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Empirical Investigation Electrical Properties of Drilling Fluid; Introduction of Novel Drilling Fluid for Drilling Process

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Abstract

The drilling fluid is a basic fluid which is applicable and so important in the drilling process. This fluid is not ignorable so the performance of nano drilling fluid is considered in this paper. In fact, the metal nano oxide is mixed with drilling fluid in an ultrasonic vessel and the physical properties of this fluid are measured, experimentally. The electrical properties of drilling fluid have important role in the heat transfer mechanisms. The ability of drilling fluid in the transfer of heat from gimlet to drilling fluid is one of duty of this fluid. The effects of nano particles on the thermo electrical and in fact, the rheological properties of drilling fluid are investigated in this research. The experimental results show, For 30 centigrade degree, amount of electrical conductivity is changed from 220 to 286 micro Siemens per centimeter, approximately. In addition, for 40 centigrade degree, the amount of electrical conductivity is changed between the 225 to 281 micro Siemens per centi meter, approximately. Temperature variations of drilling fluid for this experiment are fixed in the 50 Centigrade degree. All of the results are fitted by mathematical polynomial. Obtained results show, the ability of distributed nano particles in the text of drilling fluid is powerful in heat transfer, totally.

Keywords

E.C., Thermal Conductivity, Drilling Fluid, Concentration, High Performance

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1. Introduction

Drilling fluids play an important role in the integral part of any drilling operation. Their role may best be defined or described in terms of the functions of a drilling fluid [7]. In the early days of rotary drilling, the primary function of drilling fluids was to bring the cuttings from the bottom of the hole to the surface. Today it is recognized that drilling fluid has as least ten important functions [4 and 5]:

1. To remove the cuttings from the bottom of the hole and carry them to the surface.
2. To cool and lubricate the bit and drill string [6].
3. To wall the hole with an impermeable cake.
4. To control subsurface pressures.
5. To hold cuttings and weight material in suspension when circulation is interrupted.
6. To release sand and cuttings at the surface.
7. To support part of the weight of drill pipe and casing.
8. To reduce to a minimum any adverse effects upon the formation adjacent to the hole.
9. To insure maximum information about the formations penetrated.

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10. Transmit hydraulic horsepower to the bit [1].

The removal of cuttings from the face of the well bore is still one of the most important functions of drilling fluids [8]. Fluid flowing from the bit nozzles exerts a jetting action that keeps the face of the hole and edge of the bit clear of cuttings [2]. This insures longer bit life and greater efficiency in drilling. The circulating fluid rising from the bottom of the well bore carries the cuttings toward the surface [10]. Under the influence of gravity the cuttings tend to sink through the ascending fluid; but by circulating a sufficient volume of mud fast enough to overcome this effect, the cuttings are brought to the surface [3 and 9]. The effectiveness of mud in removing the cuttings from the hole depends on several factors [17]:

1. Velocity – is the rate at which mud circulates, and the annular velocity is an important factor in transporting the cuttings to the surface. Annular velocities between 100 and 200 ft/min are frequently used. Velocity is dependent upon pump capacity, pump speed, borehole size, and drill pipe size [11 and 15].
2. Density – is weight per unit volume of mud and has a buoyant effect upon the particles. Increasing mud density increases its carrying capacity due to the buoyancy effect created by additional solids [10 and 16].
3. Viscosity – is significant in affecting the lifting power of mud. Viscosity depends upon the concentration, quality, and dispersal of the suspended solids. In the field it is measured as a timed rate of flow using a marsh funnel [12].

With increasing depths, the weight supported by the surface equipment becomes increasingly important [13]. Since both the drill pipe and casing are buoyed up by a force equal to the weight of mud displaced, an increase in mud density necessarily results in a considerable reduction in total weight which the surface equipment must support [14]. The optimum values of all the properties of drilling fluid are necessary to offer maximum protection of the formation, yet sometimes these values must be sacrificed to gain maximum knowledge of the formations penetrated [15]. For example, salt may upset a mud and increase the fluid loss, yet it may be added to control the resistivity in order to get the proper interpretation of an electric log [18]. Again, oil may improve the performance of a mud and even the production of a well, but if it interferes with the work of the geologist, it may be forbidden for use in the drilling fluid [19 and 20].

