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Barite Sag Problem in Directional Drilling

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ABSTRACT

Directional drilling is one of the best ways of drilling wells in oil and gas industry for more than three decays. A lot of companies prefer this technology to get target point which is the reservoir, this is due to way of drilling is more economical, get the high production rate in limit time and more environmentally friendly if it is compared to the vertical wells. The sink of barite during drilling process which causes trouble in directional drilling in term of stuck pipe and rotary assemble. The preparation for the drilling fluid which is mud, one of the element uses to make particular mud in horizontal drilling is the barite powder. Owing to the deviating well has angle, this angle allows to barite sink soon than it happens in vertical well and the gravity has the impact in this process.In this work, an attempt has been made to use two type of polymers to find out which one is the best to extension barite sag in directional drilling and also which concentration of polymers is suitable to use for making mud. According to the experiment work showed that the xanthan gum polymer is delay barite sag process more than gum arabic. Relating to concentration, the appropriate weight for xanthan gum is 0.2grams and it is used as a stander by companies in the rig but for gum Arabic, I found the best weight is 0.5grams because when use less 0.5grams the barite sink even during measuring density or weighting and more 0.5grams is not economical to spend each sample more than 0.5grams. Water-based polymer mud has been recognized as an appropriate alternative to oil-based mud because of its shale inhibition possessions, temperature stability, and environmental effectiveness, easy of management, high lubricity, cost effectiveness and stuck pipe prevention.

1. INTRODUCTION

The capability of drilling fluid to hold elements in suspension is very significant. The non- success of drilling fluid to hang weighting materials has caused the trouble which is identified as barite sag. Some of the troubles produced by barite sag include well control problems, casing and cementing problems, formation fracture and borehole instability.Numerous of laboratory examinations of barite-sag methods and potential have been started over the past decade. Consequences from a laboratory study showed by Hanson et al. and he found that barite sag is maximum problematic under dynamic, not static, circumstances. The exam indicate that barite sedimentation and bed formation occur when drilling fluid is being circulated and that fluid-like beds can "slump" downward while circulation is immobile.Barite sag remains to be a possible trouble in drilling processes mainly in directional drilling.The difficulty has turn into more serious with the growing number of high- temperature, high-pressure (HTHP), extended reach, and horizontal wells where circumstances might be in bad situation for settling of weight materials. The advanced rheometers can be utilized to conduct accurate settling quantities to examine the connect among sag and fluid properties. The method can be utilized to exam dynamic settling and has ability for delay to static sag.It be able to describe the sag procedure that is familiar by an important (>0.5

Ibm/gal) drilling fluid density variation by Hanson, P.M., et al, lighter followed by heavier than the nominal fluid density, gauged while circulating bottoms up, where a weighted fluid has continued uncirculated for a while of time in a horizontal well. It is predictable that sag is both a static and dynamic phenomenon and has the probability to happen when the drilling fluid is movement.In fact, barite sag is the settling of the drilling fluid weight material in the wellbore, which can lead to density differences as high as 4.0 lb/gal at the flow line. It is more severe in non-aqueous drilling fluids (NAF) where it is possible to happen over a comparatively wide fluid density range, 12.0-20.0 lb/gal. Barite sag able to allow to potential drilling difficulties such as well-control problems, lost circulation, induced wellbore instability and stuck pipe.

The importance of barite sag and the potential results of troubles linked with it highlights the requirement for quantitative measure- ments of dynamic sag before and during the drilling process. Such capacities are necessary for numerous of reasons:

•Let optimization of fluid design for diverse drilling scenarios.

•Give ways of associating the performance of dissimilar anti-sag additives.

•Allow checking the performance of drilling fluid while the drilling process at the rig site.

Laboratory quantity of dynamic sag is usually done in one of two techniques: by a viscometer sag examination machine where the sag performance of the fluid is examined under two laminar flow conditions (where fluid rheology is the dominant effect), or in a flow loop where other parameters such as flow rate, eccentricity, pipe rotation and inclination are considered to be effective. The viscometric technique is faster and easier, and it needs significantly less fluid by Jefferson, D.T., (1991). In deviating wells the barite sag is more usual trouble related to vertical well because while the inclination rise the quantity of barite will rise to fall in wellbore. Whereas the angle of inclination of bit or mud motor more than 45° the barite settling in wellbore will be high and cause the stuck to pipe and motor assemble.

