Factory-like Optimum Drilling Design of Cluster Well in Jimsar Well Block

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Abstract. The deep heavy oil reservoir of Jimsar well block, which located in Xinjiang oilfield, was developed by cluster well in 2016. In view of the ground environment, long open hole section and poor wellbore stability, the scheme which based on the research of factory-like wellsite platform deployment, well trajectory design and reservoir protection, was designed and carried out in the block. Firstly, the platform was divided into different control regions according to the anti-collision requirement. Secondly, truck-mounted drilling rig and civil power were applied to the factory-like drilling. Thirdly, well track was designed to be three parts: straight, increase and steady. The design can improve the proportion of composite drilling footage. Fourthly, the method of plane scanning and normal surface scanning was adopted to ensure the safety of downhole trajectory. Finally, the natural polymer drilling fluid system and drilling fluid reuse system were used to protect environment and reduce drilling cost. The results show that the maximum reducing time of single drill rig is 32.5 day, and the penetration rate of whole platform is increasing continuously.

1 Introduction

The deep heavy oil reservoir of Wutonggou formation in Jimsar Well Block is located in Xinjiang oilfield. The buried depth of the block is about 1500m~1700m[1-2]. Before 2015, the single well deployment was mainly adopted, there was no obviously economic benefit from middle and deep heavy oil reservoir in this block. In 2016, in order to protect the farm, grassland and environment, reduce the land acquisition area, the cluster wells should be deployed[3-7].

The difficulties of factory-like drilling in Jimusar Well Block are mainly concentrated on platform layout, drilling cost reduction, wellbore trajectory calculation method, anti-collision technology, and so on. The main researches are as follows[8-9]:

- The open hole section of the wells is long and the borehole wall of this section is unstable. The formation above Xsy is mainly pelite with strong water sensitivity, and liable to cause wellbore shrinkage and collapse.
- The cluster well track of factory-like drilling is very tight, so that giving rise to collision risk. The spacing of the platform well is 5m and some wells' angle is equal or lesser than 15 degree. It is easy to drift in azimuth and difficult to control well trajectory.
- Factory-like drilling is a relatively advanced drilling operation model, which involves various of specialties and complex related technologies.

2 Optimum design of factory-like wellsite platform

2.1 Deployment of factory-like wellsite platform

According to the wellhead position, well hole axis trend, drilling target and distribution of well control area, the platform with 43 wells is divided into three different control areas to avoid the occurrence of cross orbit in the different control areas, and to reduce the overall risk of anti-collision10. The platform is designed as double rows platform with 5m wellhead spacing and 60m rows spacing (Figure 1).

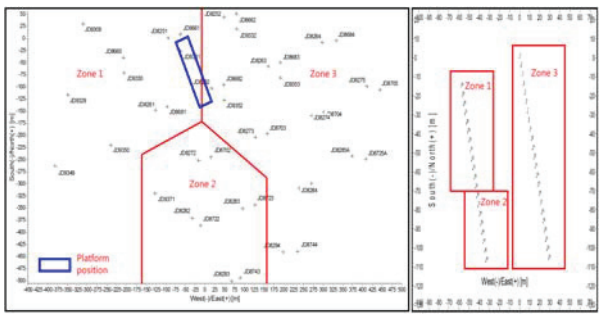

Figure 1. Control area distribution of platform and wellheads deployment in the platform

2.2 Equipment of factory-like drilling

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In order to realize factory-like drilling and rapid movement of drilling rig, ZJ20(Figure 2) rig is equipped to achieve the overall movement of the platform. Some power equipment in the wellsite use the civilian electricity to reduce exhaust emissions of diesel engines. To reduce the times of peripheral equipment moving and save the drilling time, extension electric cables are used instead of the power system, extension outlet pipe are used instead of the tank circulatory system movement and extension high-pressure ground pipeline instead of drilling pump movement (Figure 3).

Figure 2. Drilling rig employed ZJ20 mounted series vehicle

Figure 3. Extended drilling fluid high pressure pump pipeline and outlet pipeline

3 Well trajectory optimization design

The well profile is mainly composed of three-section: straight, increase and steady. Very few well, which are unable to meet the demand of the anti-collision by adjusting the wellhead location, kick off point and build rate, are adopted by the five-section profile: vertical, increase, steady, fall and second steady (Figure 4). The design improved the proportion of composite drilling footage.

