The effect and design of the mass fracturing technology for the Polymeric Surfactant flooding in meandering river deposit

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Abstract. The fracturing technology in the process of improving recovery after the polymer flooding of meandering river in Daqing oilfield is the key technology and research focus of polymer flooding in late stage and oil recovery. Based on the experimental zone geological fine dissecting and residual oil description of the meandering river sand, combining movement to determine the location of the remaining oil and fracturing scale, integrated the meandering river sand mass fracturing technology is determined. finally, enhance oil over 5.6 times. Studies show that geological fine study and anatomy is the precondition of the effective construction measures, the premise of effective through movement at the same time combined with the characteristics of area of remaining oil is described, through the reasonable fracturing method and size to extract and the scale effect; after polymer flooding the abandoned channel sand body and lateral accretion of the meandering river sand body reservoir for well group unicom relations and remaining oil has a serious impact, remaining oil exists in abandoned channel side and the interior of the lateral accretion; at present, the fracturing of meandering river sand body is required to increase the construction scale appropriately, and release the remaining oil at the top of the oil layer by means of pressing to wear abandoned channel and lateral accretion.

Keywords: Meandering river sand; mass fracturing; Polymeric surfactant flooding; Abandoned channel; Residual oil

1. Introduction

In Sazhong Development Area, a class of reservoirs, typified by meandering river deposits, has been completed in the development stage of polymer flooding. Most of the well patterns continued to develop after subsequent water flooding or return to the upper level. After some of the pilot zones were further flooded, Oil recovery field test. It is one of the on-the-spot experiments being carried out in the eastern part of the fault-prone poly-flooding polymer reservoir in order to further tap the heterogeneity reservoir after the polymer flooding is distributed in medium and low permeability reservoirs and away from the remaining oil of the two wings of main streamline of injection and production wells[1-5]. Based on the fine geologic study of poly-aggregator test area and the detailed description of remaining oil in reservoirs, the driving characteristics of poly-surfactant after poly-flooding are further clarified. Combined with multi-year multi-well fracturing tests and follow-up evaluation, the author puts forward a new fracturing model for large-scale fracturing during chemical flooding under meandering river deposition in order to cut off the mezzanine at the top of the reservoirs by means of large-scale fracturing and release the remaining oil at the top of the reservoirs, provide guidance on fracturing design during chemical flooding under stream deposition conditions.

2. Geological Survey Area

According to the identification methods proposed by scholars[6], the experimental area identified the abandoned river channels at the top of $PI2^2$ and PI3 units with side-intercalated melanges at the edges, which greatly hindered the seepage the top of the reservoir[7-8]. According to the discriminant criterion of regional dominant channel, when the rate of water production is more than 95%, the displacement efficiency is more than 65% and the permeability is more than $500 \times 10^{-3} \mu m^2$, RLLD can be divided into dominant seepage channels when the shale content is less than 10%. Therefore, the bottom of $PI2^2$ and PI3 develops 2m of the dominant percolation channel. In summary, the $PI2^2$ and PI3 units manifested as the top abandoned river development, which accompanied by the presence of lateral mezzanine, the bottom of the dominant channel obvious features.

3. Well Fracturing Well Election Program

3.1 Injection Well Dynamic Analysis of Auxiliary Well Selection Method

Laboratory measured results show that: Poly tableting agent has the advantages of good tackiness and good 24-hour dynamic viscosity stability, and the retention rate of 7-day viscosity can reach 127%, and its self-adhesive ability under static conditions is strong. The 7-day emulsion analysis shows that the emulsification stability is good, and the emulsion viscosity is 131mPa·s when the aqueous phase is 90%. Therefore, the poly-aggregates have the properties of bulk hydration once-tackified to form a two-stage thickening of the emulsion secondary thickening[9-11]. If the poly-aggregates can play a role in the meandering river, the dominant channels at the bottom of the sand body are effectively flooded and plugged, and an effective emulsified oil wall is formed in the high oil saturation zone in the layer.