Totally, the metal nano oxide is mixed with drilling fluid in an ultrasonic vessel and the physical property of this fluid is measured, experimentally. For example, the electrical properties of drilling fluid have important role in the heat transfer mechanisms. The ability of drilling fluid in the transfer of heat from gimlet to drilling fluid is one of duty of this fluid that is investigated in this paper, empirically.

2. Materials and Method

The lead oxide nanoparticles are added to drilling fluid to improve the physical properties of drilling process. The specific area of nanoparticles is so high and it seems to enhance the function of this fluid. A rotational viscometer is used for blending of nanoparticles with drilling fluid. In addition, the electrical conductivity meter is used for measuring of electrical properties. This device measures the ability of anion and cation ions that are effective in the electrical current transfer and heat transfer, also. The percentage of adding nano particles to drilling fluid is measured by weight balance. In addition, the electrical conductivity of drilling fluid is measured by electrical meter. The operating temperature of this fluid is sensed by thermometer. The electrical conductivity is measured in the different operating temperature. Also, the mathematical correlations are presented in the results and discussion section. The operating temperature is so effective on the electrical ability of drilling fluid. So, dependency of electrical conductivity to operating temperature is shown in the research part.

3. Results and Discussions

A good drilling fluid should deposit a good filter cake on the wall of the hole to consolidate the formation and to retard the passage of fluid into the formation. This property of the mud is improved by increasing the colloidal fraction of the mud by adding bentonite and chemically treating the mud to improve deflocculating and solids distribution. In many cases it may be necessary to add starch or other fluid loss control additives to reduce the fluid loss. As mentioned the specific area of nanoparticles is so high and it seems to enhance the function of this fluid. A rotational viscometer is used for blending of nanoparticles with drilling fluid. In addition, the electrical conductivity meter is used for measuring of electrical properties.

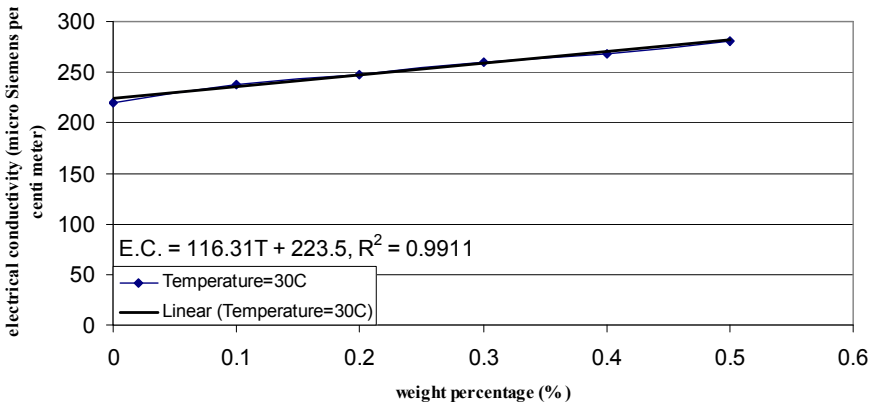

Figure 1. Electrical conductivity versus nano weight percentage (T=30C).

The effect of weight percentage of added nano particles on the electrical conductivity is shown in the Figure 1. As shown, the correlation with high regression is defined in the Figure 1. The amount of electrical conductivity is changed between the 220 to 286 micro Siemens per centimeter, approximately. The equation 1 shows this relation by mathematics science. The effect of operating temperature on the electrical ability is measured in the 30, 40 and 50 centigrade degree.

