Exploration on Fracturing Technology of Oil Production Well in Transitional Zone

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Abstract. There are low permeability and poor crude oil physical property in the second-class oil layer of the eastern transitional zone, especially crude oil viscosity is high, and underground crude oil viscosity reaches 14mPa.s. After the weak-alkali ASP combination flooding was carried out, the liquid production dropped sharply in some oil production wells, during the initial effective stage of the oil production wells, by combining the analysis of fine geological research results and the dynamic and static reflection of oil production wells, fracturing transformation was implemented for oil production wells, and good oil increase and water decrease effect was achieved.

Keywords: transitional zone, second-class oil layer, weak-alkali ASP flooding, fracturing.

1. Introduction
Well 121 is a central production well of weak-alkali ASP flooding in the second-class oil layer of the eastern transition zone. This well went into production in September 2015, the exploitation horizon SH10-16+SH1, and the five-spot well pattern was used for mining, the injection-production well spacing was 125m, the sandstone thickness was 17.1m, the effective thickness was 13.4m, and the formation coefficient was 4.386μm²•m, the effective permeability was 0.327μm², the original formation press was 11.87MPa, and the saturation press was 11.0MPa. By the end of September 2020, this well has produced 0.1319×10⁴t oil. There are 4 injection wells around this production well, the overall development sandstone thickness of well group is 15.1m, the effective thickness is 11.2m, the formation coefficient is 3.321μm²•m, and the effective permeability is 0.296μm².

Well 121 began to blank water flooding in September 2015, entered into the pre-polymer flooding stage in October 2018, and started ternary main slug injection in June 2019, and it is currently in the main slug injection stage. This well began to work effectively in October 2019, its surrounding 4 injection wells are well developed, all of which are layered injection and have good injection conditions.

2. Potential Analysis and Determination of Fracturing Horizon
2.1. Applying dynamic and static data to determine fracturing wells
The daily liquid production was 20t/d at the end of the blank water flooding of well 121, with the injection of chemical agents, the liquid production capacity gradually decreased, by the end of April
2020 (before fracturing), the daily liquid production was 5t/d. When blank water flooding ended, the formation press of this well was 11.73MPa, the formation press of this well had reached 12.83MPa before fracturing, and the total press difference was 0.96MPa, which was 0.50MPa higher than the whole area. The flowing press of this well was only 2.30MPa before fracturing, which was 1.43MPa lower than the whole area. From the point of view of press data, the formation energy of this well is enough, and the skin coefficient is 5.18, it shows that the oil well is holding press seriously and the oil layer has pollution. Fracturing transformation is needed to improve the liquid production capacity of this oil production well.

2.2. Applying fine geological research results to determine the fracturing horizon

The main connection layer between well 121 and the surrounding injection wells are SⅡ13+14a, SⅡ13+14b, SⅡ11 and SⅡ19b. Among them, SⅡ13+14a and SⅡ13+14b mainly developed river channel sand, and most of them are connected with the surrounding injection wells by river channels, and they are the main potential layers of remaining oil. SⅡ19b mainly develops river channel sand, and this well is connected with the surrounding 4 injection wells and belongs to the second type of connection; the SⅡ10 sedimentary unit belongs to inter-river development, and this well and the surrounding 3 injection wells belong to inter-river connection. Since SⅡ19b and SⅡ10 belong to intermediate water flooding, they also have the potential of remaining oil, so they are also the main horizons for measure tapping potential.

2.3. Analysis from dynamic monitoring data

From the point of view of liquid production section in front of the well fracturing, the main liquid production layer of this well is SⅡ1, the relative liquid production capacity is 66.4%, the water cut is 98.7%, the secondary liquid production layer is SⅡ19b, and the relative liquid production capacity is 32.8%, water cut is 98.8%. The main potential layer SⅡ13+14a and SⅡ13+14b did not produce liquid; it shows that fracturing transformation is urgent needed for this layer to further tap the remaining oil potential. Although SⅡ12 and SⅡ10 are inter-river developed, the degree of water flooding is intermediate water flooding, and they have the potential to further tap the remaining oil. Moreover, since this well has just been injected into the main slug at the current stage and begins to become effective, the main purpose of this stage is to promote the effect, therefore, measures should be taken as much as possible for layers with residual oil potential.

3. Selection and Implementation of Fracturing Ways

3.1. From the point of view of development condition and liquid production differences

The well group 121 is well developed but poorly connected. The effective thickness of this well is 13.4m, it is 1.3m higher than that of the whole area, and it is 1.7m lower than that of the second belt. The thickness ratio of the first type of connection is 28.73%, it is lower than 6.23% of the whole area and it is lower 5.94% than the second belt.

