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A New Ultra Inhibitive Ecological System for Offshore Drilling Applications

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***Abstract* - Considering the on-going interest in developing and operating new productive perimeters at increasingly higher depths and temperatures, the enhancement in the rules required for the environment caused by removal of cuttings and limited performance of water based drilling fluids in hard to reach areas led to the need to develop high return drilling fluid systems and continuously improve them further based on data taken onsite.**

The paper herewith envisages updating and bringing new data in view of elaborating a new drilling fluid of high performance and permanently adapted to well requirements.

Keywords: Drilling, Ultra-Inhibitive, Offshore

I. INTRODUCTION

Technical challenges in drilling are new encountered in many of the hydrocarbon reservoirs worldwide. These challenges generally show up by drilling into narrow operating windows between pore-pressure and fracturing gradient occurring out of geological deposits or depletion of hydrocarbon strata inside the reservoir after a long period of time. The drilling narrow windows need strict control of drilling equivalent circulation density (ECD) or the use of such technologies that are able to handle the closest medium of borehole so that to allow for drilling progress by using other densities than prescribed in the density range, [2].

The existing water based drilling fluids sometimes have limited performance compared to oil base muds or synthetic product based drilling fluids. Performances refer to:

- Inhibition;
- Rate of penetration;
- Conditioning of drilling fluid;

The ultra-inhibitive drilling fluid system with high properties of clay inhibition does not only improve drilling of upper sections but also has applications in the entire well drilling operation at high depths and temperatures,[1]. The ecologically improved drilling fluid stands for a plus in the technology of water based systems compared to the present applications of drilling fluid as they allow the ecologically improved drilling fluid system to be in comparison with oil and/or synthetic product based systems.

II. EXPERIMENTAL DESIGN AND TESTING

The ecologically improved drilling fluid system is very inhibitive, elaborated and envisaged to assure a higher stability and capacity of drill-ability of reactive and dispersible clay formations. The proposed system may also significantly help cross with very good results the productive formations presenting maximum interest. The ecologically improved drilling fluid is designed to assure:

- Maximum inhibition of clays;
- Maximum stability of borehole;
- An accumulation of displaced rock particles near to zero per the assembly of the drill string;
- Easy maintenance of drilling fluid properties;
- Flexibility in the density for work;
- Flexibility in selection of the source of ions (potassium, sodium);
- Applicability in various areas being sensible from point of view of environmental regulations.

The main inhibitor of clays in the proposed ecologically improved drilling fluid is a polyamide followed by an cationic polymer acrylamide together with a poly-alkaline glycol assuring secondary inhibition of clays and stability of encapsulating cuttings, [4].

Preparation of the ecologically improved drilling fluid is presented in the table 1

III. MEASUREMENT TECHNIQUES AND RESULTS

The ecologically improved drilling fluid will allow for being prepared by means of various brines and also with a large range in selection and utilization of densities. A laboratory study was carried out in order to monitor the manner how reactive solids incorporated within the proposed system affect the properties of the drilling fluid. A fluid having 1.56 SG/13.0 ppg density was prepared and tested (table 2). The fluid was contaminated as it can be seen below (Table 2) with 35, 70, 105, 135 and 235 kg/m^3 of clay and MBT tests were conducted and tests on the concentration of the used inhibitors. No adjustment has been done as for depletion of clay inhibitors, [5]. [7].

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Table 1. Preparation of the ecologically improved drilling fluid

Product	Function	Recommended concentration
Fresh Water	Base fluid	
Soda Ash	Hardness control	0.5-1.5 kg/m^3
Potassium chloride	Inhibition	95-100 kg/m3
Polyamine	Clay inhibition	1.5 – 3.0% (v/v)
Acrylamide polymer	Clay encapsulation	3-6 kg/m^3
Cellulosic polymer	Fluid loss control	8-14 kg/m^3
Poly glycol	Clay encapsulation/inhibition	2-3 % v/v
Modified starch	Fluid loss control	2-4 kg/m^3
Biopolymer xanthan	Rheology control/LSRV	0.5 – 3.5 kg/m^3
Mix Surfactant	Bit balling / Lubricity	1.0 – 1.5% (v/v)
Synthetic oil	Lubricity	0.5-1.0 % (v/v)
Micro Barite	Density control	Function of density
Polymeric alkaline materials PTS 200 (MI)	Temperature stabilization / Reducing polymers degradation	6-10 kg/m^3
Micro calcium carbonate	Density control / Bridging	Depend on project

Table 2. A fluid having 1.56 SG/13.0 ppg density was prepared and tested

Fluid properties	Fluid	Reactive clay 35 kg/m^3	Reactive clay 70 kg/m^3	Reactive clay 105 kg/m^3	Reactive clay 135 kg/m^3	Reactive clay 235 kg/m^3
Density , SG/PPG	1,56/13,0					
Ɵ 600	75	82	88	94	105	
Ɵ 300	42	46	50	55	62	
Ɵ 200	29	37	39	42	44	
Ɵ 100	17	19	20	24	28	
Ɵ 6	5	6	6	6,5	7	
Ɵ 3	3,5	4	4	5	5	Inaccurate date
PV [cP]	33	36	38	39	43	Non measurable
YP [lbs/100ft^2]	9	10	12	16	19	
Gel strength 10 sec [lbs/100ft2]	5	6	6	6	7	
Gel strength 10 min [lbs/100ft2]	8	8,5	9	9	12	
HTHP FL , cc/30 min	4,4	4,2	4,8	4,7	7,5	
MBT , kg/m3	0	7	17,5	38,5	42	63
Principal inhibitor , [% vol.]	3	2,7	2,4	0,5	0,1	0,001
Second Inhibitor 1, [kg/m^3]	3,5	3,5	3,4	3	2,9	2,7
Second Inhibitor 2 , [% vol.]	2,5	2,4	2,3	1,9	1,8	1,6

