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The Practice on Accelerating the Horizontal Well of the Xin 123-Ping 80

JIA Yinlu[a],*

[a]Daqing Drilling Engineering Company Drilling Company III Heilongjiang, Daqing, China.
*Corresponding author.

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Abstract

The well Xin 123- Ping 80 is a development horizontal well located in XinZhao Oilfield of the NO.9 oil production plant of the PI5 layer. The original design of the well uses single arc section with a full angular rate of change of 8.47°/30 m. The wellbore orbit optimization technology is used in the field construction, and the design is optimized to the vertical well section by the computer software - the first build and hold wellbore - the second build section - the oil detection and landing - the horizontal section seven-section track profile, the full-angle change rate is optimized to 7°~8°/30m, and the 1.25° single-bend screw LWD measurement system is used in conjunction with the construction. The self-orientation of the inclined angle starts to enter the inversion hole assembly, using directional drilling and composite drilling. In a combined manner, a drilling construction is realized, the mechanical drilling speed of the inclined section and the horizontal section is improved, the drilling cycle is shortened, and the comprehensive drilling cost is saved.

The successful implementation of this well has provided useful reference for such horizontal well construction, and accumulated valuable experience, which has important guiding significance to shorten the drilling period of horizontal well in Daqing oilfield and popularize the application of horizontal well technology.

Key words: Orbital optimization; Single bit-run drilling; Inverted drill string; Shorten the cycle

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1. DAQING HORIZONTAL WELL CONSTRUCTION STATUS AND SPEED-UP POTENTIAL ANALYSIS

So far, more than 300 horizontal wells have been completed in Daqing Oilfield. The single well drilling cycle is usually around 25d (Liang, 2017). After investigation and analysis, the factors affecting the horizontal well drilling cycle of the middle and shallow sandstone reservoirs in Daqing area are as follows:

(a) Horizontal well design build-up rate is relatively high, mostly 8~9°/30m. The 1.5° single bend screw is required for the construction of the deflecting section, while the engineering geology of the landing section and the horizontal section requires a small angle (0.75°~1°) to control the dog's leg and ensure the quality of the well. At the same time, it can avoid the increase of the borehole diameter and the damage of the screw drill due to the excessive screw eccentricity during the horizontal section compound drilling. The number of drills has been extended, which has extended the drilling cycle.

(b) At present, the horizontal well drilling construction process needs to be improved. At this stage, the conventional horizontal wells usually in the deflecting section (well deflection 40°~50°) need to change measuring instrument (MWD is replaced by LWD), and the drilling assembly should be flipped at the same time. The large size and heavier drills are adjusted to the straight section or the small deviation section to ensure the frictional reduction and the effective drilling pressure of the drill bit during the sliding drilling process, but at the same time increase the drilling cycle of the whole well.

(c) There is uncertainty in the development of the oil layer. During the construction process, the vertical depth should be adjusted to find the oil layer. This leads to an increase in the proportion of sliding drilling, which reduces drilling rate and increases the drilling cycle.

2. GEOLOGICAL INTRODUCTION

The well Xin 123-Ping 80 is an adjusted horizontal well in the XinZhao Oilfield of Daqing NO.9 oil production plant. It is located in the nosing structure of the Sanzhao Depression of the Songliao Basin. It is used to develop the PI5 target stratum and finish drilling vertical depth of 1390.09m. Table 1 is a brief description of the geological conditions.

Table 1
Brief Introduction of the Geological Conditions of the Well Xin 123-Ping 80

Well		Adjustment well		Well type	Horizontal well	Well number	x123-p80
geographic location		XinZhao Oilfield of Daqing NO.9 oil production plant					
structural location		nosing structure of the Sanzhao Depression of the Songliao Basin					
geodesic coordinate (collar)	X	5074464.87	magnetic inclination	-10.13	Design well depth （altitude） m	-1911	finishing drilling position	$P1_5$
	Y	21615520.98	ground level	129.74	target	$P1_5$		
well completion system		Casing perforation completion			Drilling principle		finishing drilling after targeting of the D point	

3. PROJECT OVERVIEW

3.1 Track Profile Design

The design of the well adopts a single circular arc orbital profile. The build angle rate of the whole well is 8.47°/30m. There is no adjustment (holding-inclination) in the process of the deflecting. If the geological horizon or the tool deflection ability is not accurate, it will be difficult to meet engineering geology requirements. The design results of the track profile are shown in Table 2.

