

Research on the Technology of Potentials and Optimizing Methods of Old Wells

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Abstract. Chang 22-19 belongs to the banshen 51 fault block of changlu oilfield, which is located 3km north of group 10 of changlu salt field. Production fell to 74% by July 2021. Through the analysis of formation potential, a perforating software is used to optimize reasonable perforating and lifting process parameters to make the well produce efficiently and develop efficiently.

Keywords: old well potential exploitation, joint operation, parameter optimization.

1. Introduction

Chang 22-19 fault block is located at the southwest end of Changlu fault. The main oil-bearing target layer in this area is Sha-3 3-4 oil formation of Sha-3 Member, among which the Sha-3 3-4 oil formation under development is a fault block structure surrounded by faults on many sides. The overall structure is high in the southeast and low in the northwest. The trap area is 2.14km^2 and the geological reserves are $297 \times 10^4\text{t}$. Chang 22-19 well is a five-stage system structure with a maximum deviation of 23.51° and a depth of 1225m. The early production interval was 3762.0-3777.7m, and the daily production of oil and liquid was 8.46m^3 and 9.65m^3 respectively at the initial stage of production. In May 2021, the daily production of oil and liquid was 2.6m^3 and 2.81m^3 respectively.

2. Deepen the understanding of oil layer and tap reservoir potential

The fault block has 16 Wells completed, and the initial production is between 7.0-88.6t. Up to now, there are 11 trial production Wells and 3 injection Wells, which show a certain development prospect from the trial production.

According to the test production of this well, this area has the following characteristics:

(1) Certain edge water in the reservoir

After putting Chang 22-19 into production, the average water cut was about 39.4%.

(2) The formation energy is insufficient and the decline rate is fast

After putting each well into production, most of the initial production is self-injection, and the self-injection period is between 2-11 months.

Banshen 51-1 was put into production in January 2004 and then was injected for 9 months. The initial daily production of oil was 58.6t, and the monthly decline rate was as high as 34%.

(3) Imperfect injection-production well pattern

Up to now, there are 3 Wells in this block, and 1 well has been opened.

Chang 22-19 originally produced ES³14#,15#,16# layers, and its daily oil production decreased from $8.46\text{m}^3/\text{d}$ to $3.01\text{m}^3/\text{d}$. Through the secondary interpretation and re-understanding of logging data, combined with regional 3D seismic data, the structural evaluation shows that the well ES³11#,12#,13# are in a favorable zone, and the possibility of oil production is very high. In August 2017, it was decided to top the backfill holes ES³11#,12#,13# layers (3693.8-3744.3m).

3. Optimization of oil testing and lifting parameters

Changlu Oilfield is a medium and low permeability block, and the buried depth of the oil layer in Chang 22-19 is between 3693.8 m and 3744.3m. It is decided to adopt the technology of tube

transmission perforation and production, and choose the perforating gun with large aperture and high porosity density.

3.1. Combined perforation and oil production technology

The combined perforation and oil production technology are the perforation and the pump completed and then put into operation on a string, using the technology. This method reduces the construction time and the operating cost of single well. It doesn't have to kill well after perforation at the same time, to avoid the risk of reservoir pollution caused by the pressure well liquid. It also provides a better protection of the reservoir, to improve the comprehensive benefit of single well.

As a mature technology, the combined perforation and production technology have been successfully applied in Dagang oilfield for many years. Single well test and production can shorten the average cycle of 1-3 days; Operation cost can be saved 10,000 to 20,000RMB per well.

3.2. Optimization of perforating parameters

Perforation is the key to open oil and gas zone in a single well. The optimization of perforation parameters has a great influence on the production of a single well. Combined with the geological data and the actual production situation of the block, the perforating software is used to optimize the perforating parameters.

3.2.1 Hole depth, Hole density

As shown in FIG. 1, the yield ratio of an oil well is in direct proportion to hole depth and hole density on the whole, but when the hole depth and hole density increase to a certain extent, the increase amplitude of yield ratio decreases sharply.

