CSCanada
Advances in Petroleum Exploration and Development
Vol. 9, No. 1, 2015, pp. 111-114
DOI:10.3968/6693

ISSN 1925-542X [Print]
ISSN 1925-5438 [Online]
www.cscanada.net
www.cscanada.org

Analysis of Thermal Recovery Horizontal Well Drilling Technology in Gudong Nine District

QIN Guanghui[a],*; GAO Xiangsen[b]; YAN Zhenlai[a]

[a] Drilling technology research institute, Shengli petroleum engineering Co., Ltd, Sinopec, Dongying, China.
[b] College of Petroleum Engineering, China University of Petroleum, Beijing, China.
* Corresponding author.

Received 9 February 2015; accepted 22 March 2015
Published online 30 March 2015

Abstract

The thickness of oil reservoir in Gudong nine district is normally 2 to 8 m. The upper parts of this reservoir are fluvial facies. Also, the sand body is a positive rhythm combination, which includes fine sandstones, coarse sandstones, argillaceous siltstones and mudstones from top to bottom. The mine type of oil wells in this area is the thermal recovery horizontal well, which is normally featured in shallow, weak formation (easily to collapse) and unmanageable wellbore trajectory. Considering drill bits, drill stem structure and drilling parameters, the horizontal well drilling technology combines the horizontal well completion technique and MEG drilling fluid system. It has been proved that this technology is especially good at increasing drilling speed and efficiency.

Key words: Horizontal well drilling technology; Weak formation; Wellbore trajectory; MEG drilling fluid; Well completion technique

Qin, G. H., Gao, X. S., & Yan, Z. L. (2015). Analysis of thermal recovery horizontal well drilling technology in Gudong nine district. *Advances in Petroleum Exploration and Development*, *9*(1), 111-114. Available from: URL: http://www.cscanada.net/index.php/aped/article/view/6693
DOI: http://dx.doi.org/10.3968/6693

INTRODUCTION

GuDong oilfield is located in the eastern drape anticline, which is developed from mesozoic buried hills of upper Tertiary and has a nearly north-south direction. The nine district is located in the southern Gudong oilfield, and is separated by faults from four and eight districts. The nine district is divided into two area, eastern and western blocks, and the western block is the main oil-bearing block.

The reservoir of the western block is shallow, mainly including Minghuazhen and Guantao Group. The Plain and Minghuazhen Group are located near the ground surface, 0-1,000 m, and have the characteristics of loosen formation, instability and easily getting collapsed. And, the depth of Guantao Group is 1,000-1,400 m, which also has a high possibility of lost circulation.

1. CONSTRUCTION DIFFICULTIES

Due to the characteristics of this reservoir, there are many construction difficulties, as follows[1]:

(a) The loosen formation of Minghuazhen Group. Hydraulic scour would lead to a well with a larger and irregular well, and easily cause collapsing and falling down, thus lead to a severe resistance during tripping in. It would be more difficult for the subsequent construction if a new borehole formed during the reaming operation.

(b) The Guantao Group has a good drillability and the kick off point usually locates in this formation. However, the underground circumstance of this formation is very complicated, and then there is a great challenge to well trajectory control because of low build-up rate and limited length of build-up section.

(c) In the horizontal section, bad angle holding effect combined with uncontrollable wellbore trajectory will lead to sticking.

(d) The completion operation involves using sand screen and external packer of free drilling device, which can avoid cement slurry getting into the sand screens. In the beginning, the external packer should be activated; then, welding head follows the well cementation operation. So the distance of reciprocating

casing should be limited in order to prevent the entrance of cement slurry into screens due to the sealing failure of external packers.

(e) During well cementation, both the permeable formation near the surface of the casing and the cement plug inside casing because of backflow of cement slurry would occur and will bring more difficulties for the later stage construction.

(f) Environmental protection. The studied area locates in the nature reserve of yellow river delta. It is important to carry out the environment protection while drilling operation.

2. THE HORIZONTAL WELL DRILLING TECHNOLOGY

2.1 Well Structure

A suitable well structure is the precondition for safe construction in the future. Considering the geological structure and construction difficulties mentioned above, the following well structure should be used. During the first spud drilling, a 346.1 mm drill bit will get deep into about 300 m with 271.3 mm surface casing, seal the Pingyuan group, and then install the casing head for the thermal recovery well. During the second spud drilling, a 241.3 mm drill bit will be used. 177.8 mm production casing (Grade: P110HB) with sand screen is used to seal the upper section.

2.2 Drilling Assembly and Parameters

2.2.1 The First Spud Drilling for Vertical Sections

The BHA of first spud includes a Φ346.1 mm bit, a 630×410 connector, a Φ177.8 mm non-magnetic drill collar, six 177.8 drill collars, twenty 127 mm heavy weight drill pipes, and 127 mm drill pipes. The details are as shown in Table 1. Combined with the drilling parameters listed in Table 1, the BHA can also increase the ROP and be beneficial to the next stage.