In this study will use the first method to determine barite sag problems and the best interpretation between share rate and share stress of mud by adding different concentration of barite to mud. In this way it can find in which weight sag occurs and after that utilize two type of polymers separately to tackle or delay sag problem during drilling process.

In delivering an e-learning system, the LOM (Learning Object Metadata) is a standard published in 2002 by the LTSC (Learning Technology Standards Committee) of IEEE. The standard is made up of four parts: IEEE 2003; Belkasmi et al 2010).

-IEEE 1484.12.1 Conceptual model of metadata

-IEEE 1484.12.2 Implementation of ISO/IEC 11404 in LOM model

-IEEE 1484.12.3 Definition and Implementation of XML schema for the LOM

-IEEE 1484.12.4 defining the framework for implementing RDF (Resource Description framework) for the LOM.

Technology has impacted on education in the following ways:

- It is economical to reproduce and distribute digitized content and knowledge
- Teachers and Learners are connected directly without intermediary
- Reduction of specialized services and increased capacity of individuals and groups.

The adoption of e-learning over the traditional mode of learning has incited various software experts to provide tools that can assist in developing LMS or CMS. Among them is AVUNET platform interface that provides easy access to the resources and to the various integrated tools (Douidi et al 2006) cited in S. Omidinia et al [E-Learning] [4]). This platform provides an easy way for the instructor to create and deploy teaching material. A user can create a self-evaluation courses and exercises.

Available technologies that are been designed and developed in the context of developed countries have several limitations in implementing them in developing countries; this is as a result of reduced ICT specialist in education and so depending solely on few pioneering and over-laboured teachers to initiate change in these institutions.

The application of e-learning system varies with each country in the areas of corporate training, technology learning, and mobile learning market (2). In 2015, statistics has it that e-learning is been adopted in a fast pace in developed countries by the following percentages; India 55%, China 52%, Malaysia 41%, Romania 38%, Poland 28%, Czech Republic 27%, Brazil 26%, Indonesia 25%, Colombia 20%, Ukraine 20% (2). In 2014, about 74% of corporate companies use the Learning Management System (LMS), Webcasting, Video broadcasting and Virtual Classroom. LMS such as Cousera and Udacity have been adopted by over 300 corporate companies for easy identification of eligible students on relevant job positions (2). Also, 80, 000 of Google' employee were enrolled in Udacity (2). In essence, e-learning is on the top speed usage in many facets of life.

2. LITERATURE REVIEW

Numerous research work has been done on e-learning for institutions in developed countries. The form of e-learning that is being practiced in Nigeria are lectures that are collated on a CD-ROM and can be played when needed. However only few institutions have been able to implement an e-learning system in Nigeria; among which are RECTAS, Federal School of Surveying, Oyo, University of Ibadan and Obafemi Awolowo University (OAU) Ile-Ife. (3). Therefore, there are no existing developed e-learning system for institutions in the Niger Delta Region.

3. METHODOLOGY

This section explains the technical approach used to achieve the design goals of the system. The Structural System Analysis and Design Methodology (SSADM) is used. This methodology is an open methodology that is founded on the Waterfall Model. Figure 1 shows the structure of a Waterfall Model that comprises of distinct stages which subjects the developer to perform a quality assurance (verification and validation) before proceeding to the next stage.

