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The First Experimental Design and Application of Large Horizontal Well Spacing Superheated Steam Flooding for Thin Heavy Oil Reservoir in Bohai Bay

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The thinner the reservoir thickness is, the greater the heat loss after steam overpass, so there were few successful examples of steam flooding in heavy oil reservoirs less than 6 meters all over the world. However, similar thin-layer heavy oil reserves account for a large proportion in Bohai oilfield, so it is urgent to carry out steam flooding after huff and puff to further improve oil recovery.
The target reservoir with formation oil viscosity 413~741mPa·s was developed by horizontal wells with large well spacing (250 m ~ 450 m) in the early huff and puff stage. The successful application of thick layer, directional well, small well spacing (70 ~ 100m) steam flooding development experience cannot be directly applied to the target oilfield. Therefore, based on the laboratory physical experiments and numerical simulation method with 13 years of huff and puff development history match, the steam flooding scheme was studied to optimize and obtain the key heat injection parameters, and field practice has been successful carried out for half a year. Research results show that: (1) formation pressure and formation oil viscosity are the main factors controlling the development effect of steam flooding with large well spacing of thin-layer heavy oil reservoir. The technical limit of formation pressure is ≤ 5MPa ,which guarantees big volume of steam to expansion displacement. The technical limit of formation oil viscosity is the ratio of viscosity to permeability ≥10mD/mPa·s at reservoir temperature, which make sure the crude oil has natural flow ability in the reservoir temperature. (2) The enthalpy loss rate of steam flooding with large horizontal well spacing in thin-layer heavy oil is 48%, which is much higher than 11% of conventional steam flooding with small well spacing in thick layer. Therefore, it is recommended to inject steam with dryness above 80% at the well bottom (conventional 50%). In order to ensure the dryness of the bottom hole steam, it is recommended that the hot medium of the boiler outlet is 20℃ superheated dry steam, rather than the conventional saturated wet steam. (3) In order to fully heat the reservoir and consider the economy, the heat injection intensity was optimized to be 1.4~2.0 m3/(d·Ha·m). (4) The production/injection ratio was optimized to be 1.2~1.6 to ensure the continuous decline of formation pressure.
The above research results guided the development of the first offshore steam flooding field test with large well spacing. In half a year, 29000 tons of steam has been injected, 59 tons of oil has been increased per day, and the stage oil steam ratio is 0.85. The research results show that steam flooding can also be applied in thin heavy oil reservoirs with large well spacing.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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