Field test practice and understanding of effective utilization technology for dense and refractory reservoir in block A

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Abstract. In view of the ultra-low permeability reservoirs in Block A of Hailar Oilfield, it is difficult to establish an effective driving system between oil and water wells due to the influence of many oil-bearing strata, poor reservoir physical properties and large vertical span of oil layers. With the deepening of development, it is more difficult to use reservoirs. In order to realize the effective utilization of low permeability reservoirs in Beier Oilfield, the successful experiences of tight oil and Hailar large-scale fracturing in peripheral oilfields are summarized, and the effective utilization technology of large-scale fracturing supplementary energy development is explored. The large-scale fracturing evaluation of ultra-low permeability reservoirs and the optimization of potential well areas are carried out, so as to fully tap the乐团.

1. Introduction

Taking Block A as an example, the buried depth of the oil reservoir in the second member of the south of this area is about 2500 m, the porosity is 9 %, and the permeability is 0.61 MD, which are all low porosity and ultra-low permeability reservoirs. Low permeability reservoirs have large reserves and low oil recovery rate. In recent years, many energy supplement tests have been carried out, but no effective breakthrough has been achieved. In order to solve the problems of large unutilized reserves and low productivity of single well in tight sandstone reservoirs, large-scale fracturing well group tests are carried out in ultra-low permeability tight reservoirs in Hailar Oilfield from the perspective of effective utilization in developed areas, improving oil recovery and revitalizing inefficient assets, so as to implement the feasibility of ultra-low permeability reservoirs. Affected by factors such as strong reservoir heterogeneity, poor physical property, large vertical span of oil layer and water injection, the fracturing effect is quite different. Therefore, it is urgent to carry out reserve evaluation and optimization of ultra-low permeability reservoirs and study on subsequent energy supplement methods[1,2,3]. The following four main results were achieved:

2. Deepening the geological understanding of low permeability tight oil reservoirs

Carry out geological research, deepen the understanding of well selection sweet spot area and effective reservoir, optimize the fracturing scheme of low permeability tight reservoir, and provide theoretical basis for the next large-scale fracturing promotion.

2.1 Geological re-understanding and analysis of favorable and unfavorable conditions for reservoir formation

The favorable conditions for reservoir formation in Block A are as follows: near-source reservoir formation, low structural uplift area, structural-lithologic reservoir formed by the cutting of early sedimentary faults, and sand deposition between rivers. The intersection of multiple rivers leads to differences in adjacent well facies, sand thickness and physical properties. Unfavorable factors: sand body staggered contiguous distribution, vertical multi-stage superimposed, poor lateral connectivity, different layers of thickness difference[4,5].

2.2 Effective thickness review under the guidance of fine facies control characterization to identify reservoir development sweet spot area

The south second member of A well area is mainly controlled by the south and southeast provenance, and mainly develops underwater distributary channel, mouth bar and turbidite sand. Through fine description of sedimentary microfacies, the development scale and distribution law of developed oilfield fans are revealed. The effective thickness of old wells was re-examined, and the interpretation coincidence rate was improved by correcting the chart. The effective thickness of some wells changed greatly, and the effective thickness distribution of the new interpretation was more in line with the understanding of sand bodies under the guidance of sedimentary microfacies. The dessert area was re-recognized in the development zone. The effective thickness of oil group II was relatively developed in the middle of the fault block, and the effective thickness of oil...
3. Standard and direction of well layer selection for large scale fracturing oil production characteristics

3.1 Optimizing the sweet spot area of tight reservoirs

The project focuses on the research on ultra-low permeability reservoirs in Bell Oilfield, combining the sedimentary characteristics of ultra-low permeability reservoirs, and in accordance with the existing knowledge of the reservoir and the results of geological and logging research, the introduction of facies-controlled geostatistics seismic attribute inversion, and the focus of tight oil development. Reservoir classification evaluation in large-scale fracturing test well area, realizing the evaluation and optimization of high-quality reserves of ultra-low permeability oil reservoirs in Block A.

