Comprehensive Treatment Technology of "Two Low and One Close" Well

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Abstract. In this paper, the criterion of "two low and one shut-in" well is formulated, and its formation reason and treatment potential are analyzed and classified. Combined with reservoir multidisciplinary research results and dynamic monitoring data, conventional technology integration treatment and new technology research are carried out for different types of "two low and one shut-in" wells, and a new comprehensive treatment technology is summarized and applied to the "two low and one shut-in" well treatment in Sabei Development Zone, and good results have been achieved.

1. Introduction
With the development of water flooding entering the late stage of ultra-high water cut, the difficulty of comprehensive adjustment and management of oil and water wells has been increasing year by year, with the proportion of "two low and one shut-in" increasing year by year. The appearance of these wells has increased the decline of water drive production and the increase of water cut, restricting the overall development effect and development benefit of the oilfield. The research on comprehensive treatment technology of "two low and one shut" wells can provide theoretical help and technical support for tapping the potential of water control in the extra-high water cut period in the old oil fields, which is of great significance for improving the development effect of the oil fields and realizing the sustainable development of water flooding.

2. Two Low and One Close" Well Criterion

2.1. Determination of Low Yield Well and Long Shut-in Well
Oil wells with daily oil production less than 1t are low-yield wells.
The shut-in well that has been shut-in for more than 6 months is a long shut-in.

2.2. Establishment of Low Efficiency Well Judgment Model
Based on the principle of profit and loss balance analysis, a decision model for inefficient wells is established;

\[ f_{w,\text{max}} = \left[ 1 - \frac{C_g + (C_{ZS} + C_{YOC} + C_{YS}) \times q_f \times 365 \tau_0 \times 10^{-4}}{365 \tau_0 \times 10^{-4} (P_o I - R_D I - C_{GZ}) q_f} \right] \times 100\% \]

S - income, yuan; CG - Annual fixed cost of single well, yuan; Cb - variable cost, yuan; R - tax, yuan; Qo - single well limit production, t / d; CCL - Annual material cost of single well, yuan; CZY - Annual Downhole Operation Fee of Single Well, Yuan; CZS - Ton Liquid Flooding Charge, Yuan; Cyqc - per ton of liquid oil and gas treatment fee, yuan; QL - Liquid production...
3. Analysis and Classification of the Causes and Potential of "Two Low and One Shut-In" Wells

Combined with multi-disciplinary research results and dynamic monitoring data, the formation causes of "two low and one shut-in" wells and the potential of remaining oil are analyzed in depth.

3.1. Cause Analysis of "Two Low and One Close" Well Formation

The reasons for the formation of long shut-in are generally to be scrapped, high water cut, low energy and low efficiency, casing damage, well falling objects to be overhauled, to be operated and other reasons. Among them, high water cut and low energy, low efficiency and long shut-in account for a large proportion. However, the formation of low-yield and low-efficiency wells is mainly affected by geological factors and development factors.

Influence of formation energy: low formation pressure and insufficient energy are one of the main reasons for low-yield and low-efficiency wells.

Influence of perfection of injection-production relationship in single sand layer: analyze whether there is production without injection or production without injection by analyzing the corresponding situation of perforation in oil and water wells; This paper analyzes the perforation horizon properties of oil and water wells and whether there is thin injection and thick production or low injection and high production, both of which will produce low-yield and low-efficiency wells.

Impact of oil layer pollution: due to poor oil layer conditions of secondary wells, the oil layer is polluted during injection water quality, drilling, perforation and operation, resulting in impurities blocking the oil layer, which easily leads to low injection of water wells and low production of oil wells.

Impact of casing damage: After casing change of water injection well, from the perspective of casing change prevention, stopping injection in the same layer of this well or adjacent wells plus some accompanying stopping layers will inevitably affect the liquid supply of surrounding oil wells; After the shallow casing of the production well is changed, the pump must be lifted and hung; The failure to take measures after casing change of low-yield wells will also affect the production of fluids in oil wells, so casing damage of oil and water wells is also another major factor leading to low-yield and low-efficiency wells.

Impact of reserve production degree: due to some special completion methods such as current limiting fracturing, the initial production capacity is higher and the oil production rate is faster, resulting in some wells reaching or approaching the water drive production limit and producing low-yield and low-efficiency wells.