In the test area, samples of wells were collected at different injection pore volume multiples and sampling wells with different well spacing from injection wells to determine the state and effect of the aggregates agent in the formation. The results of the interwell sampling are shown in Table 1. As for April 2017, the results show that when the accumulating agent is injected into 0.8PV accumulatively, the sample concentration at the 106m well spacing of the mainstream of injection well has reached 701mg/L and the concentration is close to the injection well of the half level, the ground test viscosity of 5mPa·s, much higher than the sampling 328mg/L in 2015, viscosity 1.4 mPa·s. Therefore, the current sampling results show that the conditions and possibilities of plugging adjustment have already been achieved in the formation near the well depth of 3/5. At the same time, sampling with emulsified crude oil shows that the formation has the condition and possibility of secondary viscosity increase of emulsion.

Table 1 The result of sampling wells in test area for polymer surfactant

WELL NUMBER	SAMPLING TIME	WELL SPACING	DIRECTION	INJECTION WELL		INTERMEDIATE SAMPLING WELL		PRODUCTION WELL	
				DENSITY /mg/L	VISCOSITY /mPa·s	DENSITY /mg/L	VISCOSITY /mPa·s	DENSITY /mg/L	VISCOSITY /mPa·s
QYJ-1	2015.10 (0.45PV)	59m	MAINSTREAM LINE	1747	75	328	1.4	313	1
QYJ-2	2017.04 (0.8PV)	106m	MAINSTREAM LINE	1413	38	701	5	475	2.8

3.2 Fracturing Wells Preferred Method

Through the careful geological modeling, the sedimentary model and inter-well connectivity in the experimental area were determined, and some areas were seriously obstructed by abandoned river courses. Taking the well JBJQJ-4 as an example, the sedimentary facies results in Fig. 1 and Fig. 2 indicate that the wells in Block JBJQJ-4 are obscured in the middle of the abandoned river channel of units $PI2^2$ and PI3 and the top of the reservoir is obscured. CMG was used for numerical simulation to characterize the remaining oil in the experimental area. The remaining oil in the experimental area was enriched in $PI2^2$ unit of the abandoned river and was obscured by the abandoned river. The amount of remaining oil in the East that is not connected is much larger than in the West. There are abandoned river channels in PI3 units, and lateral side interbeds intercept, and the remaining oil exists in the edge of abandoned river channels and is enriched in the lateral mezzanine.

The results of geologic fine interpretation and numerical simulation of the experimental area show that the residual oil potential of the well group in the experimental area lies in the residual oil in the interior of the lateral mezzanine and obstructs the edge of the abandoned river. Therefore, the selection of well fracturing wells well again considering the well to have abandoned river channels and lateral sandwich structure, with some residual oil potential.

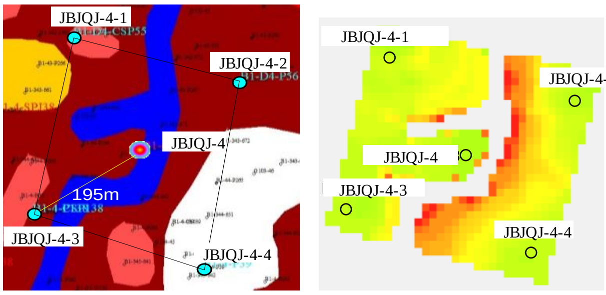

Figure 1 The results of geological interpretation and remaining oil for $PI2^2$ in JBJQJ-4 well

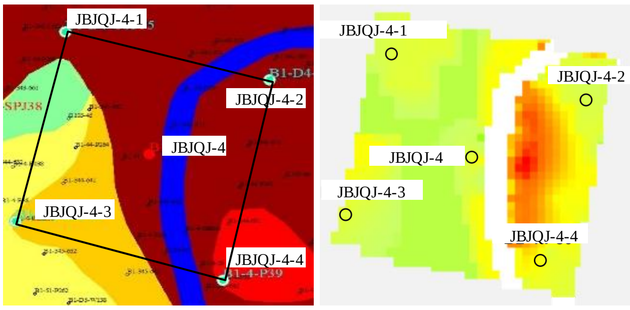

Figure 2 The results of geological interpretation and remaining oil for PI3 in JBJQJ-4 well

