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Empirical study of basic and fundamental performance groups of nano drilling fluid

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Abstract: The roles of drilling fluid in the drilling process are so clear and essential. The objective of designing drilling fluid for extreme and deep environment (HPHT wells) is to develop high performance drilling fluid system in well bore to achieve zonal isolation. The primary objective of drilling fluid is to improve thermo electrical and rheological properties and displacement efficiency of drilling fluid system. Oil well slurries depend on its homogeneity of additive concentrations, quality and quantity to contribute the placement and success of a well drilling cementing operation. The experiments show the increase in the amount of plastic viscosity due to the increase in the amount of nano ferric oxide. Also, the increase in the amount of nano particle increases the amount of viscosity of slurry. It seems each extra 0.2% nano oxide increases the viscosity about 0.2 Pa.s from 0.2% to 0.6%.

Keywords: Electrical conductivity; Thermal conductivity; Drilling fluid additives; High performance drilling fluid system; Rheology; Ferric oxide nano particle

INTRODUCTION

The thermo electric and also, the rheological properties of drilling fluid play important role to determine the workability of slurry, fineness [1]. The mixing process is very important parameters for thermal and rheological behavior of drilling slurry, the criteria of designing slurry depends on formulation, thermal conductivity, density, plastic viscosity, shears tress, yield point and gel strength for enhance durability and toughness for drilling slurry[2]. Cement grout is used for sealing geothermal wells for is olatezones drilling fluid operation. The electrical and rheological behaviors of drilling slurry are important for the drilling process; it will be optimum to predict correctly about slurry placement [3]. Drilling slurry is concentrated suspensions of small and heavy particles so thermal and rheological measurements are suffering to the disruption of drilling operation [4]. The thermo electrical properties and the rheology of Oil Well drilling fluid (OWDF) should be considered when it applied on the originally and primarily casing drilling. Therefore, fundamental knowledge of OWDF slurry rheology is necessary to evaluate the ability to mix and pump grout, remove mud and slurry placement optimization and to predict the effect of temperature on the slurry pit [2]. Incomplete mud removal can result in poor drilling fluid bonding, zone communication and ineffective stimulation treatment [3]. A rheology is study related to the flow of fluids and deformation of solids under stress and strain. In shear flows, fictitious parallel layers of liquid past each other in response to a shear stress to produce a velocity gradient, in term of two shear rate, which is equivalent to the rate of increase of shear strain [5]. The property of drilling slurry is complex which has the appearance and interactions between the additives [6]. The chemical composition of drilling fluid, particle distribution, test in g methods, size shape, W/DF ratio, mixing time and temperature [7]. The drilling slurry is viscous plastic materials that exhibit yield stress and tension below the yield stress ultimately slurry behaves as a rigid and solid [8]. The Bingham plastic and power-law model is widely used to describe the rheological properties of drilling slurry measurements. Frittella *et al*. [7] that can be determined the properties of drilling fluid flow i.e., plastic is cosity, yield point, friction characteristics and gel strength [9]. The concentration and form of so lid particles has a significant impact on the thermo electrical rheological properties of the OWDF slurry to yield stress and plastic viscosity of drilling paste usually increase as the cement becomes finer and increases the stability of slurry [10]. Equivalent Circulating Density (ECD) is important factor to understand the flow behavior, flow rate, annular velocity and differential pressure; for that purpose number of computer simulation software is available to predict the ECD. The displacement efficiency is achieving the maximum mud displacement. A standoff value of the percentage of casing centralization in the wellbore, job operation time for proper thickening and Reynolds numbers base on laboratory methods is measuring rheological properties to understand flow behaviors [11]. These parameters will be evaluating the drilling fluid pump-ability and drilling paste grout with strength correspond to behind the casing to increase efficiency and displacement. High flow rate may cause fracture the formation there should be investigated the current effective equivalent cement density [12]. Maximum drilling fluid or colloids or emulsions as a non-Newtonian liquids in plastic or behave in such circumstances is that the gel analysis function of the intermolecular forces. The initial 10-sec and 10-min gel strength measurements gelation indications of the gel that will occur after the flow is stopped and the drilling fluid remain static [13]. When circulating drilling mud and fluids during cementing operations abnormal results in bottom hole, which may cause challenge to the integrity and safety. Soliman *et al*. [14]. To maintain hydrostatic pressure of the fluid column below the fracture gradient but above the pore pressure and designing drilling slurry to improve efficiency and displacement without causing any form of collapse to the formation for this condition to focusing on ECD and rheological properties [15].

MATERIALS AND METHOD

The ferric oxide nanoparticles, a common ingredient has a huge variety of applications. This topic is proven that, the application of Fe2O3 nano particles in low dosage is not toxic. So, this type of metal oxide is chosen as additive. The nano fluids that are used in this experimental work are prepared in two steps. The Rotational Viscometer (RV) is used to determine the viscosity of samples in the high temperature range of manufacturing and construction. The RV test can be conducted at various temperatures, but since manufacturing and construction temperatures are fairly similar regardless of the environment. The RV test helps ensure that the drilling fluid binder is sufficiently fluid for pumping and mixing. The basic RV test measures the torque required to maintain a constant rotational speed (20 RPM) of a cylindrical spindle while submerged in drilling fluid binder at a constant temperature. This torque is then converted to a viscosity and displayed automatically by the RV. The standard Rotational Viscometer procedure is according to AASHTO T 316 and ASTM D 4402: Viscosity Determination of Asphalt Binder Using Rotational Viscometer.