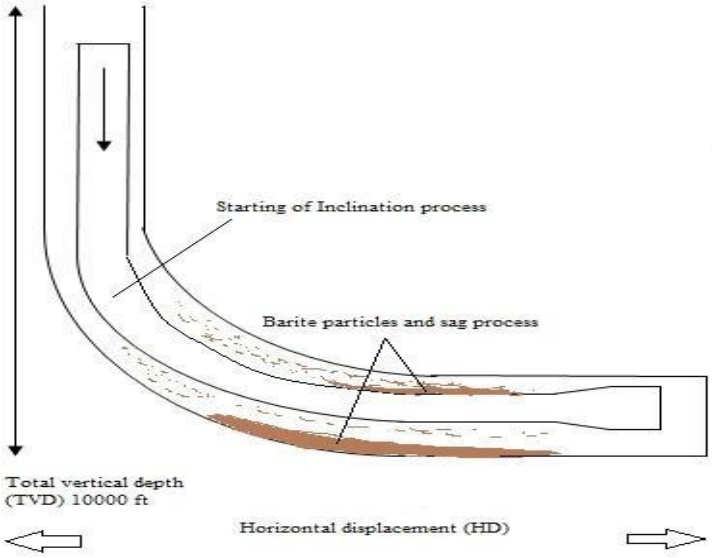

Figure 1 shows the accumulation of barite in directional drilling

2. EXPERIMENT

2.1. Materials

The drilling fluid can perform the significant purposes which is dependent on the elements that fluid included or produce for particular elements. An element might make a particular work, when two or more components may work together to make one function.

In this experiment use many materials such as fresh water, Caustic soda to change the pH of water, polymers; in this test was used two type of polymers with different concentration for each sample. Another material was barite, to make a mixture which is real mud like any type of mud use in directional drilling in the rig.

According to this test eight samples of muds were prepared in total in order to determine the barite sag problems in directional drilling, rheological and mud cake forming properties of polymers additives. The first four samples for each one consist of fresh water 350ml, one drop of caustic soda, 0.5grams of gum arabic polymer powder and with different amount of barites 37.5grams, 300grams,490grams and 830grams respectively in powder. The second four samples for each one contain of fresh water 350ml, one drop of caustic soda, 0.2grams of xanthan gum powder polymer and with different amount of barites 37.4grams, 235grams, 480grams and 815grams respectively in powder. The amount of barite were used different because to achieve these mud weights, the 9, 12, 15 and 18 ppg in density or weight and the amount of polymers were different due to 0.2grams of xanthan gum and 0.5grams of gum arabic. Relating to concentration, the appropriate weight for xanthan gum is 0.2grams and it is used as a stander by companies in the rig but for gum arabic I found the best weight is 0.5grams because when use less 0.5 grams the barite sink even during take a measurement of density or weight and more than 0.5grams is not economical to spend each sample more than 0.5grams.

