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Using Shallow Platform Drilling Technology to Tap the Reserves of the Below Constructed Area of Fuyu Oilfield: Taking Chengping Block 12 as an Example

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Abstract

The special geographical conditions in the below constructed area of the surface have caused the poor oil-water well condition, incomplete well patterns, difficult measures for tapping potential, and no effective development of reserves, which have affected the comprehensive adjustment of Fuyu oilfield. In order to solve this problem, the shallow large platform horizontal well technology was studied in Fuyu oilfield by taking Chengping 12 reservoir as an example. This technology has been successfully applied under limited ground conditions, and underground reserves have been fully utilized. This study has laid a solid foundation for fuyu oilfield to increase recoverable reserves and achieve stable production during the 12th Five-year plan.

Key words: Shallow large platform; Below constructed reservoir; Chengping 12 block; Fuyu oilfield

1. THE GEOLOGIC ASPECTS OF CHENGPING 12 BLOCK

Chengping 12 block is located in Songyuan urban area, which is in below constructed area. It is located in mid-south of Fuyu III, and its tectonic form is a complicated anticlinal structure complicated by multiple north-south normal faults. The west structure is a westward monocline dipping, and the east is banded fault block tectonics which is cut by several north-south normal faults. The area of the block is 1.35 km^2, and it is located in the central area of the city. The problems of the oil and water well casing damage, the serious fluid overflow resulted from casing deformation or damage, and the safety and environmental protection are very prominent. The development effect of the block is very bad with the recovery percent of 10.1% and the oil recovery rate of 0.2%. Without active and effective measures, the recovery percent is only 14.7%, and the development level of the block is relatively low.

2. PROBLEMS EXISTED IN THE DEVELOPMENT OF CHENGPING 12 BELOW CONSTRUCTED AREA

2.1 Low Oil Production Capacity and Low Reserves

Chengping 12 overburden area was put into development in 1971. Water injection began in 1976. Infilling adjustment was carried out from 1981 to 1986, and secondary adjustment was carried out from 1995 to 1998. At present, wells are closed in the below constructed area due to safety factors, resulting in incomplete well patterns. The recovery rate is only 10% which is far less than 23% in the oil field. In addition, the average daily fluid production of single well is 4.2 t/d, the daily oil production is 0.8 t /d, and the total water cut is 67%.

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2.2 Poor Well Condition, Low Well Working Rate and Incomplete Well Patterns

Due to ground reasons, it is very difficult to carry out various operations and maintenance in urban areas, resulting in poor well conditions and low well opening rate of production wells in urban areas. As a result, the well pattern in the area is extremely incomplete at present, including 165 casing deformation wells and 24 oil, gas and water backflow wells outside casing, accounting for 46.9%. The number of open wells accounts for 40.7 percent of the total now.

2.3 The Formation Pressure Decreases Year by Year, and the Production Decreases Too Fast

Due to the deterioration of water injection conditions year by year, the formation pressure decreased from 4.28 MPa in 1999 to 2.21 MPa in 2002. It is 2.40 MPa at the end of 2005 and 1.90 MPa in June 2007. The annual output decreased from 34.4×10^4t in 1997 to 27.5×10^4t in 2002 and 4.8×10^4t in 2007. The annual oil production decreased from 12.3×10^4t in 1997 to 5.9×10^4t in 2002 and 3.2×10^4t in 2007, with the natural decline rate as high as 20%. Due to the high injection-production well ratio, incomplete injection-production well pattern, serious underground deficit and insufficient formation energy, the overall development effect of the block has been affected. In recent years, water injection, liquid production and oil production have dropped significantly.

2.4 Ground Coordination Is Difficult, and It Is Difficult to Develop by Vertical Wells

Most of the ground is occupied by buildings in the below constructed area, which is difficult to coordinate. Therefore, it is difficult to control reserves by vertical wells.

2.5 Higher Remaining Reserves Abundance, Greater Oilfield Potential

At present, the remaining reserves abundance is156×10^4t/km^2 and the average single well controlled reserve is 21.3×10^4t/well, which provides a material basis for further potential tapping.

In order to utilize the resources in the below constructed urban area, the large platform horizontal well technology is adopted to maximize the control and utilization of the below constructed area reserves by using the smaller ground area.

