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Practical Evaluation of Usage of Nano Coagulant and Polyacrylamide in Treatment Process of Drilling Oily Waste Water

Hesam Rezaei[1], Daryoush Emadzadeh[2, *]

[1]Department of Petroleum Engineering, Fars Science and Research Branch, Islamic Azad University, Marvdasht, Iran and Department of Petroleum Engineering, Marvdasht Branch, Islamic Azad University, Marvdasht, Iran
[2]Department of Chemical Engineering, Gachsaran Branch, Islamic Azad University, Gachsaran, Iran

Abstract

Application of mixture of nano coagulant plus auxiliary mineral and polymeric coagulant in treatment of drilling wastewater is investigated in this experimental work. The effect of amount of nano zinc oxide as a main coagulant, addition of three commercial coagulants (ferric sulfate, ferric chloride and aluminum sulfate) and poly acryl amide and pH of feed on characteristics of drilling waste water is studied experimentally. In other words, the coagulation and flocculation is considered as chemical mechanism of treatment for wastewater of drilling in this study. The effect of zinc oxide nano coagulant besides sodium hydroxide and sodium carbonate is investigated. Also, the effect of application of mixture of coagulants which contains ferric chloride, ferric sulfate, aluminum sulfate and poly acryl amide as additives is investigated. The pH of feed wastewater is important in chemical treatment mechanism. Results show, The increase in the amount of nano zinc oxide doesn't show the fixed trend in changes of pH value of treated wastewater. Usage of 0.5 gr/lit of zinc oxide nano coagulant shows decreasing trend in pH value till 21 hr and after that time period the value of pH increases. Application of 1 gr/lit of nano zinc oxide increases the pH value after 25 hr.

Keywords

Polyacrylamide, Oily Compounds, Treatment Unit, Drilling Wastewater, Coagulant

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1. Introduction

Drilling fluid -mud - is usually composed of 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 [12]. 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 adds, 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 in 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. 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 the 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 [5]. 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

* Corresponding author
E-mail address: daryoushemadzadeh@gmail.com (D. Emadzadeh)

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.

1.1. 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].

1.2. The Role of Drilling Fluid

Undoubtedly, the drilling fluid has a vital role in a drilling process [11, 12]. Two basic items included; frictions and in the recycling cycle. 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 the environmental impact of operations, making water-based alternatives more attractive [16-18]. The amount of sulfur removal from waste drilling fluid with using the zinc oxide nano particles as novel coagulant is evaluated in this paper [19-21].

Therefore, the application of mixture of nano coagulant plus auxiliary mineral and polymeric coagulant in treatment of drilling wastewater is investigated in this experimental work.

2. Materials and Methods

Experiments are held in the two PVC series tanks equipped with adjustable agitator. The treatment process is done in two series mixing reactors. 450 cc Na_2CO_3 and 600 cc NaOH are inserted in the drilling mud feed line. The first reactor is a fast mixing reactor to insert a coagulant during 2 min with 110 rpm. The second slow mixing reactor vessel (40 rpm, 1 min) is equipped with hot water jacket. The volume of feed is 4 liters watery drilling mud. Three auxiliary mineral coagulants, Aluminum Sulfate, $Al_2(SO_4)_3$, Ferric Sulfate, $Fe_2(SO_4)$ and Ferric Chloride, $FeCl_3$, and one synthesized coagulant, poly acryl amide are used in the pretreatment process of waste stream of drilling. Moreover in softening process Sodium Carbonate and Sodium Hydroxide must be added to the waste drilling fluid. To prepare the NaOH and Na_2CO_3 solution, 10 gr Na_2CO_3 and 10 gr NaOH solutes in one liter distilled water and then the appropriate volume of the solution is taken to the first reactor. So, the appropriate fraction of these additives to coagulant is considered. 300 cc of ZnO nano solution (0.5 to 2 gr per one liter of pure water) is as a main coagulant and gather the contaminants and also the sulfur around the structure. The first reactor is for coagulation and the second is for flocculation and sedimentation process. After the sedimentation and at the constant final pH, the clear water is withdrawn from the second tank and heated the tank for 1 hr.'s. to evaporate the water remained in the mud. The free oxygen in the drilling solution reacts with the sulfur and so, the sulfur content is decreased, severely. In order to, the sulfur changes into SO_2 and vent out the sediments. The optimum values of pH, amount of zinc oxide nano solution when turbidity of waste drilling fluid reaches to minimum amount are studied. The Figure 1 shows the pretreatment setup with details. The drain valves of two reactors are designed in the setup. The jointed line is equipped with the valve, also. The details are shown in the Figure 1.