3.2. Analysis of Remaining Oil Potential of Well "Two Low and One Close"

According to the reasons for the formation of the "two low and one shut" well, it can be divided into: multi-layer high water cut, interlayer, plane contradiction, imperfect injection and production, oil layer pollution, and pump rod and pipe problems. According to the analysis of cumulative oil production per unit thickness and recovery rate, the treatment potential of "two low and one shut" wells is concentrated in interlayer and plane conflicts, oil layer pollution and injection and production imperfect wells. The recovery rate of multi-layer high-content wells is generally higher than that of other wells in the same layer system, and the treatment potential is small and difficult. However, the wells with pump rod and pipe problems generally need to be treated with stimulation measures. Due to the limitation of the current technical level, some problems can not be treated with measures, which brings great difficulties to the treatment work.

3.3. Classification of "Two Low and One Close" Wells

According to the dynamic and static monitoring data and the fine geological research, the "two low and one shut" wells are classified according to the causes of formation and the distribution of
remaining oil.

Classification of causes: multi-layer high water cut, inter-layer, large plane contradiction, imperfect injection and production, pump problem, casing problem and ground problem;

Potential classification: remaining oil at the top of thick oil layer, remaining oil at the edge of river channel, remaining oil in tuo-shaped sand body, remaining oil at the variation part of river channel, remaining oil in fault-shielded type and remaining oil in thin and poor oil layer.

4. Two Low and One Close” Well Matching Treatment Technology

The "two low and one shut" well is a difficult well produced in the long-term development and production of the oilfield. Generally, it is difficult to achieve the best results without major development adjustment, injection-production system adjustment, injection-production relationship and structure adjustment. Therefore, in the process of governance, we should follow the principles of "one strengthening", "two priorities" and "four combinations", namely: strengthening the matching governance of surrounding water injection wells; Priority should be given to the treatment of remaining oil-rich well areas and to the treatment of single wells that affect the development of well areas. Static and dynamic combination: combining static and dynamic data with monitoring data of oil and water wells, point-to-surface combination: combining sedimentary single sand body with well points of different strata, combining lifting and controlling: combining oil-increasing measures with water-controlling measures, combining prevention with control: combining treatment with prevention.

4.1. Fracturing Measures

According to the production data of the fractured wells, the relations between the sandstone thickness HS in the measure section, the effective thickness HY in the measure section, the formation coefficient C in the measure section, the water cut FW in the measure well, the total pressure difference and the increase in oil production in the measure section are obtained by using the multiple regression method. That is, the limit formula of oil well fracturing technology in Sabei Development Zone:

\[
\Delta Q = 1.16 \frac{h_s}{12.63} + \frac{h_y}{4.16} + c/0.54 + f_w/84.55 + \Delta p/0.3
\]

4.2. Water Plugging Measures

Daily oil production \( a \) and daily water production \( b \) after water plugging are determined according to the average water cut during water plugging, heterogeneity of the water plugging well, the status of the water plugging layer, the flow coefficient of the whole well, the average permeability of the water plugging well, the production pressure difference before and after water plugging of the water plugging well, the water cut of the water plugging layer, daily oil production before water plugging and daily water production:

\[
\begin{align*}
\ln a &= 7.825711 + 1.054095x_1 - 0.000585x_2 + 0.2318040x_3 - 0.212310x_4 - 0.224226x_5 - 0.021782x_6 - 0.034360x_7 + 0.14023x_8 + 0.000757x_9 \\
\ln b &= 2.859374 - 1.432531x_1 + 0.000107x_2 + 1.910275x_3 + 0.011015x_4 - 0.093582x_5 - 0.043368x_6 - 0.014585x_7 + 1.356963x_8 + 0.466238x_9
\end{align*}
\]

4.3. Hole Filling Measures

This paper studies the relationship between hole filling effect and remaining oil type and water injection direction of 20 hole filling wells. It is clear that the top of thick oil layer, the edge of river channel and narrow channel sand body with less than 2 water injection directions and well developed oil layer are the main directions for hole filling potential, and the effective thickness limit of 3t or more oil filling increasing is determined to be 3.75 m or more.
Figure 1. Relationship between Oil Increase and Effective Thickness in Initial Stage of Hole Repairing Measures

5. Conclusions and Recommendations
(1) The best governance effect can only be achieved by combining the governance of "two low and one shut" wells with the injection and production system and the adjustment of injection and production structure;
(2) 44% of the long shut-in surface equipment is missing, which makes it difficult and expensive to restore and control.
(3) The treatment of "two low and one shut-in" requires a large number of water injection well adjustments, measures modification and maintenance measures to ensure that the treatment of "two low and one shut-in" can be effective and long-lasting.

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