3. PRECISE GEOLOGICAL DESIGN TO REALIZE MAXIMUM CONTROL OF RESERVES

On the basis of finely implemented structure and fine reservoir research, the sedimentary theory and sediment data were used to predict the sand body distribution characteristics and effective thickness distribution characteristics of the target layer, and the distribution characteristics of the interlayer and barrier were predicted. On the plane, the sedimentary micro-facies were studied and the reservoir development was described subtly; In the longitudinal direction, the distribution of reservoir sand body is accurately predicted, and the horizontal section is deployed in an area where the effective thickness of the main layer is greater than 3m. Through the optimization of well location deployment (Cai, 2010), 32 wells (including 23 horizontal wells and 9 directional wells) were designed in Fuyu District's extra-large platform, Chengping 12, and the reserves were 502×10^4t, and the production capacity was 3.56×10^4t. The design depth is up to 1050m and the shallowest is 600m.

4. THE SHALLOW LARGE PLATFORM DRILLING TECHNOLOGY IS USED TO REALIZE THE EFFECTIVE UTILIZATION OF BELOW CONSTRUCTED RESOURCES

Shallow large platform drilling technology is used for Platform 12 to effectively develop the remaining underground reserves located in urban areas, river channels and other areas with land expropriation difficulties. Construction difficulties:

i. The ground area is limited, the vertical depth of oil reservoir is shallow, the number of drilling wells is large, well spacing is difficult in the platform, and adjusting the position of the deflecting point is greatly restricted;

ii. The problems of intensive underground hole trajectory and anti-collision is very prominent;

iii. Multi-pressure layer system is formed underground, which is prone to well leakage, well collapse and water intrusion

4.1 Platform Well Optimization Design

4.1.1 Optimize Wellhead Location and Overall Towing Orientation

Due to the limited ground, the location of the ground wellhead is unlikely to be in the center of all targets, and the density of the targets in each azimuth is not balanced, which makes it difficult to select wellheads. Under the limitation of ground conditions, only the wellhead can be optimally arranged to optimize the platform placement (Figure 1).

According to the relationship between the target orientation and the whole towed orientation, the kickoff point is flexibly adjusted within the range of 15 to 30m, so that the kickoff point is optimally selected in the effective space instead of 50m in the oil industry standard, effectively solving the problem of creating a kickoff point (Figure 2)

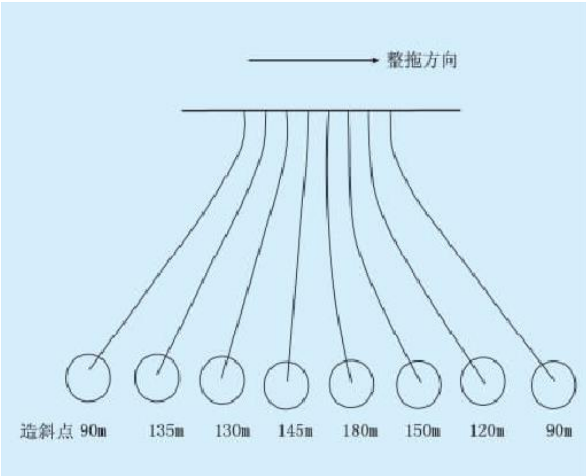

Figure 1
Ground Schematic Diagram of platform 12 well point

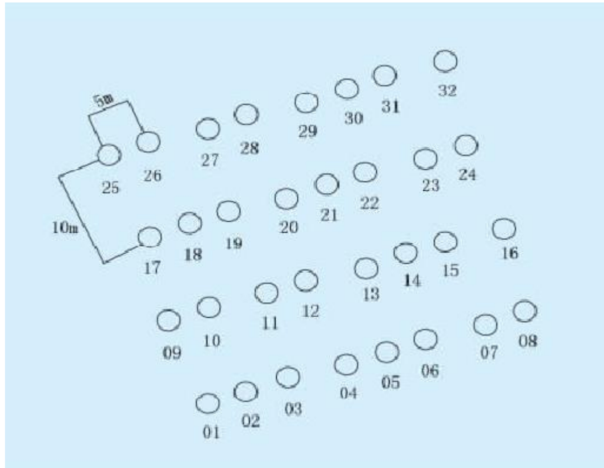

Figure 2
Schematic diagram of target bearing and Integral trailing bearing of wellhead in the platform 12

4.1.2 Optimizing the Position of the Slanting, Real-Time Anti-Collision Scanning, Continuous Prediction, and Realizing Anti-Collision

The problem of mutual interference of different well rows is eliminated: During the design, the inferior well deepens the kickoff point and reduces the deflection rate which makes the trajectory run below and realizes anti-collision and avoidance of obstacle; Firstly, the well trajectory at the top of the well is implemented to improve the safety of drilling construction and reduce the difficulty of trajectory control for preventing collisions.