SⅡ13+14a and SⅡ13+14b mainly develop river channels; water flooding degree is high, SⅡ11 water flooding degree is intermediate water flooding, however, this well is the main liquid production layer, so these two layers adopt selective fracturing way. The SⅡ19b water flooding degree is the combination of high water flooding and intermediate flooding, and it is the secondary liquid production layer of this well, so selective fracturing is also used. SⅡ10 belongs to inter-river development, in order to further tap the potential of remaining oil, multi-fracture fracturing is adopted.

3.2. Plan compilation

The fracturing plan was compiled in April 2020, this well is divided into three sections to implement fracturing: the first section SⅡ12~SⅡ11 selective fracturing; the second section SⅡ19 selective fracturing; the third section SⅡ10-1 multi-fracture fracturing. Fracturing measure was implemented on May 29, 2020, and it achieves good oil increase and water decrease effect.
4. Fracturing Effect Analysis and Plan Adjustment

4.1. Enhancement of oil layer seepage capacity
The well testing data result of this well showed that the pre-fracturing curve hump in the constant flowing section was steep, and the curve hump disappeared after fracturing, and the trend was flat, the influence of constant flow was reduced, the seepage capacity was enhanced, and the formation press decreased from 12.83MPa before fracturing to 12.24 MPa, decreased by 0.59MPa, and the formation energy was released. The flowing coefficient rose from 0.069μm$^2$.m/mPa.s before fracturing to 0.122μm$^2$.m/mPa.s, increased by 0.053μm$^2$.m/mPa.s, and the flowing capacity of the system was enhanced. Moreover, the skin coefficient dropped from 5.18 before fracturing to -1.97 after fracturing and the bottom hole has high perfection degree.

4.2. Improvement of liquid production section
From the comparison of the liquid production section of this well before and after fracturing, it can be seen that the relative liquid production capacity of the SII13+14a without liquid production after fracturing was 15.73%; the relative liquid production capacity of the SII13+14b without liquid production after fracturing was 6.45%; the relative liquid production capacity of the main liquid-production layer SIII1 before fracturing decreased from 66.4% before fracturing to 37.5% after fracturing, decreased by 28.9%; The relative liquid production of the secondary liquid producing layer SIII9b before fracturing decreased from 32.8% before fracturing to 9.68% after fracturing, decreased by 23.12%; the relative liquid production capacity of the section SIII10 without liquid production is 30.65% after fracturing. The liquid production section of the whole well has been improved, the relative liquid production capacity of each layer has become uniform, the water cut of each layer has decreased, and the potential of remaining oil has been effectively tapped.

4.3. Enhancement of oil production capacity in oil layer
After the well 121 was fractured, the daily liquid production of the whole well increased from 5t/d before fracturing to 72t/d, increased by 67t/d, the daily oil production increased from 0.5t/d to 7.8t/d, increased by 7.3t/d, the water cut decreased from 90.80% to 89.20%, decreased by 1.6%, the effect of oil increase and water decrease is obvious. So far, the water cut has been in a downward trend. Because this well directly changed pump after fracturing, the pump diameter was changed from 44mm to 57mm. In the initial stage of fracturing well, the liquid production increased significantly, and the flowing press increased significantly, it rose from 2.3 MPa before fracturing to 7.3 MPa at the initial stage after fracturing. After the oil production well was opened for a period of time, the flowing press decreased from 7.3 MPa at the initial stage after fracturing to the 3.4 MPa at present. Due to the timely enlargement of the production press difference, the effect of fracturing measures was consolidated.

4.4. Post-fracturing plan adjustment
In order to ensure the fracturing effect, the pressure rise space of the surrounding injection wells were combined, the injection volume of the surrounding 3 injection wells was increased in time. The injection volume of injection well 120 was increased from 45m$^3$ to 50m$^3$, the injection volume of well 122 was increased from 40m$^3$ to 50m$^3$, and the injection volume of well 122 was increased from 30m$^3$ to 40m$^3$. Through the adjustment and implementation of the above plan, the formation energy was supplemented in time, and the effect of fracturing measures was guaranteed.

5. Conclusion
1). In the early stage of becoming effective, fracturing is an effective way to dig the remaining oil for oil production wells whose oil increase of oil and water decrease are not obvious.
2). After the oil production well is fractured, it is an effective method to ensure the fracturing effect by enlarging the production pressure difference in time and supplementing the formation energy.
3). Timely tracking and adjustment of injection wells around oil production wells is an effective way to extend the effective period of fracturing measures.

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