CSCanada
Advances in Petroleum Exploration and Development
Vol. 21, No. 1, 2022, pp. 34-37
DOI:10.3968/12558

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

Apply Compound Salt Drilling Fluid in Yong559 Drilling Block

ZHANG Lu[a],*

[a] Drilling Technology Research Institute of Shengli Oilfield Services Co., Ltd. of Sinopec (SLDTI), Dongying, Shandong, China.
*Corresponding author.

Received 23 January 2022; accepted 16 April 2022
Published online 26 May 2022

Abstract

In the drilling blocks of shengli oilfield, the application of compound salt drilling fluid is becoming a new normal. Utilize compound salt drilling fluid could make a contribution to reduce the enlargement rate of hole diameter, also resolve the sticky and reaming problems in the upper section of Guantao formation and the wellbore instability problem of Shahejie formation under the condition of wellbore is clean. This paper is going to introduce what is compound salt drilling fluid system and the advantages of this system, and analyze the application of this drilling fluid in Yong559 drilling block. According to the wellbore diameter data, it approves that the compound salt drilling fluid system has a significant effect on reducing the enlargement rate of hole diameter.

Key words: Compound salt drilling fluid; Enlargement rate; Wellbore instability

Zhang, L. (2022). Apply Compound Salt Drilling Fluid in Yong559 Drilling Block. *Advances in Petroleum Exploration and Development*, *21*(1), 34-37. Available from: http://www.cscanada.net/index.php/aped/article/view/12558
DOI: http://dx.doi.org/10.3968/12558

1. COMPOUND SALT DRILLING FLUID SYSTEM

1.1 Introduction of Compound Salt Drilling Fluid System

What compound salt drilling fluid is, it is the inorganic salt components contains not only conventional NaCl, KCl and an appropriate amount of Na_2SO_4, $(NH4)_2SO_4$, etc., which are directed against large sections of salt, gypsum, and mud composite salt layers. The compound salt drilling fluid system applied in Shengli Oilfield is evolved on this basis for local blocks, mainly using NaCl, KCl and AP-1 as shale inhibitors. Compared with traditional polymer drilling fluid relying on the bridging and coating of PAM and other polymers, it has additional function of physical inhibition, that is using high salinity to reduce the activity of filtrate and improve the osmotic pressure of drilling fluid to the formation[1], so as to prevent and slow down the invasion of water phase into the formation mudstone.

1.2 Advantages of Compound Salt Drilling Fluid

Firstly, the characteristics of low activity, strong inhibition and non-dispersion that the compound salt drilling fluid has could ensure the wellbore stability and well diameter regular； Secondly, due to the characteristics of high cleanliness, low-solid phase and low-viscosity, it maintains hole cleaning and ROP improvement. Thirdly, cutting the period of drilling operation and increasing the comprehensive cost of drilling; Meantime, the potassium, calcium and chlorine plasma in the drilling fluid system can effectively improve the salinity of filtrate, lower the activity of filtrate[2], and reduce the damage to oil and gas reservoirs.

2. THE APPLICATION OF COMPOUND SALT DRILLING FLUID IN YONG559 DRILLING BLOCK

The encountered formations in the upper section of the second spud in Yong 599 block are Guantao member, Dongying member, Sha 1 and Sha 3 section. The diagenesis of the upper formation is poor, the mudstone is soft and the sand layer is developed. The drilling fluid is mainly used to inhibit the formation mud making, carry cuttings, prevent the mudstone shrinkage and ensure the safety of drilling. The formation encountered in the lower section of the second spud is the fourth member

of Shahejie formation. The effective porosity of the glutenite reservoir in the lower part of the Shasi formation is 7.93%-10.21%，The average porosity is 9.07%，Average permeability is 14.16×10^{-3}um^2, it belongs to ultra-low porosity and low permeability reservoir. The reservoir lithology in this area is mainly gravel sandstone and gravel bearing sandstone, and occasionally fine conglomerate and medium conglomerate are seen. It is mainly aimed at controlling formation slurry making, effectively carrying cuttings, preventing wellbore from shrinking due to mudstone and collapse, and ensuring safe drilling[3]. The application of compound salt drilling fluid system can solve the problem of rheology control brought by strong mud making ability in this area. It has been applied in many wells such as Yong559-D10, and the application effect is good in this area.