Table 1. Reservoir classification evaluation in well block A

<table>
<thead>
<tr>
<th>Well number</th>
<th>liquid measure (m³)</th>
<th>sediment discharge (m³)</th>
<th>sand strength</th>
<th>quan tity</th>
<th>production (t)</th>
<th>liquid measure (m³)</th>
<th>sediment discharge (m³)</th>
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<th>quan tity</th>
<th>production (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A15</td>
<td>460 610</td>
<td>50 70</td>
<td>2.4 2.4</td>
<td>0.1</td>
<td>2246 120</td>
<td>120 140</td>
<td>6.8 6.4</td>
<td>7</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>A85-67</td>
<td>320 80</td>
<td>60 30</td>
<td>1.2 3.2</td>
<td>5</td>
<td>2300 60</td>
<td>160 20</td>
<td>1.2 4.1</td>
<td>7</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>A39-61</td>
<td>550 220</td>
<td>60 25</td>
<td>3.2 4</td>
<td>4</td>
<td>2462 80</td>
<td>80 30</td>
<td>3.0 7.5</td>
<td>7</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>A4-1</td>
<td>750 30</td>
<td>80 3</td>
<td>5</td>
<td>1.3</td>
<td>2650 1245</td>
<td>1245 180</td>
<td>1.8 5</td>
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3.2 Geological analysis of fracturing wells

Referring to the exploration ideas of tight oil and the technology of volume fracturing, secondary fracturing of old wells such as A39-61 in the oil layer A39-61 in the second member of the South around block A was carried out. Good oil-increasing effect, the combined pressure of the third section of Well A15, 6611 cubic meters of fluid out. Good oil-increasing effect, the combined pressure of second member of the South around block A was carried technology of volume fracturing, secondary fracturing of

4. Formation of mature matching technology for tight oil fracturing

According to the characteristics of reservoir development and development status, the fracturing technology and fracturing scale are selected, and the key parameters are defined for the low permeability interbed of sand and mud. The sand production and sand plugging risk are reduced by optimizing the process to ensure the fracturing effect. In view of the problems of difficult sanding, sand stuck pipe string and long flowback period in 2019, several process improvements of tight oil fracturing geological design and engineering design in 2020:

4.1 Geological design optimization of tight oil fracturing

Reduce the number of single-stage fracturing sections and reduce the risk of stuck strings. The number of single-stage strings is controlled at 3-4 segments and the span of single-stage string tools is controlled within 150 m. The application of hydraulic pump to speed up the flow rate, large-scale fracturing fluid volume, long time into the well, fracturing fluid fracture ability at the same time to consider reducing residual pollution, after the use of hydraulic pump drainage, the daily flow rate of pumping unit increased from 30 m³ to 100 m³, strive to flow rate within 30 days can reach 100 %.

4.2 Optimization of tight oil fracturing process design

In view of the difficulties in sanding, sand stuck string and long flowback cycle in 2019, the engineering department puts forward the following five suggestions for fracturing in 2020:

4.2.1 Optimized fracturing fluid for comparative test

Large-scale fracturing fluid consumption, long time into the well, fracturing fluid fracturing ability while

Table 2. Comparison of construction parameters between conventional fracturing and fracture network fracturing

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<th>quan tity</th>
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average value 452 49 2.4 0.6 1997 74 3.9 4.9
considering residual pollution; it is suggested that 1 – 2 clean fracturing fluid tests should be continued in 2020, and guar gum fracturing fluid should be used in wells. The concentration of crosslinking agent and the adding procedure of gel breaker in each stage should be optimized.

4.2.2 Increasing construction displacement and reducing sand plugging risk

The construction displacement is proportional to the seam width. The maximum construction displacement in 2019 is 7 m³/min, and the pump truck pressure limit is 60 MPa. In order to improve the seam width and reduce the risk of sand plugging, it is suggested that the construction capacity should be improved in 2020, the pump truck pressure limit should be increased to 65 MPa, and the displacement should be increased to 8 m³/min.

4.2.3 Optimizing the structure of seat pressure string and reducing the risk of pipe sticking

In 2019, 24 layers of 5 wells were constructed. Due to the large scale of construction and long time of well down, the phenomenon of pipe string sticking after pressure is common. In order to reduce the influence of tool string factors on the pipe string, it is recommended to replace the pipe string once in 2020 when the stratification exceeds 3 segments or the tool crossing distance exceeds 100 m.

4.2.4 Speed up drainage at high water cut stage

The average oil breakthrough time after well pressure measures in 2019 is 40 days, and the average production is 237 days, with a cumulative return rate of 82 %. During the operation in 2020, after the fracturing string is lifted, the pump is not lifted. Three wells are optimized to use hydraulic pump to discharge liquid. The daily discharge capacity is about 100 m³, and the return rate is expected to reach 100 % within 30 days.

