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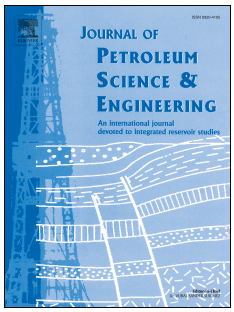

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A New Method of Water Phase Trapping Damage Evaluation on Tight Oil Reservoirs

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Abstract: Displacement pressure difference and initial water saturation are two key factors of evaluating water phase trapping (WPT) damage under a given reservoir situation. Requiring a high displacement pressure to drive liquid through a tight rock, the conventional method has difficulty in measuring very small liquid flow rates. Besides, it exists a strongly advantageous flow path selectivity phenomenon, causing a situation that the water existing in those thinner pores cannot be moved effectively. As a result, the irreducible water saturation is high after oil displacing water, thus leading to an overestimated oil permeability damage from WPT. This paper would have presented a high back pressure displacement method (HBPD) for the establishment of initial water saturation and measurement of liquid permeability of core samples from tight oil reservoirs. Then the damage of WPT using this new method was compared with the results obtained by the conventional method. According to the reservoir fluid flow situation, pore pressure and downstream pressure were simulated by the operation of back pressure. Results showed that an average initial water saturation (S_{wi}) of 46.2% was established by the conventional method. However, the S_{wi} established with the use of this new method was only 29.9%, which was consistent with the results from sealed core data of the reservoir. The oil permeability damage derived from water phase trapping was estimated as an average of 37.0% with the conventional method while that of 21.8% by the new method respectively. The conventional method overestimated the damage of water phase trapping at 41.4%. Our research appears to have an insight into analyzing oil-water flow behaviors and investigating the reservoir forming process of tight oil reservoirs.

Keywords： tight oil reservoirs; water saturation; water phase trapping; back pressure; new method; experimental evaluation

1. Introduction

Nowadays, tight oil (including shale oil) has already become one of the resources in oil-gas exploration and development (Furimsky 2015; Wang et al., 2015; Brandt et al., 2016; Luo et al., 2017). The global recoverable tight oil is estimated as 2 513 × 10^8t approximately (Wang et al 2016), accounting for more than half of the unconventional oil resources. Thus, development of tight oil is expected to remedy the inadequate supply of oil. Due to the extremely low matrix permeability, conventional well drilling technology and development scheme cannot enhance tight oil recovery effectively (Ghanizadeha et al 2015). In order to enhance tight oil recovery, hydraulic fracturing technique learned from the shale gas reservoir's development is widely used in tight oil reservoirs (Wei et al., 2015; Shrestha et al., 2017). Unfortunately, amounts of working fluid may invade into the reservoir under the combined action of positive pressure difference and capillary force to induce water phase