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Research on Optimum Design of perforation scheme for horizontal well

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Abstract. In the extra high water cut stage, the remaining oil mainly exists in the channel sand body, and the low and non watered thickness of the reservoirs with poor utilization is mainly distributed in the top of the thick oil layer and the variation zone in the layer. The horizontal well is drilled, the horizontal trajectory does not guarantee that all in the remaining oil in the region, so in the concrete establishment should be based on the actual position of perforating drilling trajectory in the reservoir, combining with the lithology and water flooded layer interpretation results and the latter measures to adjust the requirements, application of new techniques of perforation optimization scheme, which can control the initial water content, and can ensure higher capacity requirements, using horizontal well succeeded in tapping the potential of remaining oil at the top of thick oil layer, better development effect.

1. Foreword

X put into the development, has experienced three major adjustments, through the research and practice of oilfield development and multidisciplinary reservoir, extra high water cut period of remaining oil mainly exists in the channel sandbody, through horizontal well drilling mode can excavate the residual potential, provide technical reserves for extra high water cut stage in thick oil layer the potential of residual oil. Through the study of reservoir sedimentary characteristics, injection production relationship and residual oil distribution, the A deposition unit in X area is determined to be the potential layer of horizontal well.

The A oil layer belongs to the distributary plain and far shore deposits. The sand bodies are distributed in the north and south. The abandoned rivers develop, and the interlayer between the upper and lower sedimentary units develop stably. The remaining oil is mainly concentrated in the abandoned river channels and the thick sand bodies that the fault blocks. According to the principle of horizontal well optimization, taking into account sand body size, interlayer development, injection production pattern and remaining oil distribution, we finally decide to develop horizontal wells in the area around Y1, Y2, Y3 and Y4 four wells in X area, and aim at A deposits. The structural features of the top surface of the A sedimentary unit are nearly north-south distribution, the top of the sandstone top is higher in the South and lower in the north, and the structure is basically gentle. According to the region have been drilled wells reservoir development, the average thickness of 3.55m A reservoir sandstone, the effective thickness is 2.72m, the maximum thickness of sandstone is 5.4m, the maximum thickness is 4.2m, the average permeability of 407 x $10^{-3}\mu m^2$ tested, maximum permeability is 1080 x $10^{-3}\mu m^2$ selection.

2. Property analysis of oil layer after drilling

2.1 Case of drilling well

After drilling in X- Ping 1 well in 2011, we made use of logging interpretation, logging interpretation and vertical well contrast method to analyze the reservoir development and water flooded condition after drilling.

The interpretation results were analyzed at 1122.49m level, and the horizontal section length was 452.61m. The total well interpreted 13 layers, and the total length was 466.4m, of which the low water flooded layer was 5 layers, the length was 422.4m, the middle water flooded layer 3 layers, the length 20.6m, the high water flooded layer 3 layers, the length 20.4m.

2.2 Comparison between actual drilling and model prediction

From the comparison of the interpretation layer of the drill and the model prediction, the horizontal section of the well actually drills the target layer A, and does not meet the other layers. The results of the logging interpretation of the horizontal well drilling trajectory show that the horizontal section of the target layer meets the good channel sand body.

3. Optimum design of perforation scheme

After the horizontal well is finished, the perforation completion mode of the lower casing is adopted. The formulation of a reasonable perforation scheme can effectively control the initial water cut and improve the productivity of the horizontal well. According to the basic theory of horizontal well perforation and some successful horizontal well perforation schemes, the perforation scheme of the well is optimized.

3.1 Perforation principle

In order to extend the development time of horizontal Wells to guarantee the development effect, the control measures of perforated well section are proposed and the following perforation principles are proposed:

When the perforation section is made, the well section should be studied and determined according to the logging interpretation data, logging data and the results of 3D geological modeling.

Perforation takes control of water content as the first. The actual drilling trajectory is interpreted as middle or high water flooded or real drilling trajectory above the surface of geological model, and mud logging interpretation is not perforation, and comprehensive interpretation is low and not flooded as perforation well segment.

The perforation scheme shou be left open for later measures.

3.2 Selection of perforation layer

Due to the discrepancy between the prediction model and the actual stratigraphic situation, there is a deviation between the actual drilling trajectory and the design trajectory. In selecting perforation section, we should not only meet the design requirements of horizontal wells, perforate the target layer, but also adjust properly with actual conditions. Considering the actual difficulties of water level rise well after difficult to control, horizontal well should be perforated low water flooded layer section remaining oil relatively more, in order to ensure the horizontal well production requirements should give priority to the perforated thickness horizontal section is relatively large, and the first shot injection production relationship better layers.

According to the design requirements, the level of the horizontal well is A. According to the perforation principle, 1138.6-1508.0m and 1531.0-1553.0m in the low water flooded section of the actual drilling level are preliminarily determined as the target of the perforation.

3.3 Determination of the length of perforated well

The yield of horizontal wells with different lengths is very different, but the difference of yield decreases with the time. This is because increasing the length of perforating section of horizontal well can increase the contact area between horizontal well and oil layer. The fluid flowing into the wellbore will increase, but at the same time, the energy attenuation of the stratum will be faster and the production will decrease faster. In the extra high water cut stage oil reservoir have been to see the water, in order to ensure the horizontal well productivity, while controlling the rising speed of water, perforation length should be based on the level of water use situation as the basis, try to use the remaining oil enrichment area poor shot. According to the test results of the theoretical model of horizontal well perforation, perforation should be multi perforation, one can get a higher capacity, on the other hand can be carried out using sandwich fracturing between each stage of production decline more parts of residual oil can be increased after plugging in the water to water higher position.