3. APPLICATION ANALYSIS OF YONG559-D10 WELL

3.1 Well Basic Data

Table 1 shows the basic information of Yong599-D10 well.

Table 1
Well Basic Information

Well Number	Yong599-D10
Well type	Directional well
Purpose of drilling	Evaluation of oil bearing capacity and productivity of glutenite reservoir in the lower part of the fourth member of Shahejie Formation in Yong 559-2 block
Design well depth / vertical depth（m）	3000
Actual drilling depth / vertical depth（m）	3061
KOP（m）	1500
Completion method	Casing completion
Types of water used in site	Water
Drilling fluid system and density of first spud /（g/cm^3）	Bentonite / 1.05-1.09
Drilling fluid system and density of second spud /（g/cm^3）	Compound Salt drilling fluid/1.10-1.25

3.2 Geology

Geological summary of Yong559-D10 well showed in Table 2.

Table 2
Geological summary

Position	Bottom depth/m	Thickness/m	Main lithology
Pingyuan Section	1060	275	Yellowish brown, light reddish clay layer
Minghuazhen Section	1060	785	Light brown red mudstone, sandy mudstone
Guantao Section	1350	290	Grey green, brownish red mudstone, sandy mudstone
ShaEr Section	1390	40	
Shasan Section	2280	890	The color of oil-bearing cuttings is grayish brown, and that of non-oil-bearing cuttings is grayish. The sand and gravel are mainly composed of quartz.
Shasi Section	2675	395	The main composition of sand and gravel is quartz, followed by feldspar.
	3000	325	

The complex situation of the block indicates that the strata of Guantao Formation and above have poor diagenesis, loose cementation and easy collapse. Attention should be paid to prevent collapse and leakage. The drilling fluid above the reservoir is mainly used to improve the rock carrying capacity, inhibition of mud making, prevent collapse and protect the wellbore.

3.3 General Situation of Drilling Engineering

Project overview see Table 3.

Table 3
Project Overview

Section	Drilling fluid system	Well size(mm)×Depth(m)	Casing size(mm)×Depth(m)	Cement top/m
First spud	Bentonite	311.2×401	244.5×400.74	Ground
Second spud	Compound Salt drilling fluid	215.9×3061	139.7×3060.21	Ground

3.4 Maintenance and Treatment of Drilling Fluid System for Each Spud

3.4.1 First spud （0～401 m）

1) Drilling with clean water. During drilling, the performance is adjusted according to the actual mud making and sand returning conditions, so as to maintain the strong carrying and suspension capacity of drilling fluid and meet the needs of large hole drilling.

2) After drilling to the designed well depth, sufficient circulation and drifting should be carried out. Hoisting is only can be carried out after confirming that the wellbore is clean, no grit and no collapse, to ensure the smooth operation of running the conductor and the cementing operation.

3.4.2 Second spud（401～3060.21 m）

1) Mud is circulated and diluted with water, and 1% $CaCl_2$ is added to adjust the mud funnel viscosity within design scope in the first spud. Add $CaCl_2$ at the dosage of 200kg per 100m footage after spud in, keep the content of Ca^{2+} about (1500-2000) ppm.

2) The viscosity and gel strength of Calcium-treated mud is low, so it is necessary to avoid intermittent operation and pinpoint circulation. Enhance the moving up and down of drilling tools while the pump is off. Sealing measures can be used in tripping out while drilling. $CaCl_2$ was stopped at the bottom of Guantao formation, and naturally consumed ca^{2+}, and gradually converted into polymer lubricating drilling fluid. During drilling, polyacrylamide gel with concentration of (0.5-1) % should be added in time to enhance the flocculation and coating ability of drilling fluid and improve its inhibition. The modified ammonium salt is used to adjust the rheological property of drilling fluid, so as to maintain low density and low viscosity of drilling fluid, so as to facilitate rapid drilling and maintain appropriate scouring capacity, prevent mudstone shrinkage and properly control well diameter expansion rate.