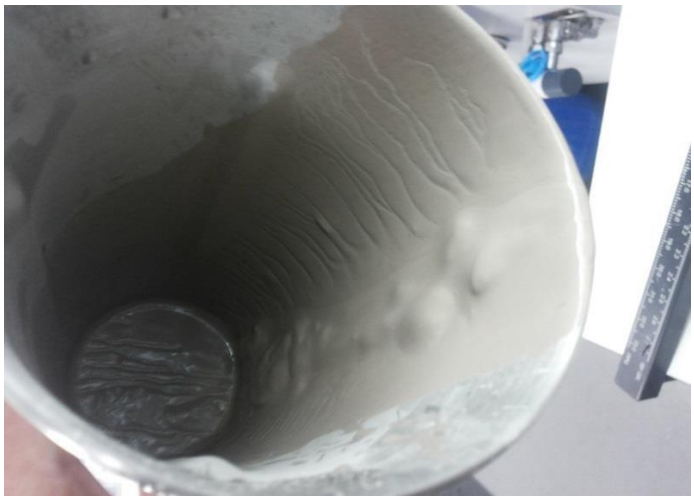

Figure 2 shows barite sag process during the measuring density in the Lab

Table 1 got PV and YP from all data were gauged in the lab

Polymer types		Gum Arabic added				Xanthan Gum added			
Prosperities	**Units**	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**	**M 7**	**M 8**
Density	**ppg**	8.8	12.3	15.1	18.3	9.0	12.3	15.2	18.4
pH	**-**	9.4	9.3	9.2	9.0	9.2	9.3	9.0	9.4
Shear Stress (600 RPM)	**Ib/100ft2**	4.0	12.0	15.0	35.0	11.0	15.0	16.0	34.0
Shear Stress (300RPM)	**Ib/100ft2**	3.0	7.0	9.0	20.0	7.0	9.0	10.0	20.0
Apparent Viscosity	**cp**	2.0	6.0	7.5	17.5	5.5	7.5	8.0	17
Plastic Viscosity PV	**cp**	1.0	5.0	6.0	15.0	4.0	6.0	6.0	14.0
Yield Point YP	**Ib/100ft2**	2.0	2.0	3.0	5.0	3.0	3.0	4.0	6.0
G. 10 seconds	**Ib/100ft2**	1.0	1.0	1.0	9.0	0.8	1.0	1.0	9.0
G.10 minutes	**Ib/100ft2**	1.0	4.0	8.0	10.0	1.0	2.0	6.0	10.0

2.2. Method

After additional of materials, the mixture mixing for 25 minutes, the examination of muds were aged to fully hydrate at room temperature for 2 days. Hence, the samples were heat up to 120 F or (50 ^{O}C) and let to cool in ambient temperature before operating. To get the rheological viscometer (viscosity, yield point and gel strength) of the test muds, model 800 viscosity (OFI Testing Equipment, Inc., Texas, USA) in the concentric-cylinder mode was used. The density of the base mud was calculated by utilizing the mud balance (OFI Testing Equipment, Inc., Texas, and USA). pH in this examination is the scale to gauge alkalinity and acidity of the mud. The liquids acid when the pH is 7 and the acidity increases when the pH reduces. Though, the fluid is recognized as an alkaline when pH more than 7 and the alkalinity increases as the pH rise. pH is important because it is measure the organic thinners and dispersal solubility of clays in the fluid. The best choice of the mud pH is from 9.0-9.5

3. RESULT AND DISCUSSION

The possibility of utilizing two types of polymers which are xanthan gum and gum arabic to improve muds and delay barite sag problem in directional drilling. The test was relating with rheology and gel strength of muds to find out the plastic viscosity, from PV it can find yield point directly. The results of laboratory tests are presented in table 1 below.

3.1. Comparison of Rheological Properties

Figure 3 indicates the properties of muds arranged with diverse quantities of barite weight separately with two type of polymers. The measurement illustrated that as the concentration of barite in the each mud rise, the rheological properties of the muds also increase. The description for this figure 3 is that the muds formulated utilizing the polymers are Non-Newtonian fluids as the curves of shear stress against shear rate. Furthermore, it can be examined that the plot of shear stress against shear rate is alike to the Bingham Plastic model and the Herschel-Bulkley model. A Bingham plastic fluid will not flow till the shear stress exceeds the yield point. At this point the shear stress is proportionate to the plastic viscosity, it is to be noted that water-based muds are non-Newtonian fluids by H.Larsen (2007).The significant description for this figure is that the mud 5,6,7 and 8 which were consist of xanthan gum, have a higher rheological properties (high shear rate) if compared to mud 1.,2,3 and 4 which were consist of gum arabic. Despite the fact that the xanthan gum was 0.2grams in each sample lower concentration of polymer than the gum arabic was 0.5grams in each sample.

