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Introduction of a Novel Method for Treating of Drilling Waste Water

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Abstract

The performance assessment of Nano ferric oxide and mixtures of it (10 and 15 gr/lit) which contain mineral coagulants (5, 10, 15 and 20 mg/lit) as auxiliary coagulants in pretreatment of drilling waste water is considered, in this pilot scale experimental work. Major parameters in coagulation and flocculation such as total hardness, turbidity, amount of poly cyclic aromatic hydrocarbon, total petroleum hydrocarbon, transmittance, initial and final pH, zeta potential and resident time are affected in two pretreatment reactors. Results show, the minimum amount of turbidity of 4.5 NTU is obtained in the best conditions.

Keywords: Environmental pollution; Nano ferric oxide; Coagulation; Treatment

Introduction

Drilling fluid-mud is usually composed by water, clay, weighing material and a few chemicals [1]. Sometimes oil may be applied instead of water, or oil added to the water to give the mud certain desirable physical properties [2]. Drilling fluid is used to increase the cuttings made by the bit and lift them to the surface for disposal [3]. But equally important, it addition, provides a means of keeping underground pressures in check. The heavier or denser the mud, is the more pressure it exerts. Therefore, weighing materials - barite - are mixed to the mud to make it exert as much pressure as required to contain formation pressures [4]. The equipment in the circulating system consists of a large number of parameters [5]. Drilling fluids are applied extensively in the upstream oil and gas industry, and are critical to ensuring a safe and productive oil or gas well. During drilling process, a large volume of drilling fluid is circulated in an open or semi enclosed system, at elevated temperatures, with agitation, preparing an important potential for chemical exposure and subsequent health effects. When deciding on the type of drilling fluid system to use, operator well planners require conducting comprehensive risk assessments of drilling fluid systems, considering health aspects in addition to environmental and safety aspects, and strike a suitable balance between their potentially conflicting requirements [6]. The results of these risk assessments require to be made available to all employers whose workers may become exposed to the drilling fluid system.

Functions of drilling fluid

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 [7]. Today it is recognized the drilling fluid has at least ten important functions: A). Assists in making hole by: A-1). Removal of cuttings, A-2). Cooling and lubrication of bit and drill string, A-3). Power transmission to bit nozzles or turbines. B). Assists in hole preservation by: B-1). Support of bore hole wall, B-2). Containment of formation fluids. C). It also: C-1). Supports the weight of pipe and casing, C-2). Serves as a medium for formation logging. D-It must not: D-1). Corrode bit, drill string and casing and surface facilities, D-2). Impair productivity of producing horizon, D-3). Pollute the environment [8-10].

The role of drilling fluid

Undoubtedly, the drilling fluid has vital role in drilling process [11,12]. Two basic items included; frictions and in the recycling cycle.

Customized solutions

Despite the excellent track record demonstrated by invert emulsion fluids, operators continue searching for a water-based system that will give comparable performance [13-15]. Increasing concern is placed on environmental impact of operations, making water-based alternatives more attractive [16-18].

Baroid has engineered high-performance water-based fluids that emulate the performance of an invert emulsion fluid. Each fluid system is customized to address specific drilling challenges [19-21].

Materials and Methods

Experiments are held in two PVC series tanks equipped by adjustable agitator. The treatment process is done in two series mixing reactors. 450 cc NaOH and 600 cc Na_2CO_3 is inserted in the drilling mud feed line. First reactor is a fast mixing reactor to insert a coagulant during 5 min with 120 rpm. The second slow mixing reactor vessel (60 rpm, 20 min). Feed is 4 liters watery drilling mud.

Operating functions for prediction of treatment performance

Some functions which are evaluated in the treatment units are listed at the below. These functions state the quality of treatment process.

Fourier transform infrared spectroscopy (FTIR): This is a proper and confident technique which is used to obtain an infrared spectrum of absorption, emission, photoconductivity or Raman scattering of fluid. The FTIR spectrometer simultaneously collects spectral data in a wide spectral range. This confers a significant advantage over a dispersive spectrometer which measures intensity over a narrow range of wavelengths at a time. The used FTIR has made dispersive

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infrared spectrometers all but obsolete (except sometimes in the near infrared), opening up new applications of infrared spectroscopy.