4. Fracturing Location and Size of the Choice

4.1 Determination of the Location of Fracturing

Through the above "the mechanism of the agent to clear the possibility of plugging, injecting wells to determine the plugging effect of step-down pressure. Corresponding to the well of geological exploration and numerical simulation combined with clear residual oil and dominant channel location, drilling down to further confirm the residual oil potential," the corresponding analysis of oil and water wells. The results show that the dominant channel at the bottom of $PI2^2$ unit and PI3 unit in the experimental area is developed. At present, the plugging feature is already present through the long-term plugging action of the polyblend agent. At the same time, the remaining oil of the oil layer has the part obstructed by the abandoned river channel and the lateral interlayer is more concentrated. Therefore, fracturing wells were selected in the test area which developed the $PI2^2$ unit and PI3 unit and the existence of abandoned river channels and lateral intercalation of wells, the top of the two layers of the implementation of large-scale fracturing measures to further improve the relationship between injection and production, through fracturing improving the leading edge diversion ability, release the remaining oil.

4.2 Determine the Size of Fracturing

The results show that under the condition of geology and well spacing (175m) Set in the range of 100-140m. If it is 40m fracturing radius, did not press to the area of high residual oil saturation. In normal production, the radial flow is flat. When the fracturing is 40m, the leading edge of the pressure reducing funnel is located at 40m and becomes a planar linear flow in the range of 40m. When fractured to 60m frac in 2016, the leading edge of the pressure-reducing funnel is located at 60m and pressed to the high saturation zone to increase the water content and reduce the water content. Therefore, it is necessary to optimize the fracturing process controllable parameters - and increase the fracturing scale. Based on the current fracturing reanalysis and numerical simulation results, the lower limit of fracturing size of oil well with polyblend is 60m (penetration ratio is 0.35).

The upper limit of fracturing size was determined by three fracturing of well JBJQJ-9. The first fracturing is the middle stage (0.41PV) injection of polyblend agent, which is a conventional fracturing operation with a fracturing radius of 40m. After fracturing, the daily production rate increases by 20.48t/d and the daily oil production increases by 5.09t/d, And the water content decreased by 5.6%. The second fracturing was a large-scale fracturing test. The fracturing radius increased to 60m, the daily production of oil increased 17.91t/d after fracturing, the daily oil production increased 8.16t/d and the water cut decreased by 13.08 %; The third fracturing is a large-scale fracturing test to explore, the fracturing radius further increased to 100m, after the flotation of Nissan increased 27t/d, Nissan 2.96t/d increase in water content increased by 1.2%, by further increasing The scale of fracturing, the overall effect after fracturing reached the fracturing effect two years ago, and achieved certain results in the late stage of the development of poly-aggregates. However, the amount of fractured sand is proportional to the square of the fracturing radius. With the increase of the fracturing radius, the amount of sand added rapidly increases the operating cost significantly. At the same time large-scale fracturing fluid on the performance of sand carrying fluid and sandblasting machine put forward higher technological requirements, the third fracturing can only use unconventional thickener as carrying sand, causing more difficult construction, And due to the difficulty of solid sand increases, fracturing produce a slight sand phenomenon. Therefore, field tests show that the upper limit of fracturing required by fracturing technology is 100m. Therefore, based on the comprehensive evaluation of fracturing technology, remaining oil distribution and economic benefits, the upper limit of fracturing size should be 80m (penetration ratio is 0.44) for the test area with residual oil with side-zone interbedded occlusion.