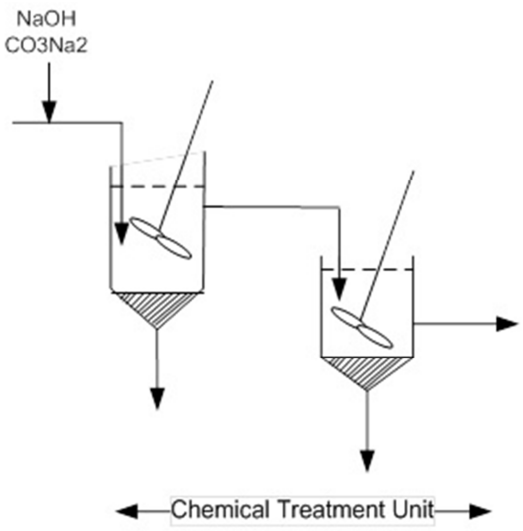

Figure 1. Schematic of laboratory setup.

3. Results and Discussions

The coagulation and flocculation is considered as chemical mechanism of treatment for wastewater of drilling in this study. The effect of zinc oxide nano coagulant besides sodium hydroxide and sodium carbonate is investigated. Also, the effect of application of mixture of coagulants which contains ferric chloride, ferric sulfate, aluminum sulfate and poly acryl amide as additives is investigated. The pH of feed

wastewater is important in chemical treatment mechanism. Figures 2 and 3 shows the amount of transmittance versus wave number at pH of 6 and 10, respectively. The quality of wastewater can be investigated by the amount of transmittance. The amounts of transmittance are compared in two figures of 2 and 3 at the same values of wave number after wastewater is treated by 1 gr/lit of zinc oxide nano coagulant. This is shown that the values of transmittance percentage at pH of 6 are higher than those are shown in Figure 3. So, pH of 6 for fee waste water is better than pH of 10 in treatment.

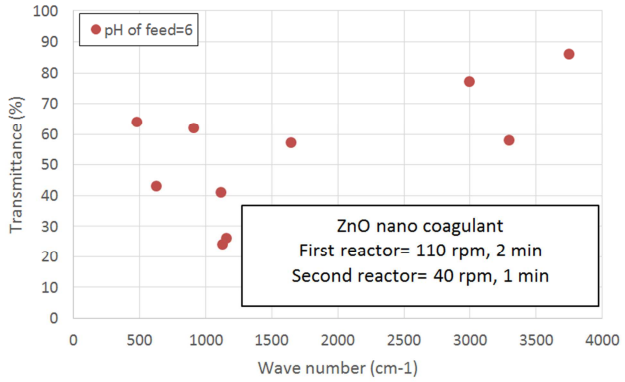

Figure 2. Transmittance versus wave number at pH of 6 for feed.

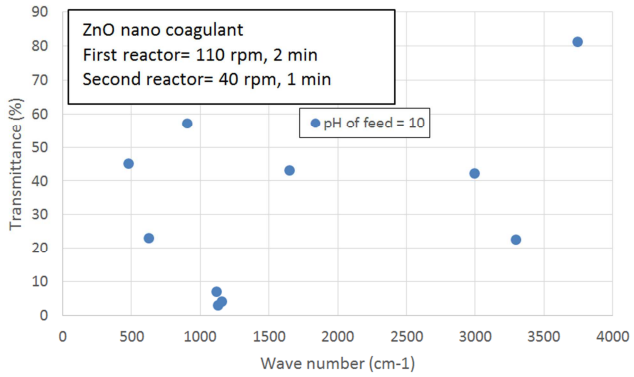

Figure 3. Transmittance versus wave number at pH of 10 for feed.