4.3 Adopt a variety of monitoring means to ensure fracturing and post-fracturing effects

Two large-scale fracturing wells were selected to carry out tracer monitoring, and tracer was injected into the fracturing interval. Through continuous sampling and analysis of the samples, the water production profile of each fracturing interval and the water production contribution rate during continuous monitoring can be obtained. From the water production contribution rate of each layer curve, it shows that fracturing has transformed the reservoir into a relatively stable seepage environment, and a comprehensive interpretation and evaluation of the fracturing transformation status of the stratified fracturing construction wells can be carried out. Comprehensive evaluation of fracturing effect in Well A2 - 71: the total fluid inflow is 4850 m³, the general flowback is 3117.2 m³, and the general flowback rate is 64.27 %. The return rate of each section from large to small is as follows: layer 2, 1, 5, 3, 4. See the following table for details. The recovery rate of tracer from high to low is as follows: layer 2, 1, 5, 3, 4.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Layer 2</th>
<th>Layer 3</th>
<th>Layer 4</th>
<th>Layer 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid production (m³)</td>
<td>1101.0</td>
<td>1334.0</td>
<td>837.0</td>
<td>539.0</td>
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<tr>
<td>Water yield (m³)</td>
<td>720.5</td>
<td>1130.6</td>
<td>450.4</td>
<td>172.2</td>
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<tr>
<td>Flowback rate (%)</td>
<td>65.4</td>
<td>84.8</td>
<td>53.8</td>
<td>31.9</td>
</tr>
<tr>
<td>Types of indicator</td>
<td>Er</td>
<td>La</td>
<td>Tb</td>
<td>Ce</td>
</tr>
<tr>
<td>Total addition of tracers (g)</td>
<td>4324.0</td>
<td>5240.0</td>
<td>3268.0</td>
<td>2076.0</td>
</tr>
<tr>
<td>Tracer output (g)</td>
<td>2612.6</td>
<td>4099.6</td>
<td>1633.6</td>
<td>624.6</td>
</tr>
<tr>
<td>Recovery rate of tracer (%)</td>
<td>60.4</td>
<td>78.2</td>
<td>50.0</td>
<td>30.1</td>
</tr>
</tbody>
</table>

The tracer test results show that the main water production layer of Well A2 - 71 is the second, first and fifth layers, and the contribution rate of water production during the 60 - day monitoring period is 80 % in total. The contribution rate of water production varies at different times, with small variation in layers 1, 2 and 5 and large variation in layers 3 and 4. The contribution rate increased to paragraphs 2 and 3 ; contribution rate decreased to layers 1,4 and 5 ; fracturing effect is good for layer 1, 2, 5, medium for layer 3, poor for layer 4.The contribution rate of water production was linearly and positively correlated with the total liquid inflow and sand addition. The correlation coefficient between water production contribution rate and total liquid inflow is 0.8552, and the correlation coefficient with sand addition is 0.9984. It shows that the amount of sand is the main factor of fluid volume in each fracturing layer.

5. The subsequent energy supplement of tight oil fracturing wells

There are 14 water injection wells in the test area. At present, there are 4 wells in the pressure-boosting water injection test, and the average daily water injection rate of single well is 7.8 m³/d. The main block is elastic mining, and the production decreases rapidly. It is necessary to carry out energy enhancement test. One is to plan to carry out large-scale fracturing well CO2 Huff and puff, and use the mechanism of CO2 expansion crude oil volume to supplement formation energy. Considering the energy supplement for large-scale fracturing wells, through the principle of carbon dioxide Huff and puff replacement, considering the energy depletion of large-scale wells, considering the low liquid production, low daily oil production, insufficient fluid supply and well condition with good casing sealing, carbon dioxide Huff and puff is carried out.

6. Conclusion

Through the geological re-understanding of structure, sedimentation, sand body and oil-water distribution law, the optimization of test well area is realized. Through the comprehensive classification and evaluation of reservoirs, the classification and evaluation standard of tight oil
reservoir reserves is established, and the optimization of well location and horizon of large-span reservoir in Nantun Formation is completed. Through the study of rock mechanical properties, block stress field and fracturing mode optimization, combined with the experience of large-scale fracturing in 2019, the optimization of fracturing scale and construction parameters are realized. Conventional fracturing cannot meet the effective production demand of tight reservoirs. According to the integration of 'sand body scale and fracturing scale', the breakthrough of effective production technology of tight reservoirs can be achieved by improving the sand body control degree and reserve production rate through the energy supplement of old wells in the to achieve the goal of improving sand body control degree and reserve utilization rate.

References