4.3 Fracturing Process Optimization

Through the above field test results, the criteria for well selection and the technical requirements of fracturing are determined. In the choice of fracturing process, the use of selective fracturing, to ensure that can open the design site. In the design of fracturing pipe, spray sandblasting, lock sandblasting, multi-stage packers direct connection, sealed airtight chamber, reserving channeling flow isolating belt and other combination applications, the implementation of precision positioning fracturing. In the optimization of fracturing program, through the different viscosity fracturing fluid slug injection, variable displacement construction, optimization of the proportion of prefabricated long slit, multi-level wedge sand support control to achieve the effective penetration of the lateral product mezzanine. First, increase the proportion of the precursor solution to ensure the effective penetration of cracks to extend; Second, refine the step of adding sand, from the conventional stage 4 to 6 stages to reduce the sand than the ladder; Third, the application of resin sand control technology, appropriate to increase sand usage of resin.

5. Fracturing Effect

Large-scale fracturing has been carried out in the zone of poly-agent deposited on meandering river, so far, a total of 4 large-scale fracturing tests have been carried out. Fracturing effect is mainly reflected in a fracturing oil increase effect, high yield multiples. The average fracturing radius is 63m, which is 2.5 times larger than the previous scale. After conventional fracturing the average multiplication rate of 2.8 times the oil multiples of 2.9 times the increase in oil is basically reflected in the effect of increasing liquid. After an average of large-scale fracturing fluid 3.5 times, 5.4 times oil, moisture content decreased significantly. The oil production intensity increased from 4.52t/(d·m) before and after fracturing to about 6.77t /(d·m) before and after large-scale fracturing.

Second, do a good job after pressure protection measures is the key to increasing production and stable production. In the early stage of fracturing, large-scale fracturing wells can achieve high-speed fluid production. However, as the development time prolongs, if the liquid supply capacity drops, the fluid production capacity can not be guaranteed accordingly. In order to improve the liquid supply capability of the well and ensure the long-term effective fracturing effect, the wells around the fractured well need to be adjusted accordingly. Well JBJQJ-4 around the well connecting situation, the pressure after the implementation of pressure protection, to maintain the development effect. On the surrounding wells JBJQJ-4-1 and JBJQJ-4-2 densification speed, to further reduce the effect of the echelon, JBJQJ-4-3 high pressure to be blocked. As the supply is more adequate, oil well JBJQJ-4 after the fracturing fluid volume stability, moisture content is stable. The well JBJQJ-9 wells around the two wells to provide, so to maintain liquid production capacity after fracturing relatively poor level of decline.

Third, fracturing can cut through the side of the body, the release of the remaining oil. The lateral interbeds are dominated by siltstone and transitional lithology. Physical parameters of the lateral interbeds indicate that they are thin (0.1-0.2m) in thickness, discontinuous and small traps with an included angle and have the fracturability theory. The results show that the crack opening range is 60m into the oval shape. The results of the sampling show that Figure 3 shows the sampling results before fracturing, and the emulsification phenomenon is not obvious. The results of the cracked production fluid, in which the emulsification phenomenon is obvious, shows that the emulsified crude oil formed in the lateral interlayer during the flooding of the polyblend is recovered, indicating that the oil part is in the expected position.

Figure 3 Before fracturing (no emulsion)

Figure 4 After fracturing (emulsifying)

6. Conclusion

After polymer flooding, the reservoirs deposited with meandering river sand bodies have a significant impact on the connectivity of the well group and the remaining oil in the well group. The remaining oil is present at the edge of the abandoned river channel and the inner side of the sandwich.

Fracturing construction measures effective prerequisite for geological study and anatomy, at the same time through the combination of static and dynamic characteristics of the remaining oil in the region described, and finally through the reasonable fracturing methods and fracturing scale to tap the potential and lead.

Polymeric agent can block the dominant channel and form emulsified oil at the top of the reservoir with high oil saturation in the meandering reservoirs.

At present, meandering fractures of the meandering river sand body after sedimentation should increase the construction scale appropriately. The penetration ratio is 0.33-0.44. The residual oil at the top of the reservoir is released through the obstruction of the side-confined mezzanine at the top of the pressure-penetration layer and the abandoned river.

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