to form the flooded dominant channel. In contrast, HFU3 is hard to be flooded under the same condition, and it's usually a relatively powerful gathering place for the remaining oil, while HFU2 reservoir is between them. Finally, the three HFUs are used to separately evaluate 3 waterflooded grade, i.e. Strong Flooded (SF), Medium Flooded (MF) and Weak Flooded (WF), in water-injected area.

In the porous reservoirs, the preceeding integrated method can be used to continously evaluate the waterflooded grade of different layers and wells in waterflooded region. When there is no fracture or fault between injection well and production well, injected water always advances along the big channal. Reservoirs of higher quality HFU will be preferentially flooded. Comparing the HFUs classification of WR-1 well with WR-4 well, WR-4 well is in higher quality of HFUs as a whole. The latest DST test and production results proved that WR-1 well was in WF, while WR-4 well was in SF with 100% water cut, which is perfectly consistent with the HFU classification.

References

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