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The study on water-alternating-steam process after steam breakthrough in Qi40 Block, Liaohe Oilfield

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Liaohe Oilfield is the most important heavy oil base in China. Qi40 Block is the major reservoir for steam flooding in Liaohe Oilfield. The thickness for the main part of Qi40 Block is about 10m with continuous interlayers in it. Meanwhile, the viscosity of oil under reservoir temperature is more than 2000mPa.s. About 25 years ago, the main part of Qi40 Block started cyclic steam injection. However, from the year 2006, this area inverted to steam flooding. Now steam breakthrough occurs in almost 60% of the wells.

Although steam flooding plays an important role in heavy oil production, steam breakthrough occurs easily because of the obvious viscosity difference between steam and crude oil. To solve the problem of steam breakthrough, this paper improves and derives the pseudo-mobility ratio which considers hot water region. This paper also shows different shapes of steam chamber under different hot water proportion. We can know that after steam breakthrough, steam override will decrease with the increasing proportion of hot water. Through the model, water-alternating-steam process will increase the oil sweep efficiency rapidly after steam breakthrough.

This paper also uses CMG to prove the correctness of the theoretic formula. Based on the geological model of four patterns in Qi40 Block, this paper chooses continuous steam flooding, interval steam injection, steam nitrogen flooding and water-alternating-steam process after steam breakthrough. The result shows that water-alternating-steam process can increase oil recovery by 5.97%, which is far more than the continuous steam flooding.

This paper indicates that water-alternating-steam process can not only enhance oil recovery, but also decrease the injection heat so that it can decrease the input costs. As a result, water-alternating-steam process is the best development method after steam breakthrough.

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