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Novel Torque Reduction Technology for Invert Emulsion Fluids in ERD wells

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Abstract

In the drilling industry as cost optimization strategy, it is recurrent the need to drill deeper, resulting in extended reach drilling (ERD) applications to maximize the well productivity. Traditionally Invert Emulsion Fluids (IEF) are more suitable to be use in this type of drilling applications due their lubricity properties, however high torque tendencies and weight transmission while drilling is a limitation to be able to reach the challenging targets. This paper describes the approach to introduce a new IEF technology to reduce the torque and help to achieve the planned depths. Extensive lab testing was conducted to customize the required formulations and then a field trial performed to evaluate the performance of the technology. In order to properly conduct this evaluation, key performance indicators were established in two wells.

The customized technology was implemented in well A & well B. High and Erratic torque was experienced in both wells, therefore IEF technology was added observing a significant reduction in torque values with no considerable effect on any rheological and fluid loss parameters, indicating full compatibility with the drilling fluid system.

The torque reduction observed in both applications was in the order of 30% with a maximum concentration of 3% v/v. Those successful field applications proved the concept of this innovate IEF technology to overcome torque and weight transmission challenges especially in ERD applications, in addition to the consequent benefits that can be obtained such as nonproductive time reduction

Introduction

In the process of extended reach drilling (ERD) the frictional forces between the drill string and wellbore or casing the high torque and drag can exceed the proficiencies of the drilling equipment and limit the horizontal displacement of the hole (Figure 1).

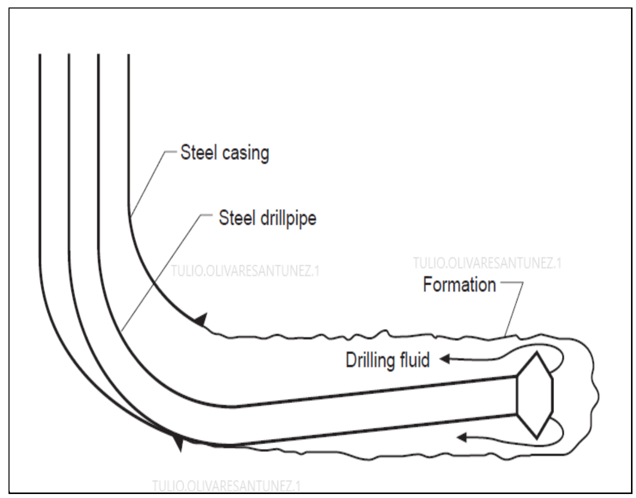

Figure 1 – Schematic of ERD well

Between the most significant factors that affect torque and drag is the coefficient of friction (COF). The nature of the contact surfaces and the composition of the drilling fluids in which surface are immersed influence the COF. Additives as "lubricants" are often used to reduce the COF of the drilling fluids. Those lubricants can be solids or liquids. For this paper we did evaluate liquids lubricant for IEF. Those lubricants form a film that is thick enough to mask the surface roughness and strong enough to withstand high compressional forces. Because liquids lubricants compete with other surface actives components in the IEF, their performance tends to depend on their concentration. The torque reductions for the new IEF technology was extensively evaluated at the lab and at the field, obtaining satisfactory results.

Performance Evaluation

In this study for the performance evaluation of the IEF lubricant, extensive assessments were performed in the lab and at the field, see below the summary of these evaluations:

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Lab Evaluation

The liquid lubricants performance evaluation was done in a conventional 85 pcf IEF formulation Low Toxicity Mineral Oil based (Base Fluid 1) and conventional 85 pcf IEF formulation Diesel based (Base Fluid 2), please refer to Table 1. A comparison between the base fluids with additions up to 3% v/v of the different lubricants A & B was done and below are the details:

Sample Composition & Preparation

	Additive	Mix Time (min)	Units	Base Fluid 1 IEF (LTMO)	Base Fluid 2 IEF (Diesel)
1	Low Toxicity Mineral Oil (LTMO)		bbl	0.49	0
2	Diesel		bbl	0	0.55
3	Primary Emulsifier	5	gpb	1	1
4	Lime	5	ppb	6	6
5	Fluid Loss Control	5	ppb	6	6
6	Water	5	bbl	0.135	0.14
7	Viscosifier	5	ppb	4	4
8	Secondary Emulsifier	5	gpb	0.25	0.25
9	$CaCl_2$	5	ppb	42.4	44
10	Weighting Material	5	ppb	188	164

Table 1 – IEF Formulations

bbl: barrel / **gpb:** gallons per barrel / **ppb:** pounds per barrel

	Torque Readings (lb/in^2)			
Lubricant	**Base Fluid 1**	**1% v/v Lubricant**	**2% v/v Lubricant**	**3% v/v Lubricant**
A	12	11	10.5	10
B	12	11	10	10

Table 2 – Torque Readings on Base Fluid 1 (LTMO)

	Torque Readings (lb/in^2)			
Lubricant	**Base Fluid 1**	**1% v/v Lubricant**	**2% v/v Lubricant**	**3% v/v Lubricant**
A	10.5	11.5	10.5	8.5
B	10.5	11.5	11	11

Table 3 – Torque Readings on Base Fluid 2 (Diesel)

	Torque Readings (lb/in^2)			
Lubricant	**Base Fluid**	**1% v/v Lubricant**	**2% v/v Lubricant**	**3% v/v Lubricant**
A	Base Fluid 1	8.3	12.5	16.7
B	Base Fluid 1	8.3	16.7	16.7
A	Base Fluid 2	-9.5	0	19.1
B	Base Fluid 2	-9.5	-4.8	-4.8

Table 4 – Torque Reduction % Comparisons

Field Evaluation

Key performance indicators were established in the two wells, as minimum 20% torque reduction after the implementation of the IEF technology. Lubricants A & B were utilized on wells X & Y to evaluate their performance while drilling horizontal wells using conventional IEF.