As shown in Figure 1, the yield ratio increases rapidly as the perforation depth passes through the contamination zone, so ensure that the perforation depth penetrates the contamination zone. According to the fitting calculation (as shown below), 16 holes /m were adopted, and the penetration depth was >700mm.

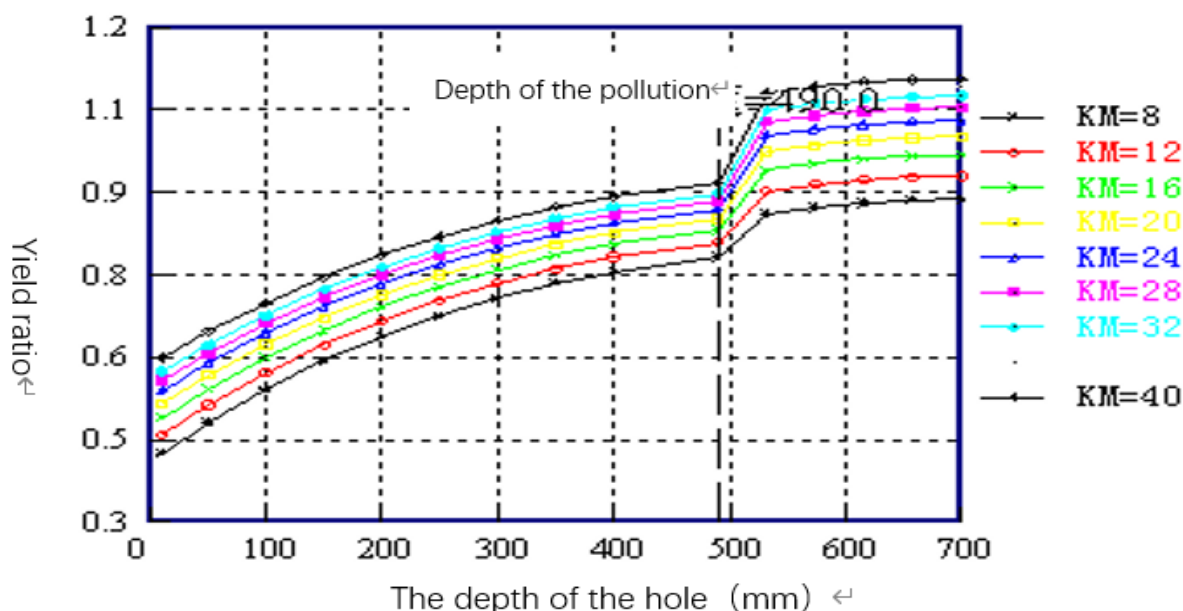


Figure 1. Relationship between hole depth, hole density and yield ratio

3.2.2 Phase angle

The curve in Figure 2 shows that the reservoir heterogeneity has a great influence on the perforating productivity ratio, and the perforating phase angle should be considered by considering the formation homogeneity. According to the fitting calculation (figure below), 90° phase is used.