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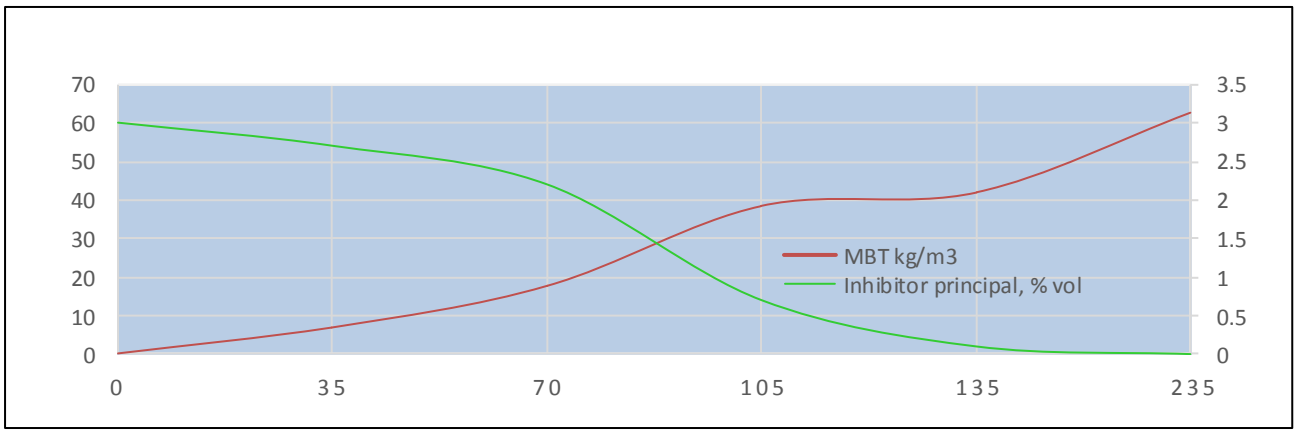

Figure 1. Graphic represent the inhibitors variation function of proposed contamination

After the first tests have been carried out, the ecologically improved drilling fluid system was subject to a second stage of tests, namely: analysis of the system rheology for a system having 1750 kg/m^3/14.6 ppg at 50^0 C depending on various pressures applied, [6]

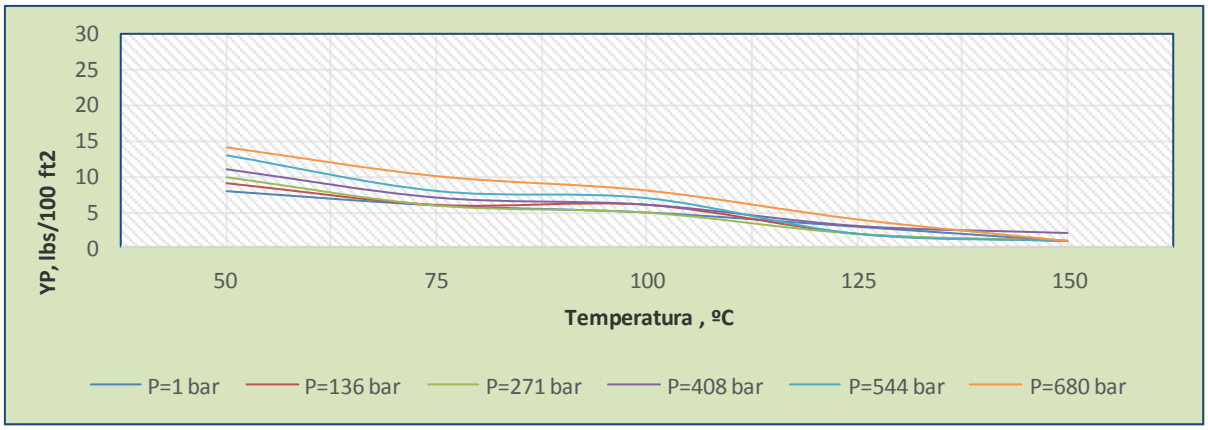

Figure 2. The dynamic shearing stress depends on pressure and temperature (fluid density:1750 kg/m^3)

CONCLUSIONS

The following conclusions were drawn after the test has been performed:

- Measurement of the MBT value does not reflect the actual amount of solid reacting in the proposed system. Great part of reacting solids was absorbed by the main inhibitor and thus they act as inert in the MBT test. This is a significant indication of the inhibitive character of the fluid on the particle of clay within the mass of the ecologically improved drilling fluid system.
- Over 105 kg/m3 of reacting clay will be needed in order to deplete the concentration of the main inhibitor.
- The "1" secondary inhibitor is not significantly affected by the level of reacting clay. This is due to the fact this test is conducted in drilling fluid but also because the "1" secondary inhibitor is an
encapsulating agent and its depletion only takes place at the cuttings surface.
- The effect of solids out of reacting clay on the system rheology is very low due to the high inhibition of the proposed and improved fluid.
- The system develops the concept of plane rheology, while gelations of the system show minor variation with temperature and pressure.
- The '2' secondary inhibitor is measured by means of a refractometer. This device has a low subtraction rate but significantly helps with encapsulating of rocks displaced together with an increase in the system lubricity thus reducing the friction coefficients.
- The results gotten herewith prove the stability of the system at high pressures and temperatures and also the fluid properties maintained even if facing high clay contaminations which makes the proof that the system proposed for analysis may easily frame the class of drilling fluids used in narrow window environments.

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