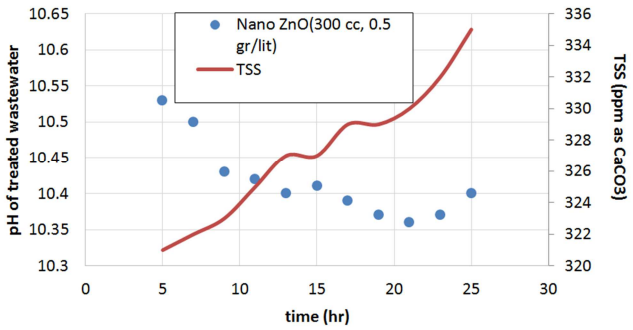

Figure 4. pH of treated wastewater versus time with 0.5 gr/lit of nano coagulant.

The amount of coagulant affects the acidity of wastewater. The effect of sedimentation time on the amount of pH value is investigated in Figures 4 and 5. Solution of zinc oxide nano coagulant (300 cc) with different amount of coagulant 0.5, 1, 1.5 and 2 gr/lit is applied and the changes in acidity of wastewater after 25 hr is presented in Figures 4 and 5, respectively. Acidity of wastewater is important on the stability of wastewater which is drained. The increase in the amount of nano zinc oxide doesn't show the fixed trend in changes of pH value of treated wastewater. Usage of 0.5 gr/lit of zinc oxide nano coagulant shows decreasing trend in pH value till 21 hr and after that time period the value of pH increases.

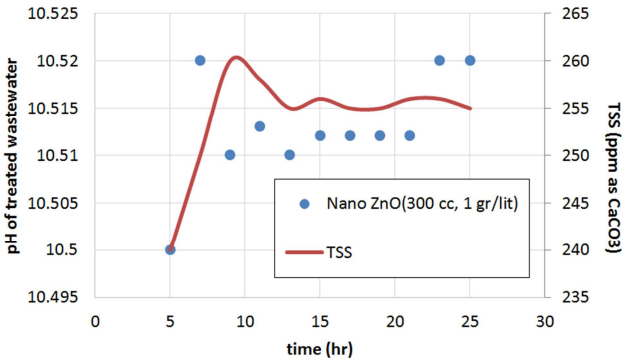

Figure 5. pH of treated wastewater versus time with 1 gr/lit of nano coagulant.

The usage of 1 gr/lit of nano zinc oxide increases the pH value after 25 hr. however, the usage of 1.5 gr/lit of nano zinc oxide shows the defined increasing trend during 25 hr. the pH values are higher than those are obtained when applying 0.5 and 1 gr/lit of nano zinc oxide. This may be the more appropriate amount of coagulant among all amounts which makes more interconnection between anions of coagulant with positive charge atoms of pollutants.

4. Conclusion

The performance of chemical treatment on drilling wastewater with coagulation and sedimentation applying the zinc oxide nano coagulant and auxiliary coagulants is investigated, experimentally. Wastewater sample, 3 lit, is treated with 600 cc NaOH, 450 cc Na_2CO_3 and 300 cc nano zinc oxide solution. The effect of amount of ZnO coagulant, binary mixture of it with $FeCl_3$, $Fe_2(SO_4)_3$, $Al_2(SO_4)_3$ and poly acryl amide, pH of feed and time of sedimentation is investigated in quality of treatment. Results show, The increase in the amount of nano zinc oxide doesn't show the fixed trend in changes of pH value of treated wastewater. Usage of 0.5 gr/lit of zinc oxide nano coagulant shows decreasing trend in pH value till 21 hr and after that time period the value of pH increases. Application of 1 gr/lit of nano zinc oxide increases the pH value after 25 hr. however, the usage of 1.5 gr/lit of nano zinc oxide shows the defined increasing trend during 25 hr. And also, the usage of 2 gr/lit

of nano zinc oxide shows the lowest value of pH comparing with the wastewater with 0.5, 1 and 1.5 gr/lit of zinc oxide nano coagulant.

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