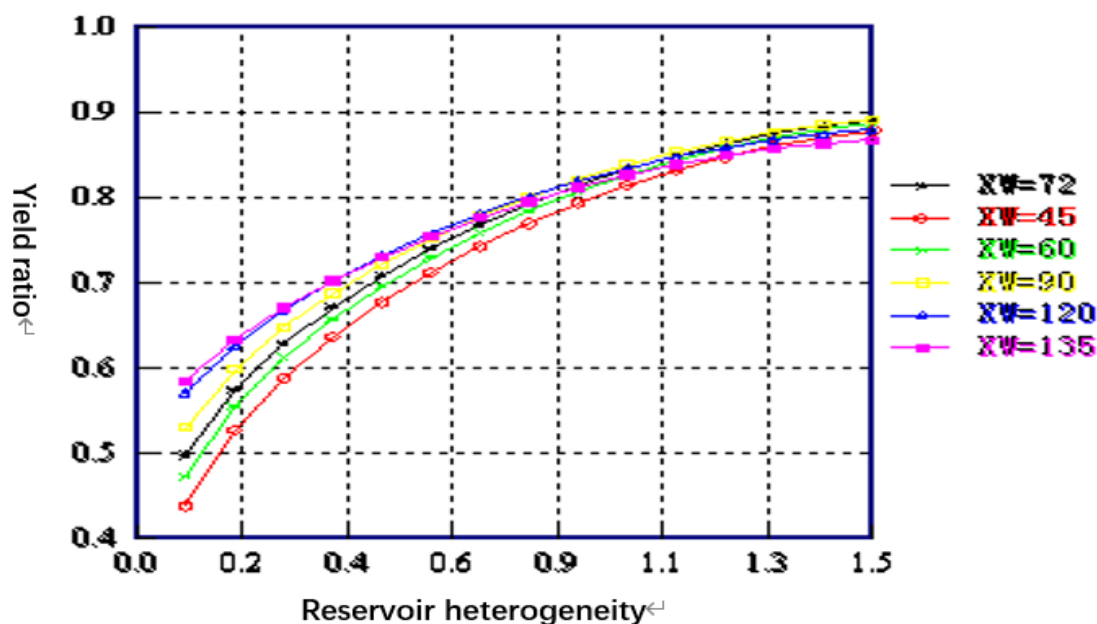


Figure 2. The relation curves of heterogeneity and phase to yield ratio

Combined with the casing and inclination sizes of the oil layer of the well, the perforating software was used to optimize the perforating parameters as shown in the following table.

Table 1. Design results of perforating parameters for Long 22-19

layer No.	Perforation interval M	Thicknes- ses m	Drop liquid level m	Perforation mode					
				Perforat- ion mode	Gun	charge	hole density hole /m	phase	Fire up manner
11	3693.8-	3.7 2.6 4.5	0	TCP	102	127	16	90°	Mechanical
12	3697.5-								
13	3736.2-								
	3738.8-								
	3739.8-								
	3744.3								

3.3. Optimization of lifting process

Considering the actual production situation and the basic data of the well, the selection of pumping unit, the type and size of pumping pump, the depth of pumping and the stroke times were simulated and optimized by using the lifting technology software. According to the forecast of oil well productivity, the well has self-injection capacity at the initial stage. The self-injection output is about 22m³, and the predicted self-injection period is about 3 months. After production for a period of time, the daily liquid was 15m³, the dynamic liquid level depth was 2000m, and the optimized pump hanging depth was 2600m; Using a ϕ 44mm shoot/production combined pump (pump barrel length 9m), the working system stroke of 7m, 2.2 times/min; Designed pump efficiency 44.4%; The predicted maximum load is about 100KN, using ROTAFLEX800 belt machine.

3.3.1 Selection of pumping unit

Although the initial investment cost of belt pumping unit is higher, it has many advantages in the use of process and has higher overall applicability.

(1) ROTAFLEX belt pumping unit stroke adjustable range, the maximum stroke up to 7m, stroke in (1.8-4 times/min) can be adjusted arbitrarily, can reach long stroke, low stroke work requirements. Under this working system, the filling coefficient of the pump barrel is higher, the

number of reciprocating cycles of the pump is reduced, the wear times of the pump, rod and tubing are reduced, and the effective service life of the rod string is guaranteed, and the risk of wear operation is reduced.

(2) The ROTAFLEX belt pumping unit has only a short torque arm, so it requires low torque. Compared with conventional pumping units, belt pumping units can use a smaller motor with a smaller reducer for the same output, saving energy consumption by 10-40%.

(3) Due to the special power transmission mode of belt pumping unit, its elastic transmission reduces the impact force of the reversing of the pumping unit, protects the pumping pump and rod, and makes it work more smoothly.