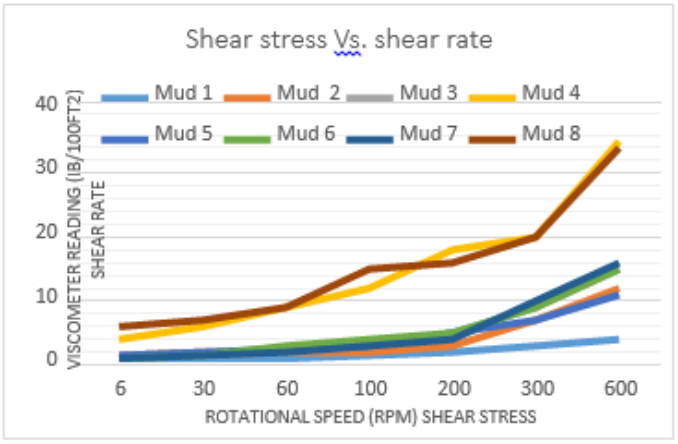

Figure 3 Rheology profiles of fluids measured on the Fann viscometer

3.2. Yield Point Comparison

The yield point is linked with two works of a drilling mud: hole cleaning capacity and pressure control. Higher yield points raise the carrying capacity of a mud and enlarge the circulating pressure reduction in the annulus by R.M. Annis and V.M. Smith (1996). The yield point of a drilling mud must be high to allow the transportation of cutting out of hole; however, no very high to make excessive pump pressure when beginning to pump mud. Figure 4 illustrate that as the concentration of barite enlarges the yield point rise immediately. The description for this is that as the particle quantities increase, there is a greater attractive force among particles, as the result the yield point get high value. Moreover, increase in mud weight is effective growing carrying capacity which means increasing yield point.

The results presented in figure 4 indicate that mud samples prepared by xanthan gum have the highest yield points when compared with mud samples prepared by gum arabic. It can be seen clearly that the red line above blue line which means the mud samples prepared with xanthan gum provide highest yield point; however, those samples were used lower concentration of xanthan gum than those samples were used gum arabic. Xanthan gum in this test gave the better yield point. Overall, gum arabic in mud samples 1, 2, 3 and 4 have the smaller yield point, this is showing that gum arabic fluid will not capably to transport cuttings from horizontal borehole perfectly.

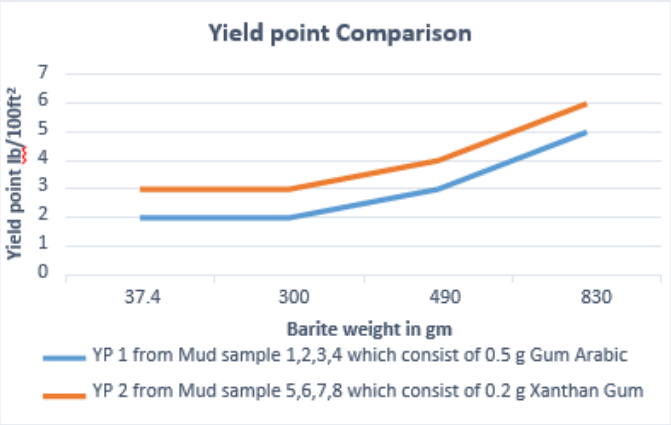

Figure 4 shows the relation between yield point and barite weight

3.3. Comparison of Gel Strength

Gel strength is a property of a drilling fluid and illustrates the capacity of a drilling mud to suspend drill solid and weighting element like barite when circulation is stopped. Therefore, cuttings and barite will settle in a mud that has no gel strength not withstanding it is viscosity. A high viscosity can only slow the rate of settling. In addition, drilling muds with low gel strength are incapable to hang cuttings professionally. Thus, while pumps are shut down, the cuttings will rapidly settle, as the result leading to hole troubles like pipe sticking and deposition of cutting beds. In figure 5 illustrates that the gel strength increases as the concentration of barite increases, the description for this, is that as the particle quantities rise lead to make a greater attractive force between particles, consequently enlarge the gel strength. By contrast, this is not true for polymers, when increasing the polymer concentration the gel strength will not increase because in this circumstance the type of polymer important not quantity or concentration of polymer.In figure 5 illustrates that the gel strength increases as the concentration of barite increases, the description for this is that as the particle quantities rise lead to make a greater attractive force between particles, consequently enlarge the gel strength. By contrast, this is not true for polymers, when increasing the polymer concentration the gel strength will not increase because in this circumstance the type of polymer important not quantity or concentration of polymer.The gel strength for fluid samples measured at 10 minutes is higher than those measured at 10 seconds. In term of gel strength the samples include of xanthan gum have higher gel strength for 10 seconds and 10 minutes as well than the samples include of gum arabic. Gum arabic fluids have poor gel properties. According to gel strength those samples were included of gum arabic would not be able to hang cuttings and solid additive efficiently.

