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Air Injection Experiment for Evaluating the Effectiveness of Tight Oil Development

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Introduction

In recent years, the effective development of shale oil has been a key area of research in petroleum engineering as an important part of unconventional resources.Given the widespread availability and low cost of air, evaluating air injection in shale reservoirs is an interesting topic to investigate.Based on full-diameter core air injection experiments, this paper examines the production performance of various methods of air injection development in the shale reservoir, including air flooding and air huff and puff.Meanwhile,the properties of residual oil and produced oil are revealed through the development of a systematic evaluation method that includes nuclear magnetic resonance, laser scanning confocal microscopy, and gas chromatographic analysis. According to the findings, air flooding development is characterised by early gas breakthrough and a long oil production period [1].

Description

Compared with air flooding, the replacement efficiency of the first round of air HnP is significantly higher, demonstrating higher feasibility of air HnP in the early stages of development, although the cumulative recovery of three rounds air HnP is lower than that of air flooding (23.36%). The large pores are the primary source of air injection recovery, while the residual oil is concentrated primarily in the medium pores. Because air injection development has a higher recovery factor for light components, the residual oil contains a higher level of heavy components. This paper examines the feasibility and development effectiveness of air injection in shale oil reservoirs, as well as its development characteristics [2].

With the gradual shift from conventional to unconventional oil and gas development in recent years, gas injection has become one of the most effective means for the efficient development of tight reservoirs, as evidenced by numerous previous publications. In particular, air injection development has gained attention due to its low cost, good injection, and easy availability. Buffalo Oilfield has been comparing the development effects of water injection and air injection [3].

Meanwhile, the heat released during air flooding from the oxidation reaction causes thermal expansion of the oil as well as the bond-breaking reaction of the oil, resulting in the formation of a flue gas front and improved displacement effects in low permeability reservoirs. Nonetheless, given the limited air injectivity of shale oil reservoirs, the thermal effect of air injection appears to be insignificant et al. summarised previous cases for a comprehensive discussion on the feasibility and potential of gas injection in shale reservoirs, concluding that factors such as microfractures, high-temperature and high-pressure environments, and low water content in shale oil reservoirs are conducive to air flooding, which has a high potential to enhance shale oil reservoir recovery.

Gas HnP exhibits more durable and stable IOR performance than gas flooding, which is limited by injectivity and gas channelling in tight reservoirs. CO2 and air are the two most commonly used injection gases in general, and CO2 HnP performs significantly better than air HnP due to its high solubility and diffusivity. However, unlike CO2, which has high production costs, severe corrosion problems, and transportation issues, air is cost-effective and non-corrosive, making air HnP a promising approach to achieving effective shale oil development. The advantage of air HnP in the early stage is high production efficiency and low cost, and air HnP would form some large-contact-area gas chambers in the near-well zone, which can improve the effectiveness of other high-cost solvents [4,5].

Conclusion

The development characteristics of shale oil under different air injection development models (flooding and HnP) were compared with a full-diameter natural core in this paper for the Lucaogou Formation shale oil reservoir in the Jimsar area. The produced oil and residual oil from air injection development in shale oil were quantitatively analysed using NMR technology, LSCM, and GC analysis. This study thoroughly investigated the effectiveness of air injection development in shale oil and can contribute to a better understanding of the effects of air injection on oil composition. In conclusion, air injection development primarily extracts oil from large pores, followed by medium pores, and recovering oil from small pores is difficult. In the early stages of shale oil development, air HnP would be a more feasible and efficient development model, whereas air flooding could achieve a higher recovery with high-intensity displacement. To combine the benefits of the two development modes, it appears that performing HnP in the early stage to achieve rapid oil production and then air flooding in the later stage to further enhance oil recovery is a good choice.

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