3.3.2 Optimize the combination of rod and column

According to the production situation, the pumping depth of the well is determined to be 2600m, and the h-class sucker rod is preferred. According to the principle of equal strength, the length of each rod column is designed with mature lifting software. Finally, the three-stage combination of rod column is determined to be used: $\phi 25\text{mm} \times 770\text{m} + \phi 22\text{mm} \times 1000\text{m} + \phi 19\text{mm} \times 630\text{m} + \phi 28\text{mm}$ (weighting rod) $\times 200\text{m}$.

Table 2. Design results of Chang 22-19 rod column combination

Rod level	Level 1	Level 2	Level 3	Weighting rod
diameter (mm)	25.00	22.00	19.00	28.00
length (m)	770	1000	630	200
Goodman stress (%)	73	79	83	/
Coefficient (%)	75	76	74	/
Max stress (N/mm ²)	255	242	208	/
Min stress (N/mm ²)	169	134	67	/
Allowable Stress (N/mm ²)	286	269	237	/
Max load (KN)	105	82	59	/
Min load (KN)	63	41	19	/

3.3.3 Supporting sucker rod centralizer

Chang 22-19 is a five-stage system, as shown in Figure 3. According to the structure of the well, the software design is mainly used to install centralizers in the inclined section, the stable section and the inclined section. The specific position of the centralizers: one centralizer is installed in each sucker rod from 800 to 1350m and from 2100 to 2400m, a total of 96. An average of 20 centralizers were deployed in the 1350-2100m interval.

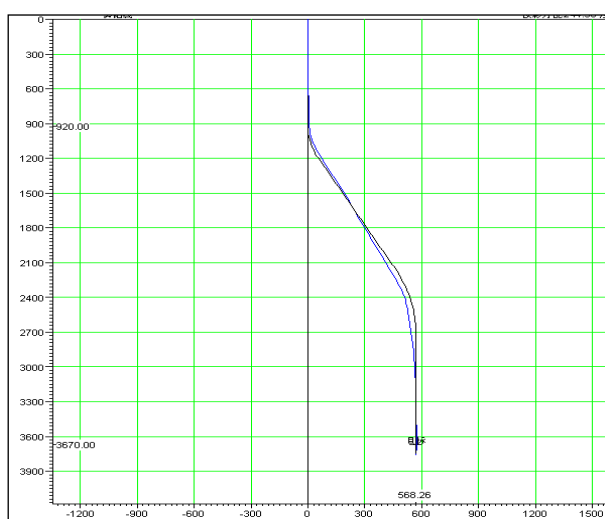


Figure 3. Schematic diagram of Chang 22-19 well results

4. Field implementation effect

On September 5, 2021, ES33(3693.8-3744.3m) has been filled with holes. At 17:50, 8mm nozzle will be used for station production, and 5mm nozzle will be replaced for self-injection production at 18:50. On November 14, 2021, the self-injection output decreased to 4.91m³/d. On November 19, 2021, the pump was put into production. The working system was 7m stroke and 2.2 flusher/min. On December 16, 2021, the load test was: 102.63KN/67.41KN and the dynamic liquid level test was: 1942m. These tests results are basically consistent with the early predictions.

5. Conclusions and cognition

Through the application of several measures and technologies in chang 22-19 well, the old well can get high production oil flow again, and the very ideal results are obtained: the selection of filling hole layer is accurate, and the optimization of perforation and lifting parameters are reasonable. Combined with the field application, the following conclusions are drawn:

(1) Some layers in Block Banshen 51 have high development potential. Further analysis and understanding are made based on formation conditions and production data. The comprehensive development effects of the fault block are then improved.

(2) It is very important to improve the preliminary formation research and analysis of perforating well so as to formulate reasonable perforating parameters.

(3) According to the actual production situation of a single well, optimize the suitable lifting method, formulate a reasonable working system, prolong the pump inspection period of a single well, and realize the efficient development of a single well.

(4) The application of combined perforation and pumping technology can shorten the production cycle of a single well, save the cost of workover, and avoid the oil layer pollution caused by the operation. This technology has a great space for promotion and application in similar blocks.

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