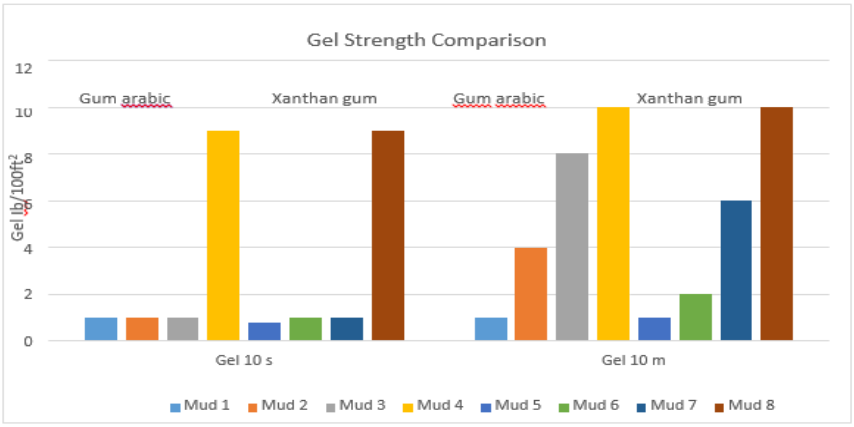

Figure 5 shows gel strength for 10 seconds and 10 minutes measurement for 8 samples

3.4. Plastic Viscosity Comparison

The plastic viscosity is vital in drilling process because it indicates the resistance to flow rising from mechanical friction. If plastic viscosity rises, surge and swab pressure also growth and if the plastic viscosity enlarge because of expand in solid contents, a possibility for differential pipe sticking also enlarges. Moreover, if the PV rises the (ROP) rate of penetration will be decreased or get the low value. To drill fast PV must be as low as probable and low PV can be gotten by reducing the solid contents. Figure 6 compares the PV test results for gum arabic and xanthan gum. This description for figure is that plastic viscosities of the fluid samples increase as the quantities of barite increase, which means plastic viscosity depends on the solid contents in the muds. Furthermore, it can be seen from figure 6 that muds formulated with xanthan gum have higher PV than gum arabic accept mud 4 was 15cp has higher PV than mud 8 was 14cp, mud 4 consist of 830grams of barite with 0.5grams of gum arabic but mud 8 consist of same amount of barite with 0.2grams in xanthan gum. Overall, if weight of barites compared with plastic viscosities, it can be seen when weights increase the PV get higher value and if type of polymers compared, the differentiation between gum arabic and xanthan gum are low dissimilarity.

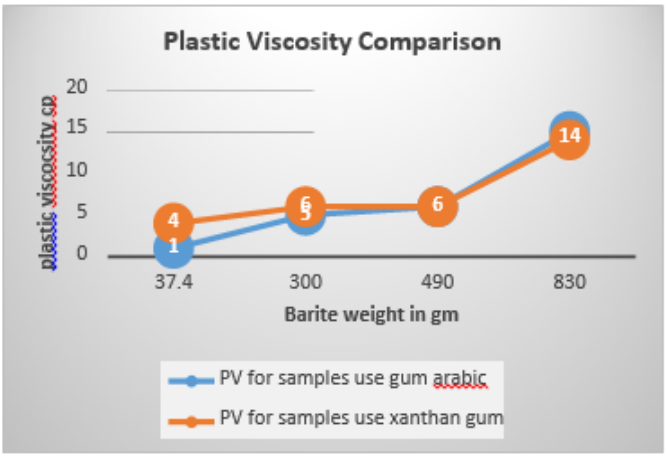

Figure 6 relation between barite weights and plastic viscosity for two type of polymers

3.5. Combination of polymers

It can plot a graph to show combination between polymers were used in this test, which can be clearly seen from figure 7 that xanthan gum is better than gum arabic in term of drilling fluid viscosifier. It means that gum arabic has unfavorable rheological properties, as the result this type of polymer is not acceptable type to delay barite sag or tackle barite sag problem in directional drilling. Nevertheless, xanthan gum in this test was provided high rheological properties which means xanthan gum was best option in this experimental.There is another technic which is instead of use one polymer use two type of polymers together. For instance, if use gum arabic with konjac gum, it could be provided good result for tackle barite sag problem much better than use only gum Arabic. When any increase in the concentration of the polymers in the mud samples happen, could have adverse influences like reduction in the rate of penetration.