3) The bentonite content in the drilling fluid should be controlled before the system transform into compound salt drilling fluid system. During the transformation, the sulphonate copolymer should be added first, and then sodium chloride and potassium chloride should be added. Then drilling fluid treatment agent should be added according to the design formula to adjust the performance of the drilling fluid to meet the design requirements. The conversion process should be stable to prevent the downhole complications caused by excessive performance fluctuation.

4) It is necessary to maintain the effective content of various treatment agents during drilling, and timely supplement according to the consumption situation. Strictly control the performance of the drilling fluid in accordance with the requirements of each well section. Agent used for normal maintenance or treatment should be mixed into fluid proportionally as gel and dry powder is forbidden to be put directly into circulating drilling fluid so that it would not be removed by solid control facilities before completely taking effects.

3.5 Properties of Drilling Fluid

Table 4
Drilling Fluid Performance of Yong559-D10

Depth (m)	Density g/cm³	FV/s	G Pa/Pa	Ø600	Ø300	PH	API mm	Mud thickness（mm）	HTHP	
									API mm	Mud thickness mm
401	1.09	31				8				
1417	1.13	31				8				
1680	1.14	34	1-2	30	17	8	14	0.5		
2226	1.16	43	2-6	48	30	8	5	0.5		
2427	1.20	45	2-6	51	37	9	5	0.5		
2876	1.24	50	3-9	62	40	9	4	0.5		
3061	1.25	40	3-7	74	49	9	4	0.5	11	0.5

3.6 Well Diameter Analysis

This well's overcut rate of target formation is 1.81%, wellbore is regular. Compound salt drilling fluid can inhibit the mud making of formation effectively, shot tripping and tripping smoothly, without shrinkage and out of round oversized hole. Well diameter analysis of Yong559-D10 see table below.

Table 5
Well Diameter Analysis（Yong 559-D10）

Section（m）	Average Well Diameter/mm	Overcut Rate/%
410-810	259.09	20.00
810-1210	261.31	21.03
1210-1610	262.15	21.42
1610-2010	228.14	5.67
2010-2410	220.23	2.01
2410-2810	219.81	1.81
2810-3061	216.81	0.42

3.7 Application Analysis of Compound Salt Drilling Fluid System in Yong599 Block

The wells used compound salt drilling fluid in this block have no collapse, leakage, block dropping problems. The average well diameter of the target layer is 223.33mm and the average overcut rate is 3.44%. Tripping operation went well in this block without shrinkage and out of round oversized hole. Well diameter analysis of Yong559 block see Table 6.

Table 6
Well Diameter Analysis of Yong559 Block

Well number	Total depth/m	Average diameter of target formation/mm	Average diameter expansion rate of target formation /%
Yong559-D3	3275	226.06	4.71
Yong559-D4	3115	223.52	3.53
Yong559-D5	3270	220.98	2.35
Yong559-D6	3213	223.52	3.53
Yong559-D7	3325	226.06	4.71
Yong559-D10	3061	219.81	1.81
Yong559-D11	3290	203.28	1.28
Yong559-D12	3091	208.53	2.87

4. CONCLUSIONS

Based on the wellbore diameter data of Yong559 block, it is known that the application of compound salt drilling fluid solved the problem of wellbore instability and decrease the enlargement rate of well diameter in Shahejie formation due to the performances of low activity, strong inhibition and non-dispersion of compound salt drilling fluid.

REFERENCES

[1] Pei, J. Z., & Wang, S. Y. (2009). *Drilling fluid technology of Shengli Oilfield.* Dongying: China University of Petroleum Press, 2009

[2] Yan, J. N. (2009). *Drilling fluid technology* (1st ed.). Dongying: China University of Petroleum Press.

[3] Qiu, C. Y., Liu, X. M., & Wang, X. S. (2014). Wellbore Stabilizing Drilling Fluid Technology of Dong 7 Well. *Natural Gas Exploration and Development.*