$$E.C.=116.31T+223.5,\ R2=0.9911 \quad (1)$$

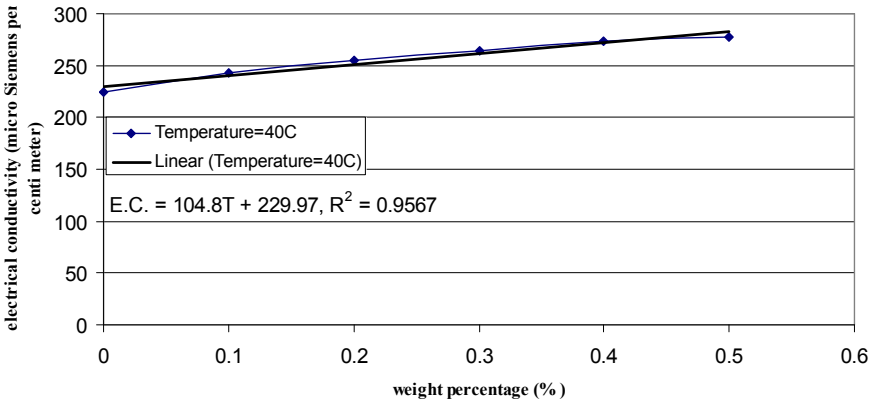

Figure 2. Electrical conductivity versus nano weight percentage (T=40C).

As shown in the Figure 2, the relation between the electrical conductivity and weight percentage of nano particles are positive. The amount of electrical conductivity is changed between the 225 to 281 micro Siemens per centi meter, approximately. The equation 2 states this relation. This may related to the electrical properties of lead oxide nano particles as metal oxide. Undoubtedly, the ability of drilling fluid in the transfer of electron can be decreased by increasing in the amount of lead oxide nano particles.

$$E.C.=104.8T+229.97,\ R2=0.9567 \quad (2)$$

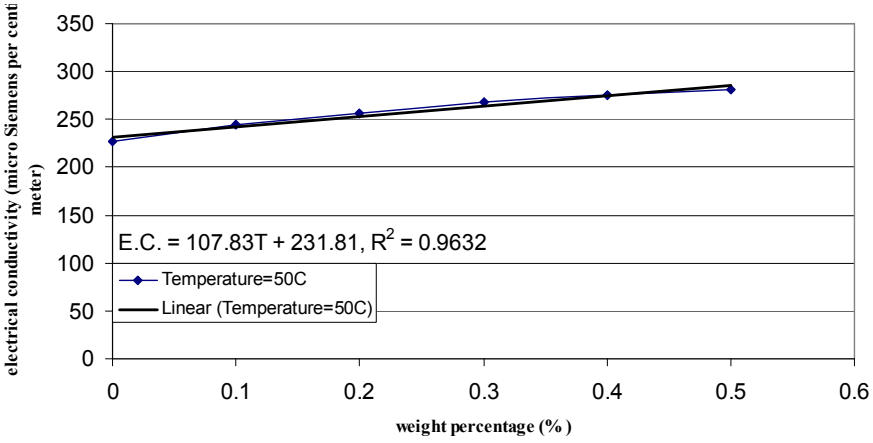

Figure 3. Electrical conductivity versus nano weight percentage (T=50C).

The relation between the weight percentage of nano particles and electrical conductivity is stated in the Figure 3. As seen, this relation is positive and this is for the electrical properties of lead oxide nano particles. Temperature of drilling fluid for this experiment is fixed in the 50 Centigrade degree. The correlation 3 states the electrical conductivity of drilling fluid versus the weight percentage of nano particles. The approximated regression for the presented formula is near one. Therefore, the correlations are with high accuracy. The obtained results show positive effect of nano particle distribution in the text of drilling fluid and operating temperature, simultaneously.

$$E.C.=107.83T+231.81,\ R2=0.9632 \quad (3)$$

4. Conclusions

The effects of nano particles on the thermo electrical and rheological properties of drilling fluid are investigated in this research. The experimental results show, For 30 centigrade degree, amount of electrical conductivity is changed between the 220 to 286 micro Siemens per centimeter, approximately. In addition, for 40 centigrade degree, the amount of electrical conductivity is changed between the 225 to 281 micro Siemens per centi meter, approximately. The equation (10) states this relation. This may related to the electrical properties of lead oxide nano particles as metal oxide. Undoubtedly, the ability of drilling fluid in the transfer of electron can be decreased by increasing in the amount of lead oxide nano particles. As obtained results, the relation between the electrical conductivity and nano particle weight percentage is positive and this is for the electrical properties of lead oxide nano particles. Temperature of drilling fluid for this experiment is fixed in the 50 Centigrade degree. All of the results are fitted by mathematical polynomial.

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