The X- level 1 determines that the first target layer is 1138.6-1508.0m and the water saturation is

41.5%, which is low water flooding. The structural features and actual drilling conditions are analyzed. For 1330.2m, there are only three 1m for the structural low point, 1232.5m and 1349.5m distance. The perforation should be avoided when considering the later water cut and preventing the perforation. Based on the theoretical basis of multi section perforation based on horizontal well, combined with the actual length and experience of this section, three sections of perforation in this section are determined. An 1126.0-1156.0m and 1336.0-1366.0m measures were left 30m, could be considered as post fracturing, interlayer plugging measures; A reservoir in quality 1121.0-1136.0m poor cementing, protection layer, prevent cross flow, in the A layer of horizontal section at the left 1138.6-1150m 11.4m A in 1531.0-1553.0m layer measures; reservoir water saturation, 46.2% for the low, flooded, normal shot, leaving behind 1153.0-1175.0m 22m A funnel; reservoir interpretation is mudstone in 1508.0-1531.0m logging and logging, but from the analysis of the model on the drilling trajectory for sand and river sand beneath the river, for tapping the potential of residual oil in this segment also shot.

3.4 The determination of perforation density and azimuth angle

The optimization of the azimuth angle of the perforation can increase the output, and the optimization of the phase angle can find the direction of the remaining oil enrichment, and the output increases with the increase of the perforation density. According to the fact that the remaining oil in the oil field is concentrated on the top of the thick oil layer and the fact that the injection and production cycle is invalid at the bottom of the layer, the perforation method of oil tube level or upward elevation is usually adopted for perforation azimuth selection, and the two phase perforation is adopted. The 10 hole /m is generally adopted in the hole density considering the characteristics of the strength of the oil and casing and the small pressure difference in the horizontal well.

Due to the different drilling intervals in different layers, in actual perforation, according to the different positions of different wells in different layers, five phase perforation sections adopt different phase angle perforation methods. At 1150.0-1126.0m, the elevation angle of 15 degrees on the perforation, a horizontal well with as far as possible the elevation of perforation mode and tapping the potential of residual oil in thick oil layer at the top of the requirements, on the other hand to avoid excessive wear to shoot elevation perforation layer on top of interlayer; in 1256.0-1336.0m and 1366.0-1508.0m, because these two wells from the A reservoir top circle vertical depth is small, consideration for the protection of the top layer to the two layer, the level of perforation,; at 1508.0-1531.0m, with the deepening of the drilling trajectory, constructed from the top to the bottom, because the perforation interval close to the upper section of the sandwich, the elevation at 30 DEG perforation; at 1531.0-1553.0m, with the further deepening of drilling the drilling trajectory has been drilled to the bottom of A, considering with production time, A at the bottom of oil will form high water flooded parts, so this section to choose The elevation angle 15 degree perforation mode is selected to avoid the bottom water coning in the water flooded layer, and the water cut rise is better controlled.

4. Analysis of initial effect and potential

X- Ping 1 put into operation in December 2011, at the beginning of operation, liquid flowing production Nissan 64.6t, Nissan oil 21.9t, 66.1% water, then insufficient fluid supply, with better production of horizontal well, ensure liquid production, after analysis and comparison, to around 2 wells Z1, Z2 on May 2012 in A reservoir in corresponding fill hole. To improve the injection production relationship. In 6 month of 2012, the pump was produced in 6 months. At present, the daily production liquid is 86.5t, the daily oil production is 15.1t, the water cut is 82.6%, and the cumulative oil production is 2926t by the end of October 2012. The average daily liquid of the surrounding wells is 22.0t, the daily oil production is 2.5t, and the water cut is 88.6%, which is 6 times that of the daily production oil of the straight well.

Potential analysis: with the extension of mining time, oil production will decrease and water content also needs to rise. First, with the increase of water content, it can seal up the lower part of A

oil reservoir at a certain time. Two, combined with logging data, such as production profile and other logging data, we can analyze the utilization of different sections, and select the suitable location for fracturing the location where the remaining oil is more. Three, in order to ensure the mining effect of horizontal wells and prolong the mining time of horizontal wells, the surrounding water injection wells should be adjusted in time according to the mining conditions of horizontal wells.

5. Summary

5.1 The oil field development enters the extremely high water cut period, using the horizontal well to dig the remaining oil on the top of the thick oil layer becomes an important method for the oilfield development.

5.2 The length of horizontal well determines the production level, but not the longer the better. We should choose perforation selectively according to the location of drilling interval and water flooded condition, and we should give priority to shooting the low and middle water flooded part with residual oil.

5.3 The multi section perforation method should be adopted in horizontal wells, on the one hand, the capacity can be guaranteed, and on the other hand, there is a measure partition for the future measures.

5.4 The perforation of horizontal well should be based on the actual drilling trajectory and select different angle perforation for the actual situation of each layer.

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