In order to reduce the risk of collision in vertical section, the large displacement wells begin to build angle from 430m to 720m, and the small displacement wells move down the kick off point. Compound drilling is applied in steady section to improve the ROP, so that the one trip drilling can be accomplished

By the method of target danger zoning, exchanging the wellhead positions and kick off points, adjusting build rate, etc. Anti-collision requirements of all wells can be met (Figure 5 and Figure 6).

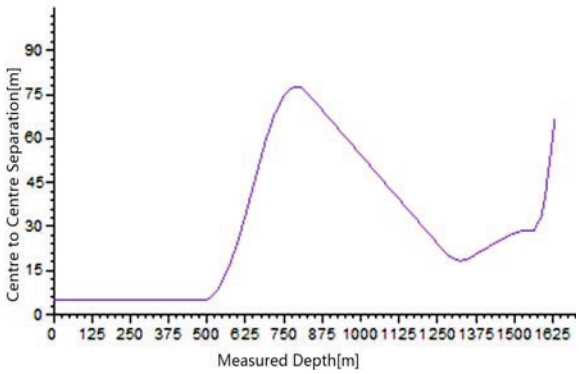

Figure 4. Well trajectory design (five-section profile)

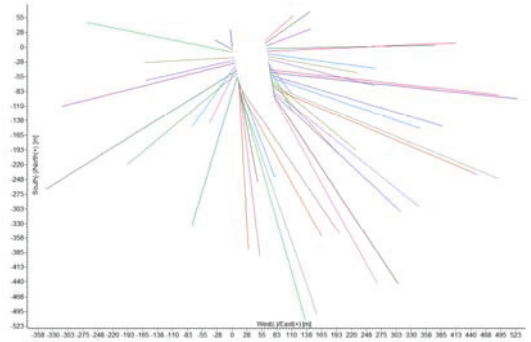

Figure 5. Horizontal projection view of the platform wells trajectory

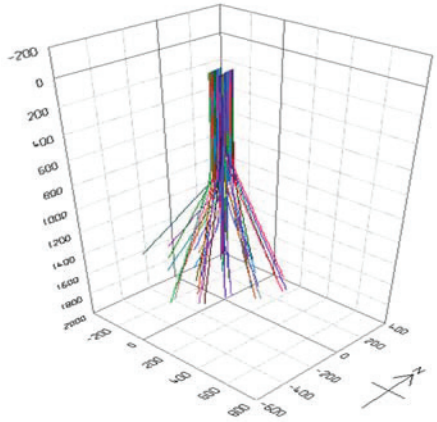

Figure 6. 3D projection view of the platform wells

The plane scanning method and normal surface scanning method show that the minimum distance of the well trajectory is greater than 5m and the separation coefficients is greater than 1.5. The design can ensure the drilling safety along the downhole trajectory (Figure 7 and Figure 8).

During the second opening interval, screw drill tools and PDC bits were used to prevent deviation in straight section. Build angle also from second open. The step laid the firm foundation of borehole trajectory anti-collision. In the process of building angle section, the error ellipsoid anti-collision method was adopted to avoid the close borehole collision through real-time data scanning.