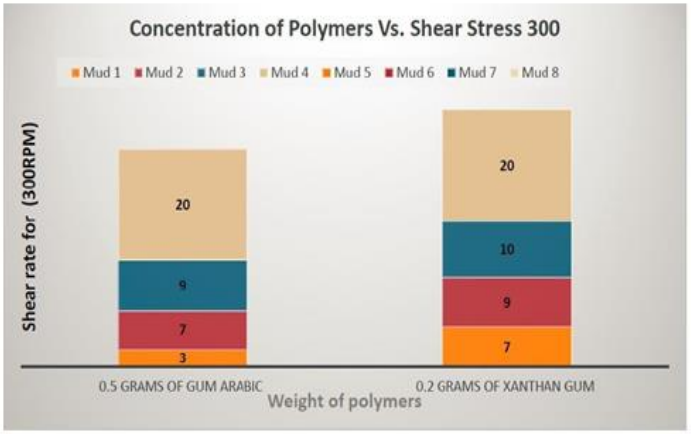

Figure 7 relation between polymer concentrations and shear rate for 300 RPM shear stress

As the result for all combinations which were got from the laboratory work by used two types of polymers namely xanthan gum and gum arabic to tackle barite sag. Consequently, the experimental from all results showed that xanthan gum is the best polymer for this purpose because it provided higher rheological properties (yield point, gel strengths, plastic viscosity and apparent viscosity) than the gum arabic. In addition, in side mud samples, those samples were density from 9 and 12ppg better than those samples were from 15 and 18ppg. It can classify those samples from 9 and 12pgg are good, samples from 15ppg are medium but samples density is 18ppg, it is the worse and it gives high probability to make deposition of barite.

4. CONCLUSION

If actual horizontal drilling techniques appear to have been perfected nowadays in more or less favorable environment, it should nevertheless be taken in mind that numerous difficulties may increase and that a well-designed drill-in fluid will often solve. One of the difficulties in this kind of well is sag of barite and accumulation of sediments in annulus especially in those areas have high angle. In this research combining polymers with barite in different densities proved to be effective in reducing sag occurrence in water-based mud. It is the best way to provide excellent solid suspension with good gel strength properties. The mud must have optimum solid contents to be able to maintain acceptable frictional pressure drop and solids-bearing capacity. These properties of the mud are controlled by its rheological parameters such as viscosity and yield point. In water based mud, the rheology is commonly controlled by using a variety of barite weights and polymeric materials. In this research the rheological properties of muds formulated using xanthan gum and gum arabic were investigated.

According to the analyses of the results from laboratory experiment, the following conclusions are drawn:

Based on the compositions of Polymer muds water-based polymer systems are environmentally friendly and non- toxic. The eco-friendly natures of polymer muds make them very attractive as governments.

Plastic viscosity, yield point, apparent viscosity and gel strength (10 sec. and 10 min.) increase with the increase the concentration of barites in the mud samples.

Those samples were consist of xanthan gum have a higher rheological properties plastic viscosity, yield point, apparent viscosity and gel strength (10 sec. and 10 min.) if compared to those sample of muds were consist of gum arabic.

Based on this investigation, xanthan gum powder is better than gum arabic powder, which means mud consist of xanthan gum has a high ability to transport cuttings from wellbore and very appropriate to use in horizontal wells. However, gum arabic has unfavourable rheological properties.

The rheological properties which are plastic viscosity, yield point, apparent viscosity and gel strength (10 sec. and10 min.) increase while the concentration of polymers increase; nevertheless, in this experimental gum arabic concentration was 0.5g in four mud samples higher than xanthan gum 0.2g, this increase were not happened in reality. It pronounced and perfect indicator that xanthan gum better than gum arabic to delay barite sag process. Furthermore, it is clear the test shows that quantities or concentrations are not significant than the type of polymers. Owing to xanthan gum was in lower concentration and it provided acceptable result and much better than gum arabic.

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