Zeta potential: Zeta potential as a scientific term is applied for electro kinetic potential in this study. In the colloidal chemistry literature, it is usually denoted using the Greek letter zeta (ζ), hence *ζ-potential*. From a theoretical viewpoint, the zeta potential is the electric potential in the interfacial double layer (DL) at the location of the slipping plane versus a point in the bulk fluid away from the interface. In other words, zeta potential is the potential difference between the dispersion medium and the stationary layer of fluid attached to the dispersed particle. Also, a value of 25 mV (positive or negative) can be taken as the arbitrary value that separates low-charged surfaces from highly charged surfaces.

The significance of zeta potential is that its value can be related to the stability of colloidal dispersions. The zeta potential indicates the degree of repulsion between adjacent, similarly charged particles in dispersion. For molecules and particles that are small enough, a high zeta potential will confer stability. When the potential is low, attraction exceeds repulsion and the dispersion will break and flocculate. So, the colloids with high zeta potential (negative or positive) are electrically stabilized while colloids with low zeta potentials tend to used coagulate and flocculate, in this work. Due to the fact that some of the dissolved hydrolysis species in composition of nano ferric oxide particle and poly ferric sulfate can be adsorbed onto the surface of the hydrolysis precipitates, the zeta potential of the precipitates could be regarded as that of the hydrolysis species in Nano ferric oxide compounds.

Results and Discussion

Auxiliary coagulant and turbidity

The solving of one mole of ferric sulfate in the drilling waste water produces six positive and six negative ions. The applying this common mineral coagulant as an auxiliary material besides nano ferric oxide is considered in the Figure 1. Changes in turbidity values are tracked at the constant pH value of 9.5 and amounts of sodium hydroxide and sodium sulfates both value of 10 and 15 gr/lit and 5, 10, 15 and 20 gr/lit of ferric sulfate.

Addition of 10 gr/lit of auxiliary coagulant decreases the turbidity clearly for both 10 and 15 gr/lit of main coagulant. Values of turbidity decreases from 41 NTU to 13 NTU for 10 gr/ lit and from 30 NTU to 8 NTU using 15 gr/lit of coagulant. At the higher concentration than 10 gr/lit, the decreasing trend in turbidity values are low. This indicates the effective and relatively complete reaction between hardness ions and coagulants using 10 gr/lit of auxiliary coagulant with 10 gr/lit and 15 gr/lit of main coagulant. There is determined amount of hardness ions in the drilling waste water samples and these amounts of auxiliary and main coagulant is the most effective amount of all.

Figure 2 shows the effect of another common aluminum sulfate coagulant combined with nano ferric oxide on turbidity. The values of 5, 10, 15 and 20 gr/lit are applied with both concentrations of 10 and 15 gr/lit of main coagulant. This coagulant has 6 positive and 6 negative charges. Value of 10 gr/ lit of auxiliary coagulant shows the more

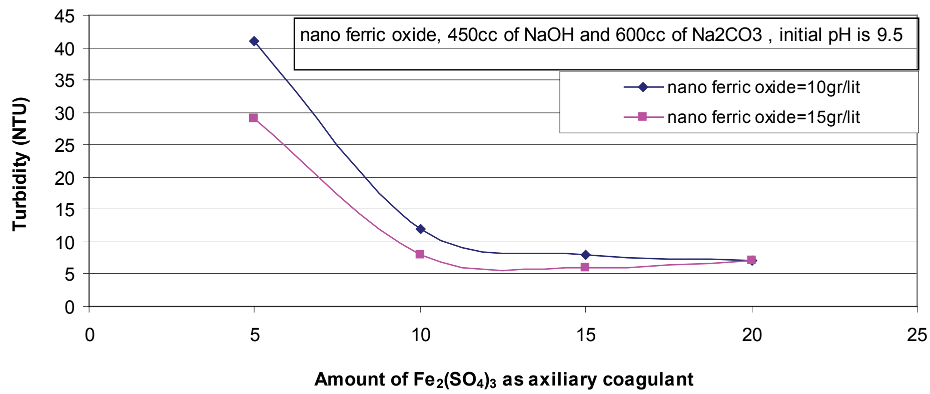

Figure 1: The effect of $Fe_2(SO_4)_3$ on turbidity.