Table 2
Track Profile Design Results

Description	Fathom (m)	Well deflection(°)	Orientation(°)	Vertical depth (m)	Earth north m	Earth east m	Vertical section m	Rate of build (°)/30m
well head	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
kick off point	1188.00	0.00	120.00	1188.00	0.00	0.00	0.00	0.00
the accomplishment of kicking off	1504.04	89.28	120.00	1390.81	-100.13	173.43	200.26	8.47
target spot B	1531.51	90.19	120.00	1390.94	-113.87	197.22	227.73	1.00
target spot B1	1621.50	90.19	120.00	1390.64	-158.87	275.16	317.73	0.00
target spot B2	1751.51	88.97	120.00	1391.59	-223.87	387.75	447.73	0.28
target spot C	1831.52	89.38	120.00	1392.74	-263.87	457.03	527.73	0.15
bottom hole	1911.00	81.45	120.00	1399.09	-303.45	525.58	606.89	3.00

3.2 Wellbore Structure Design

The well is designed with a two-layer casing structure, and the horizontal section is completed by 139.7mm casing perforation fracturing method, as shown in Figure 1. The well adopts the structure of the two-open well structure, and the casing is perforated and completed by the 244.5mm casing to seal the upper collapsed formation and the 139.7mm casing, which can meet the requirements of drilling and oil production process. At the same time, in order to improve the drilling speed, reduce the number of drills and improve the drilling efficiency, the type of drill bit and the optimized hydraulic parameters compatible with the formation were selected. The specific drill bit and drilling parameters are shown in the Table 3.

Table 3
Drill Bit and Drilling Parameters

Bit serial number	Bit size mm	Hole section m~m	Nozzle combination mm	Drilling fluid density g/cm³ Drilling fluid	Displacement L/s	Hydraulic conditions						
						Bit pressure drop MPa	Circulating pressure loss MPa	Ground pressure drop MPa	Drill speed m/s	Drill pipe internal speed m/s	Screw pressure loss MPa	Pressure loss while drilling equipment MPa
1	311.2 (G535)	0~921.00	11.11×7	1.25	45	6.05	10.21	1.05	92.84	4.86	/	/
2	215.9 (B425)	~1188.00	12.70×2 +11.91×2	1.35	3	2.62	8.18	0.59	58.80	3.02	/	/
		~1504.04		1.35	28	2.47	8.05	0.59	57.04	3.02	2.0	1.0
		~1911.00		1.35	28	1.92	10.08	0.61	50.37	3.02	2.0	1.0

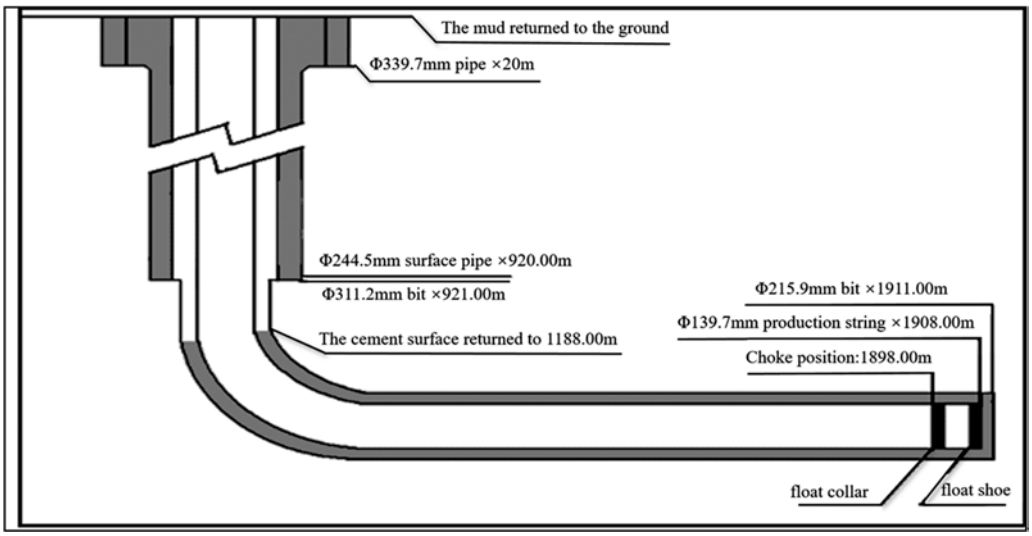

Figure 1
Wellbore Structure Design

4. CONSTRUCTION DIFFICULTIES AND TECHNICAL MEASURES

4.1 Construction Difficulties

(a)The front displacement of the designed target in this well is relatively short, only 227.73m, which makes the control difficult. Therefore, the requirements in the straight well section are high.