Table 1
The Drilling Parameters of the First Spud for Vertical Section in Gudong Nine District

Well	Drilling interval, m	Bit type	Nozzle, mm	WOB, kN	Rotate speed, r/min	Pump pressure, MPa
Plain-8	0-314	SKG124	10, 10, 10	60-80	110	9
Plain-12	0-314	SKG124	10, 10, 10	60-80	110	9
Plain-13	0-316	SKG124	10, 10, 10	60-80	110	9

2.2.2 The Second Spud Section

The BHA for second spud drilling includes a Φ241.3 mm bit, a Φ177.8 mm non-magnetic drill collar, eight 177.8 drill collars, twenty 127 mm heavy weight drill pipes, and 127 mm drill pipes. The details are as shown in Table 2. This assembly can effectively prevent deviation in the vertical section, and in the meantime, provide the convenience for the following directional construction.

Table 2
The Drilling Parameters of the Second Spud for Vertical Section in Gudong Nine District

Well	Drilling interval, m	Bit type	Nozzle, mm	WOB, kN	Rotate speed, r/min	Pump pressure, MPa
Plain-8	314-1,112	HAT127	12, 12, 12	80-100	33	10-13
Plain-12	314-987	HAT127	12, 12, 12	80-100	33	10-13
Plain-13	316-1,054	HAT127	12, 12, 12	80-100	33	10-13

2.2.3 The angle build-up section of second spud

The second drilling assembly for directional section includes a Φ241.3 mm bit, a Φ196.7 mm 1°30' single curved power drilling tool, a Φ127 mm non magnetic pressure drill pipe with MWD, twenty Φ127 mm drill pipes with sloping shoulder, nine Φ127 mm heavy weight drill pipes, a Φ177.8 mm bumper jar, twenty one Φ127 mm heavy weight drill pipes and a Φ127 mm drill pipe. The details are as shown in Table 3. This drilling assembly combined with proper parameters can make sure the build-up rate and adjust well azimuth in time.

Table 3
The Drilling Parameters for Build-up Section in Gudong Nine District

Well	Drilling interval, m	Bit type	Nozzle, mm	WOB, kN	Rotate speed, r/min	Pump pressure, MPa
Plain-8	1,112-1,373	HAT127	12, 14, 14	60-100	33	12-13
Plain-12	987-1,357	HAT127	12, 14, 14	60-100	33	12-13
Plain-13	1,054-1,336	HAT127	12, 14, 14	60-100	33	12-13

2.2.4 The Horizontal Section of Second Spud

The BHA for horizontal section includes a Φ241.3 mm bit, a Φ196.7 mm 1°30' single curved power drilling tool, a Φ127 mm non magnetic pressure drill pipe with LWD, a Φ127 mm non magnetic pressure drill pipe, forty two Φ127 mm drill pipes with sloping shoulder, nine Φ127 mm heavy weight drill pipes, a Φ177.8 mm bumper jar, twenty one Φ127 mm heavy weight drill pipes and a Φ127 mm drill pipe. The details are as shown in Table 4. This drilling assembly combined with proper parameters can effectively control the wellbore trajectory for drilling in horizontal section.

Table 4
The Drilling Parameters for Horizontal Section in Gudong Nine District

Well number	Drilling interval, m	Bit type	Nozzle, mm	WOB, kN	Rotate speed, r/min	Pump pressure, MPa
Plain-8	1,373-1,705	HAT127	12, 14, 14	60-100	33	13-14
Plain-12	1,357-1,785	HAT127	12, 12, 14	60-100	33	13-14
Plain-13	1,336-1,660	HAT127	12, 12, 14	60-100	33	13-14

2.3 Technical Points for Construction

(a) During the faster penetration in second spud drilling, making a connection should be fast and the pump should be opened early and stopped later to lead a full circulation and avoid solids settling sticking.

(b) Prior to pull out of hole, the well should be cleaned by a large circulation of drilling fluid. When resistance of trip encountered[2], a trip should be made after a normal circulation instead of running against pressure directly.

(c) Due to the layer formation of Minghuazhen Group, the drilling should proceed steadily and avoid the free fall of drilling string. When drilling into a hard layer, electromagnetic brake can insure the steady drilling process and also ensure the long service life of the drill bit.

(d) The kick off point locates in Guantao Group layer with a 25°/100 m directional build-up rate. This direction should be fixed until the horizontal section to avoid a large dog leg severity. The WOB, tool face and wellbore trajectory should be controlled well according to the slow building-up rate in this layer. The accumulation of cuttings bed should be cleared up by mechanical desanding at a well deviation of 70°-80° combined with a short trip. This procedure can avoid a sticking accident due to the accumulation and ensure the downhole cleanliness and good condition of the drill pit[3].

(e) It is easy to flush into a big hole due to the unconsolidated reservoir in this studied area. Thus, the displacement of pump should be controlled at 28 L/s. In the meantime, a new reaming should follow each compound drill to let rock debris in the horizontal section get out completely after getting into the oil layer.

