Feasibility analysis of large scale horizontal fracturing in Block N

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Abstract. After entering the ultra-high water cut stage, it is more and more difficult to tap the potential of remaining oil, especially in Block N, the conventional measures are not ideal and lack of effective measures to tap the potential. This paper describes the principle of large-scale horizontal fracture fracturing technology, analyzes the distribution characteristics of remaining oil in Block N, compares the effect of large-scale horizontal fracture fracturing measures, and initially provides the direction for the follow-up measures to tap potential.

1. Introduction
In view of the development of narrow and small channels in the transition zone, low degree of water drive control and multi-directional connectivity, large-scale fracturing technology is optimized for the residual oil existing in sporadic core beach, narrow and small channels, sheet sand at the edge of channel, thin and poor layer of front facies and off surface reservoir to improve connectivity and establish effective displacement between oil and water wells. According to the sand body distribution, the penetration ratio and sand adding scale matched with the sand body are designed according to the maximum sweep range.

2. Analysis of fracturing effect over the years
From 2011 to 2013, 33 wells were fractured in Block N for three consecutive years. After the measures, the average daily fluid yield of a single well was 36.3t, the daily oil production was 4.0t, and the comprehensive water cut decreased by 3.77%. Among them, 8 wells were fractured in 2011, with an average daily fluid increase of 36.4t and oil increase of 3.5t, and the comprehensive water cut decreased by 2.13%. In 2012, 15 wells were fractured, and the average daily fluid increase of single well was 39.3t, the daily oil production was 4.3t. In 2013, 10 wells were fractured. After the measures, the average daily liquid production of single well was 31.6t, the daily oil production was 3.9t, and the comprehensive water cut decreased by 4.4%.

3. Analysis of remaining oil potential
According to the analysis of dynamic and static data, there are four types of remaining oil in the northern transitional zone

3.1. Remaining oil of abandoned channel sheltered type
Some sedimentary units of A oil layers formation belong to the distal and middle shore deposits of distributary plain facies. Abandoned channel deposits are generally developed in these units, which are formed on the thin channel deposits at the bottom and thick fine-grained abandoned channel deposits
in the middle and upper parts. The lithology and physical properties of the abandoned river channel become worse, which can block the sand body of the river channel, and make the displacement effect worse. The relatively rich residual oil will be formed on both sides of the abandoned river channel, that is, the remaining oil covered by abandoned river channel.

3.2. The remaining oil of channel edge type
There are two kinds of remaining oil in the riverside: one is that the channel sand body in the riverway changes into the interchannel mudstone laterally. When the drilling is near the pinch out line of the channel sand body, the plane residual oil can be formed between the pinch out line of the channel sand body and the drilling well. The other is the single channel sheltered residual oil in large-scale composite channel. In the large-scale composite sand body, the inter channel part between single channel is very narrow, which is difficult to identify when the well pattern is sparse, and abundant sheltered residual oil can be formed in this kind of river channel.

3.3. Remaining oil in poor oil layers distributed in patches
This type of residual oil mainly exists in the thin and poor layers and extra surface reservoirs of delta-front facies. This kind of reservoir has the characteristics of large sand body distribution area, thin oil layer and poor physical property, and its producing degree is low. This kind of residual oil exists in some sedimentary units of B and C oil layers.

3.4. Remaining oil with uncontrollable well pattern
Most of the sedimentary units of A, D and C formations belong to the distributary plain facies over water nearshore deposits or delta front facies underwater nearshore and middle shore deposits. Narrow banded channel sand and irregular sporadic Tuo sand reservoirs are developed. The well pattern can not be controlled. In some well areas, injection without production or with production without injection will be formed, resulting in the imperfect injection production relationship of single sand body Remaining oil enrichment area.

4. Principle of large scale horizontal fracture fracturing
Process principle: the process string is similar to conventional fracturing, and the multi-layer technology of ball sliding sleeve setting pressure is adopted. The main features are to expand the scale of fracturing reform, control the whole sand body with the fractures produced by fracturing, and realize the full linear flow of formation fluid seepage into fractures and fracture fluid seepage into wellbore. Change the seepage mode of fluid in reservoir from radial flow to linear flow, reduce the seepage distance and seepage resistance.

5. Determination of fracturing horizon and effect analysis

5.1. Determination of fracturing horizon
Based on the fine geological research results and remaining oil monitoring data, it is considered that large-scale fracturing can be carried out in well M. Well M is a basic well in Block N. It adopts a 350m four point pattern to connect three water injection wells. The main oil layer of S is exploited. Nine small layers are drilled out in the whole well. The thickness of sandstone is 19.8m and the effective is 10.7m. The daily fluid production is 40.7t, the daily oil production is 3.3t, the water cut is 91.89%, the formation pressure is 10.52MPa, and the cumulative oil production is 6.7848×10^4t.