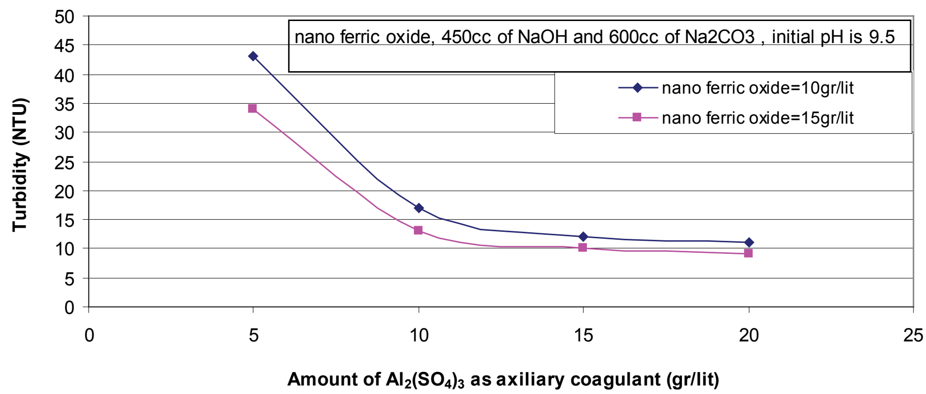

Figure 2: The effect of $Al_2(SO_4)_3$ on turbidity.

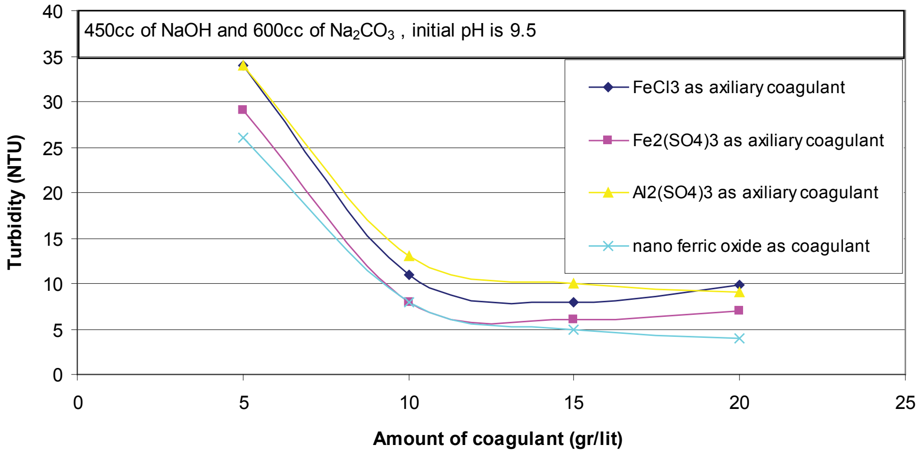

Figure 3: Turbidity assessment.

decrease in value of turbidity however the same value of ferric sulfate obtains lower value of turbidity at the same condition. This shows the effective interaction between ferric and hardness ions comparing with one between aluminum and hardness ions.

The performance of four different coagulants in turbidity removal is evaluated in the Figure 3. Three combined coagulants contain main nano ferric oxide coagulant and mineral coagulant. The best results and lowest values of turbidity relate to the nano ferric oxide. This may because of more light flocs produced using combined coagulant which needs much time to sediment, so are suspended in the solution and increase the value of turbidity. Performance of combined mixture contains ferric sulfate shows close amounts of turbidity to ones are obtained using nano ferric oxide. So, 15 gr/lit of nano ferric oxide with 5 NTU is the best result.

Conclusion

Nano ferric oxide coagulation capability is evaluated in comparison with mixtures include this poly coagulant and three common mineral coagulants of ferric chloride, ferric sulfate and aluminum sulfate. Pretreatment of drilling complex with these coagulants in two series reactors is investigated experimentally.

Below results are deduced from the experimental work.

1. The better capability of nano ferric oxide in pollution reduction as a coagulant is obvious for all materials than other combined coagulants. This can be described by the proper molecular weight and ion charges of this poly coagulant which affect the interaction between it and undesirable compounds.
2. The minimum amount of turbidity is of 4.5 NTU, amount of poly cyclic aromatic hydrocarbon is of 10 mg/gr.

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