RESULTS AND DISCUSSIONS

Experimental results are shown in this section of article. Yield stress, plastic and also slurry viscosity are investigated in this paper.

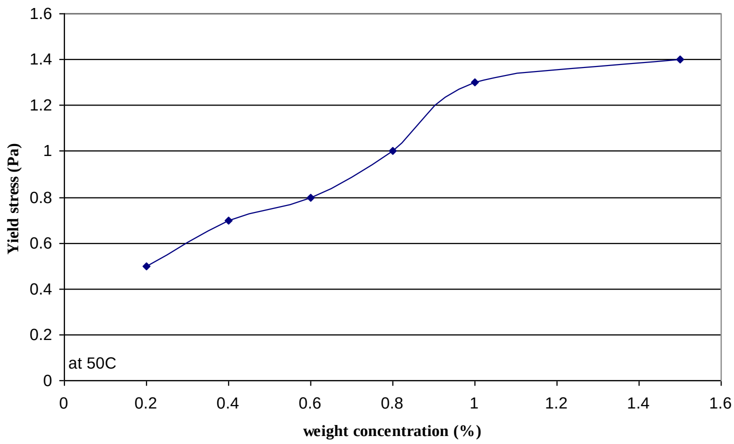

Fig-1: Yield stress versus amount of nano particles

At constant temperature 50 C the effect of dosages of nano ferric oxide on the amounts of yield stress is shown in Figure 1. The increase in the amount of ferric oxide (0.2% to 1.5%) increases the amounts of yield stress (0.5 Pa to 1.4 Pa). So, the molecular interaction between nano ferric oxide and drilling fluid seems to make the drilling fluid to bear higher stress to flow.

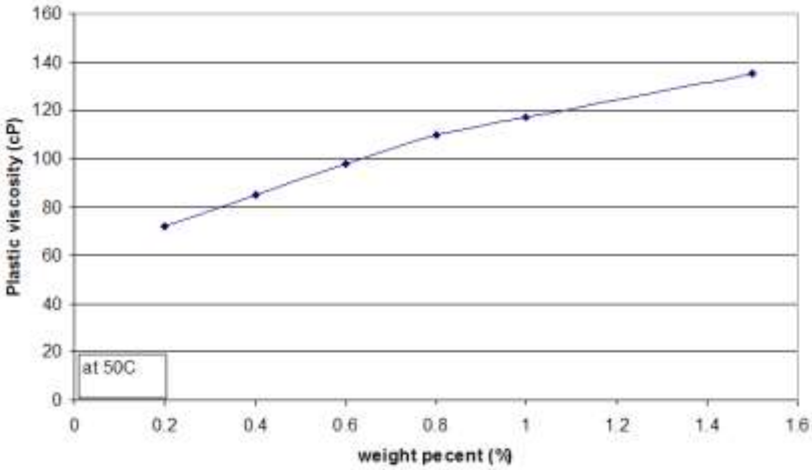

Fig-2: Plastic viscosity versus amounts of nano ferric oxide

The Figure-2 shows the effect of nano ferric oxide addition on the amounts of plastic viscosity; at the constant temperature 50 Centigrade degree**.** The experiments show the increase in the amount of plastic viscosity due to the increase in the amount of nano ferric oxide.

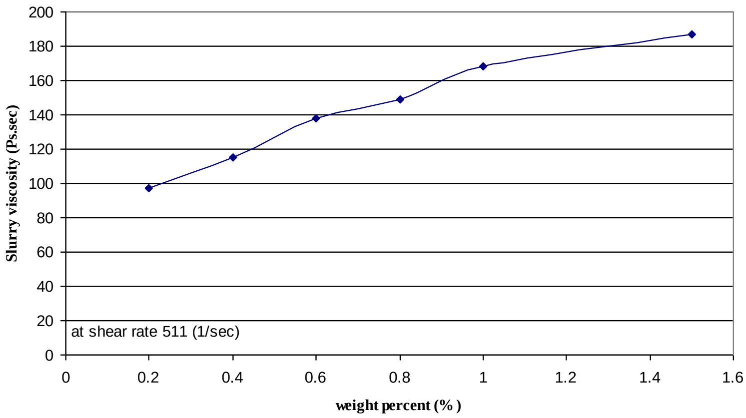

Fig-3: The effect of amount of ferric oxide on the values of viscosity

The effect of amounts of nano ferric oxide on the amount of viscosity of slurry at the constant amount of shear rate (150 1/sec) is shown in Figure 3. The increase in the amount of nano particle increases the amount of viscosity of slurry. It seems each extra 0.2% nano oxide increases the viscosity about 0.2 Pa.s from 0.2% to 0.6%. The slope of the curve in Figure 14 decreases with the increase in the amount of nano ferric oxide (0.6% to 1.5%). So, a value of nano ferric oxide seems to be which at higher than that value, the amounts of viscosity will be constant.

CONCLUSIONS

Experimental results are shown in this section of article. Yield stress, plastic and also slurry viscosity are investigated in this paper. Experimental results show the increase in the amount of ferric oxide (0.2% to 1.5%) increases the amounts of yield stress (0.5 Pa to 1.4 Pa). In addition, the experiments show the increase in the amount of plastic viscosity due to the increase in the amount of nano ferric oxide. Also, the increase in the amount of nano particle increases the amount of viscosity of slurry. It seems each extra 0.2% nano oxide increases the viscosity about 0.2 Pa.s from 0.2% to 0.6%.

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