2.4 Technical Points for Drilling Fluid

2.4.1 The First Spud Section

The first spud drilling should be carried out with circulation of water via mud tank with natural mud. The solids control equipment should be well used. The rock debris and inferior solid phase should be cleared up in time to ensure that the drilling fluids stay with the low viscosity during the drilling, and have a higher viscosity before running casing. Then the surface casing will be safely run into the bottom of the well after fully circulation.

2.4.2 The Second Spud Section

(a) The layer during vertical section drilling is mainly Minghuazhen Group and the well will easily get collapsed. The circulation via mud tank should be used earlier at a poper location combined with PAM glue soluting to condition the mud. The viscosity of drilling fluid should be kept at 38 s. The solids control equipment should be well used. The inferior solid phase should be cleared up in time to avoid its adhesion to the well wall and thickening the filter cake. The drill bit should be off bottom during the circulation to avoid flushing into a bigger hole-diameter. Before proceeding to the Guantao Group, modified ammonium salts should be added into the drilling fluid to change its rheology behavior. The solids control equipment should be well used to clear the rock debris and inferior solid phase, and keep the viscosity of drilling fluid at 34-36 s with a filter loss of 10 ml.

(b) The drilling fluid should be pre-prepared before the directional section[4]. During the drilling of directional section, the drilling tool can easily stick to the well wall. Therefore, the drilling fluid must have a good lubricity to avoid sticking. The lubricant should be refilled according to the footage and friction conditions in the well to make sure its lubricity. Before drilling to 100 m above the well bottom, the properties of the drilling fluid should be adjusted and changed to MEG drilling fluid system. The MEG fluid drilling fluid system is used for the down section. The pH of the drilling fluid should be adjusted to 10-11 by refilling new fluid or fluid loss agents. After a full circulation, MEG is added and the adding rate is under control. The rheological property is controlled by ammonium salts. Before drilling to the reservoir, the filter loss of the drilling fluid should be 4 ml and the viscosity should be 46-50 s. The drilling should pass the reservoir quickly and avoid flush the reservoir too much. This fluid system not only has good properties of inhibitory, lubricity, and compatibility of calcium and salts, but also

presents a better protective ability for oil-reservoirs than other normal drilling fluids. Meanwhile, it is good at environmental protection for the nature reserve of yellow river delta.

2.5 Well Completion

(a) The completion operation involves using sand screen and external packers with free drilling device, which can avoid cement getting into the sand screen. In the beginning, the external packer is activated; then, the welding head follows the well cementation process. Considering that the procedure would not leave extra moving room for the reciprocating casing, the landing joint should be put in a much lower place. After filling up the casing and finishing circulation, raise the landing joint to the calculated position and a force will be applied on the casing to ensure that the casing sitting on the circular plate.

(b) After pressure bumping, the pressure inside the casing should be kept at 8 MPa for 4 hours to avoid the cement circulating back and leave extra moving room for the reciprocating casing. This procedure makes the welding head convenient.

CONCLUSION

(a) During the whole construction process, the circulation should be strictly controlled in order to control the hole diameter enlargement in the thermal recovery horizontal well drilling technology in Gudong nine district.

(b) It is prohibited to hit obtrusively during RIH in Minghuazhen Group layer. If running into obstacles, the procedure of drifting, flushing and reaming should be used. In the meantime, the new wellbore should be avoid. If the down section is buried by borehole wall sloughing, accurate tool face can still fix the direction.

(c) The lubricity and the ability of carrying rock debris and sands of the drilling fluid should be kept stable in the directional well section. In order to avoid the risk coming from rock debris accumulation, the short trip should be adapted when drilling into some sections.

(d) The discharge capacity should be kept at 28 L/s during the horizontal well drilling. The drilling bit should pass the reservoir quickly and avoid flush the reservoir too much. The rotating speed should be raised up before tripping out to let the drilling fluid fully circulate.

(e) External packer should be used to seal this section during the well cementing process. The hole enlargement where external packer locates should be controlled well to ensure the sealing work effectively.

(f) The MEG drilling fluid can let the semipermeable membrane formed on the well wall. This fluid system not only has good properties of inhibitory, lubricity, and compatibility of calcium and salts, but also has a better protective ability for oil-reservoirs than other normal drilling fluids. Meanwhile, it is good at environmental protection.

REFERENCES

[1] Ezzat, A. M. (1993, April). *Horizontal drilling and completion fluids design criteria*. Paper presented at Middle East Oil Show, Bahrain.

[2] Hanson, P. M., Trigg, K., Rachal, G., & Zamora, M. (1990, September). *Investigation of barite "sag" in weighted drilling fluids in highly deviated wells*. Paper presented at the 65th Ann. Techn. Conf. in San Antonio, USA.

[3] Mitchell, R. F. (1986). *Frictional forces in helical buckling of tubing*. Paper presented at the 59th Annual Technical Conference and Exhibition, Houston, USA.

[4] Wu, J., & Juvkam-Wold, H. C. (1993). Frictional drag analysis for helically buckled pipes in extended reach and horizontal wells. *Journal of Energy Resources Technology*, *115*(3), 196-201.