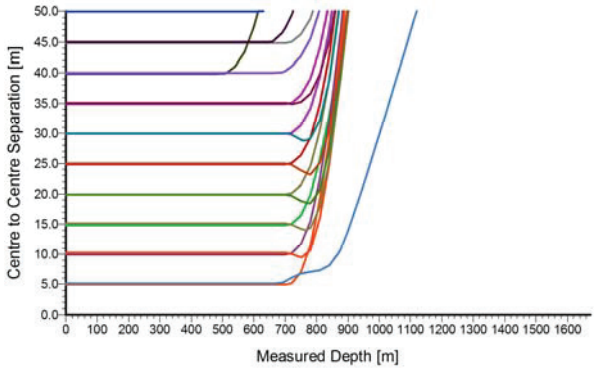

Figure 7. Scanning distance consequence between platform adjacent wells

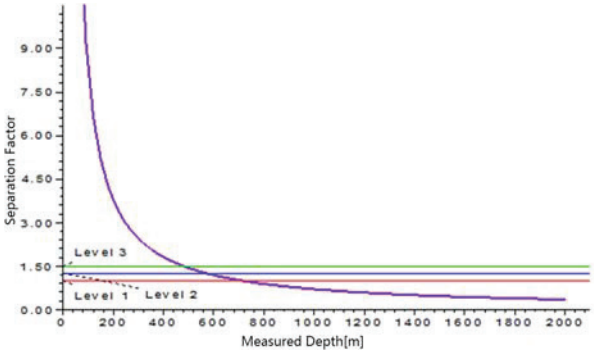

Figure 8. Vertical separation coefficient of straight wells

4 Environmental protection drilling fluid systems

Natural polymer drilling fluid system was adopted in Jimsar well block, whose treatment agent is all-natural high polymer, such as guar gum, konjac gum, sesbania gum, starch, or other vegetable gum, It's non-fluorescence and easily biodegradable. On the premise of satisfying drilling engineering requirements such as mudstone inhibition, etc., it will not pollute the surrounding environment of the wellsite. Its reservoir protection mechanism is as follow:

- Natural raw material treatment agent is easy to degrade.
- White asphalt is used as a good oil and gas protective agent for shielding temporary plugging.
- The microemulsion formed by the cloud point effect of the polyol can helpfully protect the oil and gas reservoirs.
- The alcohol can be adsorbed on the pore surface of the oil and gas zone or oil water interface, thus reducing the interfacial tension and the water-locked phenomenon.

The recovery test of mud pool was carried out in view of the environmental protection performance of natural polymer drilling fluid. The test results show that plants can grow in the mud pool after backfilling, which proved that the natural high polymer drilling fluid was non-toxic, harmless, and no pollution to the environment, so that achieved the purpose of environmental protection (Figure 9).

(a) Before recovery

(b) After recovery

Figure 9. Recovery situation of in mud tank

Because factory-like drilling adopts batch operation, the drilling fluid can be reused in many wells to reduce drilling cost. Drilling requirements, drilling fluid parameters and properties can be adjusted by adding proper drilling fluid additive at different opening. These methods improve drilling fluid reuse rate. By the simple operation, easily maintenance and transform, it is convenient and quick to achieve the reuse of drilling fluid at different opening. The highest reuse rate of drilling fluid is up to 51.2%.

5 Application results of factory-like drilling operation

The largest drilling time saved by single rig is 32.5 days since May 2016. Through the factory-like operation model, the total time of drilling and cementing have been reduced greatly. The penetration of the whole platform is continuously improved by optimizing each process (Figure 10).

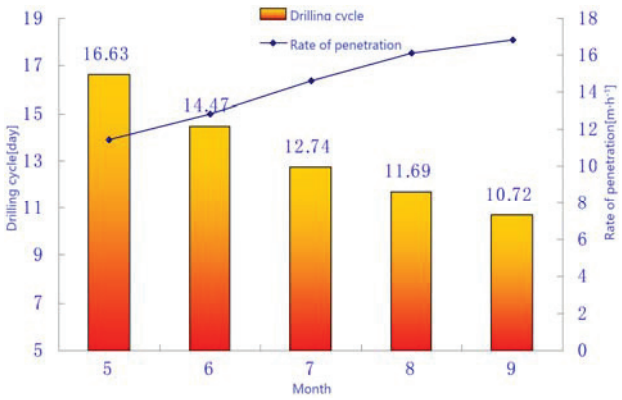

Figure 10. Drilling technical index statistics

6 Conclusions

Considering the overall anti-collision needs of platform wells, the platform with 43 wells is divided into three different control areas, designed into double rows platform with wellhead spacing of 5m and row spacing of 60m. The well site is equipped with ZJ20 truck-mounted rig and civil power supply, which can reduce exhaust emissions and save transportation time. Most wells' profile is mainly composed of three-section, in order to improve the proportion of composite drilling footage. Few wells use five-section profile. Through plane scanning and normal surface scanning, the minimum distance of the well trajectory is designed greater than 5m and the separation coefficients is designed greater than 1.5. The design can ensure the safe drilling along the downhole trajectory. The natural polymer drilling fluid system is adopted to reduce environmental pollution. The drilling fluid reuse process system is established, which improves drilling fluid reuse efficiency and reduces drilling cost. The largest drilling time saved by single rig is 32.5day, and the penetration rate of the whole platform is continuously increasing month by month.

Acknowledgement

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