(b) The original design of the well track build-up rate is higher, and there is no (maintain angle) adjustment section. If there is insufficient well inclination in the upper section during the construction process, it is difficult to adjust, which will increase the construction pressure of the lower wellbore.

(c) The design of the well is 1188.00m deep, mainly for the second member of the Nen Formation, with loose geological cementation, more interlayers, variable geological conditions, uncertainties in the ability to strike the formation, and difficulties for construction. The wall is unstable, and it is prone to borehole collapse and circulation. It has high requirements on the lubrication performance of the drilling fluid and the ability to clean and stabilize the well wall.

(d)The target layer's vertical depth is uncertain, and the target window requires high requirements, with only 0.5m above and below. The precision of the control is very high, which increases the difficulty of entering the target.

(e) The oil layer of this well is relatively thin, the average thickness is only 1.2m, and the development is uncertain. The oil in the horizontal section will increase the proportion of sliding drilling in the horizontal section, affecting the drilling speed and increasing the drilling cycle.

4.2 Technical Measures

(a) Upper straight section

Straight well section adopts Φ311.2mm drill bit, large pendulum hole assembly drilling, insists on deviational surveying once every 150m, and the deviation angle of the well at the bottom of the well is controlled within 1°. During the construction process, if the well deviation exceeds the standard encryption inclinometry. And take effective measures in a timely manner. Second section of vertical well before the end of the 50 m, the small drilling pressure is required, and the inclination angle of the well at the point of inclination is controlled within 0.5°, and the horizontal displacement is not more than 10m.

(b) Oblique section construction

①The deflection point is oriented 13m ahead of time, and the original designed wellbore orbital section is re-optimized. The seven-segment wellbore orbital section is used to formulate the design to be drilled, and the build-up rate is reduced to 7.97°/30m, and the stability is increased by 8m. Adjust the segment. The optimized wellbore orbital profile is shown in Table 4.

②According to the wellbore orbit optimization design results, the drilling tool assembly is optimally configured. According to the adjacent well construction experience and theoretical calculation, it is concluded that the 1.25° single-bending screw can meet the construction requirements of the inclined section and the horizontal section. The use of a 1.25° single-bend screw makes the wellbore track relatively smooth, while the screw eccentricity is relatively small with respect to 1.5°, which reduces the wellbore expansion rate and is beneficial to subsequent logging and cementing operations.

Table 4
Optimized Wellbore Orbital Profile

Project	Well depth m	Well deflection °	Position °	Vertical depth m	Northing m	Easting m	Displacement m	Borehole curvature °/30m
kick off point	1175.00	0.00	0.00	1175.00	0.00	0.00	0.00	0.00
The first part is done obliquely	1335.29	41.50	119.99	1321.63	-27.77	48.12	55.56	7.768
hold angle	1343.29	41.50	119.99	1327.62	-30.42	52.71	60.86	0.00
The second part is done obliquely	1500.95	89.73	119.99	1390.81	-100.13	173.43	200.26	7.917
Landing section	1528.42	89.73	119.99	1390.94	-113.87	197.22	227.73	0.00

Due to the weighted drill pipe is heavier, it will sink to the low side well bore, which increases the friction of the drill. In line with the principle of shortening the drilling cycle, the inverted drilling tool is directly inserted into the inclined section.

The inverted drill assembly consists of:

Φ215.9mm drill bit + Φ165mm screw (1.25°) + Φ172mm LWD+Φ127mm Non - magnetic weight drill stem +Φ127mm Slope of drill pipe +Φ127mm heavy weight drill pipe + Φ127mm Slope of drill pipe +Φ127mm drill pipe.

③According to the model (the downhole sandstone and cuttings bed fluid mechanics model), the cuttings bed is most easily formed between 30~60° deviation, and the adjustment section of the wellbore track is optimized at 41.50°. In the process, due to the accurate prediction of the construction tool and stratum build-up rate in the previous section, the drilling method is used in the well section to effectively destroy the cuttings bed, which is beneficial to the sand return of the wellbore to reduce the occurrence of complex underground conditions.