While drilling at 10,647 ft with 87 degree inclination on well X using 76 pcf IEF , erratic torque of 17.8 klbs-ft was evident. The fluid system was then gradually treated to have the Lubricant A concentration up to 3 % v/v in the fluid system.

Once Lubricant A treatment was initiated at 10,647 ft, there was a significant reduction in torque values from 17.8 to 12 klbs-ft (29.4 % reduction in Torque). See graph below:

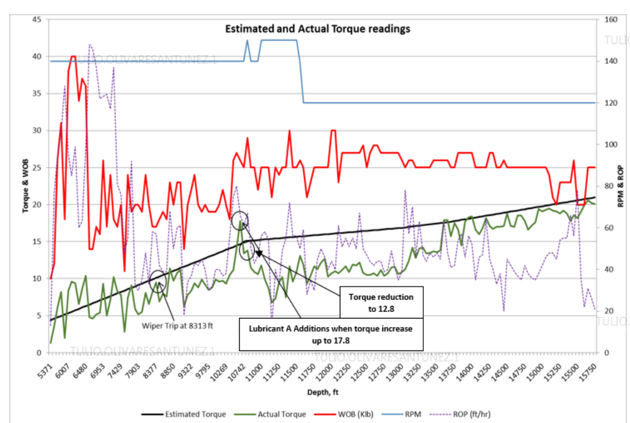

Figure 2 – Lubricant "A" Torque reduction on well "X"

A total of 11,090 ft were drilled horizontally in this well X with lower torque values than estimated after Lubricant A additions.

Another 11,089 ft horizontal section was drilled on well Y, using 76 pcf IEF on 8 1/2" section with a deviation of maximum angle of 90 degree.

Due to the actual angle of this section, good hole cleaning was important to avoid the formation of excessive cuttings beds. Therefore hole cleaning best practices were followed.

While performing a wiper trip in at 14,900 ft serious torque problems were observed. It was proposed to add lubricant in order to reduce it. A concentration of 3% v/v of Lubricant B was agreed. After the additions torque dropped from 20 klbs-ft to 13 klbs-ft; resulting in 35% torque reduction. Drilling continue with an acceptable torque up to 18 klbs-ft, but at 22,000 ft torque increased up to 19 klbs-ft and was decided more Lubricant B additions and the torque was reduced to 15 klbs-ft, occasioning 21% reduction. See graph below:

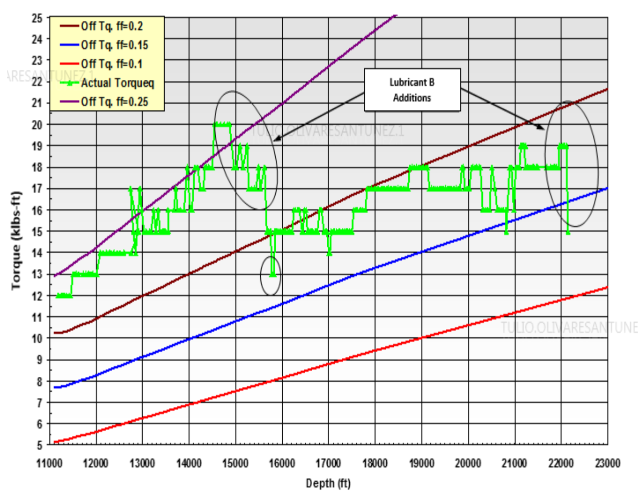

Figure 3 – Lubricant "B" Torque reduction on well "Y"

Looking the results on lab and field evaluation was evident the dramatically effect on torque reduction of the Lubricants A & B in IEF.

Another interesting subject to mention was the fact that no increment on viscosity or rheological properties were observed on the field applications, using relatively low drilling fluid density 76 pcf.

Recommendations

- Pilot test any Lubricant for IEF before any field implementation. This will help you to customize the concentration required and evaluate their effectiveness.
- Lab and field results showed that 3% v/v was the optimum concentration for Lubricants A & B, looking dozens of case histories, seem is a general recommended concentration, however as mentioned before, case by case are different and need to be customized depending of the particular conditions.
- On field applications, lubricants should be added slowly and directly to the mud system, maintaining a small constant stream wherever there is good agitation or through the missing hopper.
- Best applications for this new technology are on ERD wells, slim holes, to run long casing or liners.

Conclusions

Considerable torque reduction was observed with both lubricants (A & B) after the lab testing, On Base Fluid 2 (Diesel based) Lubricant A showed better performance in terms of torque reduction achieving 19.1%.

Regarding the field evaluation, key performance indicator of 20% torque reduction was achieved in both wells (X & Y), it was clearly observed torque reductions between 21% to 35% after the implementation of the IEF technology.

IEF rheological properties were not affected after lubricant additions.

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