5.1.1. Determination of potential layer from sand body development characteristics
Combined with the development of sand body, the following potential layers are determined

E sedimentary unit: the well is developed in the contiguous main sheet strong sand, with the sandstone thickness of 1.4m and the effective thickness of 1.0m. Although there are three water wells for water injection, due to the relatively poor development of the sand body in the whole well and the
low degree of production for many years, it has the potential of transformation and tapping. The remaining oil in the reservoir can be replaced by elastic driving of reservoir.

F sedimentary unit: the well is developed at the edge of the river channel, the sandstone thickness is 1.4m, the effective thickness is 1.2m, the East is the off surface reservoir, the two water injection wells are in the East, so the long-term injection capacity in the East is low, and a certain amount of residual oil is enriched in the edge of the river channel, so the injection production relationship can be improved by expanding the fracturing radius, so as to improve the production degree of the reservoir.

G sedimentary unit: developed as sheet sand single sand body, south close to river channel, sand body development condition is poor, sandstone thickness is 0.8m, reservoir production is low, there is a certain amount of residual oil, reservoir liquidity can be improved by increasing the fracture radius, at the same time, a part of remaining oil at the edge of river channel can be reformed.

H sedimentary unit: it is developed at the end of sheet sand. Most of the connected water injection wells are developed outside the surface. It is a layer with poor reservoir conditions in this well. Because it has a certain amount of residual oil, it is considered to improve reservoir production by increasing the transformation radius and relying on elastic drive.

I sedimentary unit: it is developed in the channel variation area, with sandstone thickness of 3.6m and effective thickness of 1.6M. most of the connected water injection wells are developed outside the surface and have certain residual oil. Therefore, it is considered to increase reservoir production by increasing the transformation radius and relying on elastic drive.

5.1.2. Further determination of potential zones by boron neutron logging results
Boron neutron logging was carried out on the well on November 1, 2014. According to the measured data, K and L are high-yielding liquid layers. E, F, G and H have low production degree and high oil saturation, which can be used as potential reservoir for measures.

5.2. Starting from the optimization of parameters, the reasonable matching between scheme and reservoir is realized
According to the numerical simulation results of sand body penetration ratio and recovery degree with the same well spacing thickness and different conductivity, when the penetration ratio is 0.3, the recovery degree of the target layer is the largest. When the injection production well spacing of M well is 350m, the penetration ratio is 0.3, and the fracturing radius is about 100m, the recovery degree is the highest. At the same time, according to the development of sand body, the fracturing radius is further optimized to be 70m-80m.

5.3. Optimization of fracturing fluid in heavy oil transition zone
In view of the problem that the physical properties of crude oil and rock in the transition zone are affected by the physical properties and temperature of fracturing fluid, measures are taken to reduce the cold damage to the formation by reducing the viscosity of crude oil, increasing the formation temperature and accelerating the gel breaking speed and forced flowback. The specific methods are as follows: firstly, 2% PB-1 viscosity reducer is used to reduce the viscosity of crude oil; secondly, foaming flowback agent is applied to improve the flowback pressure and flowback rate, and reduce the wax and gum damage caused by low temperature injection; secondly, the fast gel breaking forced flowback technology is applied to reduce the residence time of fracturing fluid in the formation; finally, surfactant fracturing fluid system is injected to produce reservoir fluid Emulsification can improve the fluidity of reservoir fluid.

5.4. Scheme design and implementation effect
On the basis of fully understanding of sand body and combining with dynamic production characteristics, two large-scale moulded fracturing wells are optimized. The maximum half fracture length of two large-scale moulded fracturing wells is 80m, and the maximum sand adding amount of single layer is 75m³.
Well M was fractured on December 18, 2014, with 250m³ sand and 1670m³ fracturing fluid in the fourth section. The daily production of fracturing fluid is 122.3t, the daily production of fracturing fluid is 122.3t, the daily production of fracturing fluid is 7.3t, the daily production of fracturing fluid is 7.3t, the daily production of fracturing fluid is 78.7t, and the daily production of fracturing fluid is 7.7t. At present, under pump production, the daily liquid production is 122.2t, the daily oil production is 13.4t, and the water content is 89.00%. The cumulative oil increase was 3084t.

Well N was fractured on April 9, 2015. A total of 201m³ sand and 1740m³ fracturing fluid were added in the fourth section. Before fracturing, the daily fluid yield was 31.3t, the daily oil production was 0.91t, and the water content was 97.10%. After fracturing, the daily fluid production was 190.1t, the daily oil production was 5.9t, and the water cut was 96.90%. At present, the daily liquid production is 180.1t, the daily oil production is 3.1t, and the water content is 98.30%. The cumulative oil increase was 710t.

6. Conclusion

(1) Large scale horizontal fracture fracturing can achieve good results in Block N.
(2) Good compatibility test of fracturing fluid and preparation of fracturing fluid according to the test results can effectively improve the properties of underground fluid and further improve the fracturing effect.

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