There is a well-proof and anti-collision section, which uses real-time anti-collision scanning, predicts and resets the well trajectory, and makes full use of the magnetic interference phenomenon of orientation with mwd instrument to judge the relative distance from the old wellbore and ensure the winding. During the construction of the Chengping 29 well, according to the above method, it is judged that the closest distance between the anti-collision section and the old well is only 0. 44 m, and the obstacle is successful. There was no accident in the big platform.

4.2 Research on Drilling Fluids With Extended Narrow Safety Density Window for Leak Resistance and Plugging

In the early stage of construction, there were 4 wells leaks in the 5 horizontal wells of the platform. For this reason, the drilling fluid technology for narrow safety density window was developed, and corresponding comprehensive treatment measures were formulated to achieve safe drilling. Reasons for leakage: The platform well is in the old well network. Due to long-term injection production and casing fracture, the multi-pressure layer system is formed underground, and the reservoir sandstone has good connectivity. At the same time, due to the gravity differentiation in the development of the injection well. At the same time, due to the gravity differentiation in the development process of the injection well, the top remaining oil layer and the bottom water-flooding layer are formed, which is prone to complex conditions such as lost circulation, well collapse and water intrusion during construction.

5. COMBINING GEOLOGY, ENGINEERING AND ON-SITE GUIDANCE TO ACHIEVE DRILLING RATE AND SAFETY OF LARGE PLATFORM WELL

5.1 The Application of Geo-Steering Technology in the Shallow Horizontal Wells and Extended-Reach Well in Fuyu Shallow Layer

Long displacement is generally controlled at 30 to 50 m. For the shallow burial characteristics of the Fuyu oil layer, the inclination angle of the well is controlled at 84° for finding the oil top. The control of the inclination angle of the well depends on the size of the dip of the formation and the target layer to be drilled. This not only ensures less loss of displacement before the horizontal section, but also facilitates adjustment at any time. (Cai, 2010; Song, et al, 2006; He, Liu, and Bao, 1996; Wei, et al., 2003)

Trajectory control after entering the destination layer. According to the analysis of debris and the analysis of fluorescence and gas measurements, the position of the window is corrected in time, the geological adjustment instructions are issued, and the adjustment is made in time. After entering the window, the cuttings logging and LWD logging while drilling curves are observed, combine the adjacent well data and seismic profiles, analyze and make correct adjustments at any time to ensure the sandstone drilling rate.

5.2 Geological and Engineering Work Close Cooperation to Complete Drilling Tasks and Achieve Effective Development of Blocks

32 new wells are surrounded by "old wells". In order to prevent "collision" between cross-phase misaligned wells and improve the quality of wells, torque and friction can be effectively controlled by optimization adjustment of the trajectory during construction; Analyze and design and construction plan, optimize the drill bit, strictly implement the safety operation rules and the downhole accident prevention work, better control the ratio of the sliding drilling and the composite drilling, and ensure the smoothness of the wellbore; Many mature drilling fluid technology technologies such as pressure bearing while drilling, wellbore stability and oil and gas pollution resistance have been promoted and applied, effectively solving the construction problems such as “reducing the diameter” of the upper wellbore and “unbalanced” formation pressure, ensuring the construction problems. Through fine geosteering, the well trajectory is precisely controlled, and extremely high target accuracy is achieved.

6. IMPLEMENTATION EFFECT

The success of the 12 major platforms in Chengping has made Jilin Oilfield a leading domestic level in the technical aspects of shallow land-based platform wells. The actual construction period was 42 d ahead of the expected construction period, and the average daily oil production per single well was 4.3 t/d, which was 4 times that of the vertical well and 7.1 times that of the old well. The area of saving is 19×104m2, and the total cost of land occupation, ground construction, safety and environmental protection coordination is 9 258×10^4 yuan. The use of shallow large-platform drilling technology has enabled the effective development of underground residual reserves in areas with difficult land expropriation such as urban areas and rivers.

CONCLUSION

The large platform horizontal well technology can effectively utilize the reserves in the below constructed area.

The combination of geology, engineering and site is the key to realize drilling ratio and safety of large platform drilling wells.

The horizontal well drilling anti-Cross technology is crucial in realizing the use of reserves in the below constructed area.

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