(c) Horizontal section

①The target window of the well is 0.5m above and below, the target is required to be high, and the trajectory is controlled before entering the oil layer. The drill is drilled at a slope of 85.38° and the slope is drilled 11m to find the position of the oil layer. Geological personnel confirmed that the geologic requirements of the well inclination and vertical depth, accurate landing.

②Due to the use of 1.25° single-bending screw construction, increased the proportion of compound drilling, improve the degree of trajectory of smooth, and the sliding drilling ratio of the horizontal section drilling is relatively reduced, and improve the mechanical drilling rate, shorten the drilling cycle.

During the drilling process, the engineers and drillers of the well team communicated with each other to master the changes of parameters such as the speed of drilling, torque and bit pressure, and closely observe the return of the cuttings, so as to help determine the position of the drill bit and effectively improve the drilling rate of sandstone.

4.3 Application

Due to the above technical measures, the well Xin 123-Ping 80 was successfully drilled on June 25, 2009. The average mechanical drilling rate of the whole well was 14.6m/h, the drilling cycle was 18.3d, and the sandstone drilling ratio was 83.42%. In comparison of horizontal wells with similar well depths in the same block, the mechanical drilling rate increased by 10.95% and the drilling cycle was shortened by 7.1% (see Table 5).

Table5
Parameter Comparison

Well name	Block	Total depth (m)	Horizontal length (m)	ROP (m/h)	Drilling cycle (d)	Drilling Rate (%)	Amplitude	
							ROP	Drilling cycle
Xin 123-Ping 80 Well	XinZhao Oilfield	1911.00	374.21	14.60	18.3	83.42	Increase by 10.95%	Shortened by 7.1%
Xin 120-Ping 72 Well		1900.46	369.54	13.00	19.70	67.73		

The successful completion of the well has accumulated valuable experience for the construction of the well type and the improvement of the horizontal well drilling speed in Daqing Oilfield, which provides a useful reference for the construction of horizontal wells in the middle and shallow sandstone reservoirs.

CONCLUSION

(a) The drilling cycle of horizontal wells in sandstone reservoirs in Daqing Oilfield has a shortened space, and the key technologies formed by the construction of this well have broad application prospects.

(b) Optimizing the wellbore curvature to 7-8°/30m can reduce the friction and make the wellbore smooth, avoid the pressure and increase the mechanical drilling rate.

(c) After the optimized wellbore orbit, the 1.25° single-bend screw can meet the construction requirements of the inclined section and the horizontal section at the same time. At the same time, the LWD instrument construction is started from the beginning of the inclined section, and a drilling project is realized to reduce the replacement of the instrument. The drilling process is shortened due to the replacement of the instrument and the small-angle screw,

which reduces the drilling cycle and reduces the drilling cost.

(d) The combination of directional drilling and compound drilling controls the wellbore trajectory, making the actual drilling trajectory smoother and closer to the design line.

(e) High-quality and efficient drilling fluid system is an important guarantee for horizontal well construction, and it must be ensured that it has good lubricity and rheological properties to ensure smooth construction.

REFERENCES

Cheng, H. G., Wang, J. D., & Liu, Y. M. (2004). Factors on the ROP and Countermeasures for Deep Wells in the Northeastern Sichuan. *Petroleum Drilling Techniques*, (05), 20-21.

Guo, H. Z., Luo, L. H., & Tian, H. (2008). Cognition and practice of improving drilling speed of horizontal wells. *Petroleum Technology Forum,* (03), 40-43.

Li, H. Q., & Ren, Y. X. (1995). Effect of differential pressure on mechanical drilling speed. *Drilling Engineering,* (02), 10-15.

Liang, H. T. (2017). Research on drilling technology of horizontal well in daqing low permeability oilfield. *Western Exploration Project*, 29(05), 65-66, 69.

Liu, Y. (2007). Discussion on speeding up drilling in Tahe Oilfield. *Western Exploration Project*, (08), 57-58.

Ren, H. X., & Zhou, F. X. (2008). Increase the rate of penetration in extremely hard formations. *Foreign Oilfield Engineering*, (01), 28-29.

Wang, F. B. (2006). Application of high quality fast drilling technology in well deviation control. *Journal of Shengli Oilfield St Aff University*, (02), 50-51.

Wu, Y. X., Zhong, S. Q., & Xu, Y. G., & Gan, S. P. (2008). Present condition of horizontal well technique strength and its development trend in China. *Oil Field Equipment, 37*(3), 33-36.