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Experimental Investigation of Nano Coagulant as Novel Agent in Treatment Process of Industrial Wastewater

Peyman Boustani[1], Farshad Farahbod[2, *]

[1]Department of Petroleum Engineering, Omidieh Branch, Islamic Azad University, Omidieh, Iran
[2]Department of Chemical Engineering, Firoozabad Branch, Islamic Azad University, Firoozabad, Iran

Abstract

The role of the mud engineer or more properly drilling fluids engineer is very critical to the entire drilling operation because even small problems with mud can stop the whole operations on the rig. So, the basic parameters which effect on the properties of drilling fluid are discussed in this paper. The sulfur removal from drilling fluid for prevention of corrosion is studied, specially. According to the results, higher initial pH =8 shows the small changes in final pH during 14 hours from 5 to 19 hours. For initial pH=7 the trend of final pH is also approximately smooth from 9 hr to 19 hours, but from 5 to 9 it shows a minimum amount of 7 for pH after 7 hr. Also, the changes in pH values make different stability behavior in the suspension. The optimum value of pH seems to be 8 and the best concentration of ZnO is 3 gr/lit which lead to effective coagulation and flocculation. The experimental results show, if time duration will change from 5 to 25 hours the trend of pH for 1 gr/lit of ZnO nanoparticle will vary from 10.53 to 10.36. In addition, this factor after 21 hours will be 104, approximately. So, in this concentration the coagulation reactions seem not to be completed and continue even after 25 hrs.

Keywords

Turbidity, Environmental Pollution, Nano, Coagulation, Treatment, pH

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1. Introduction

In early offshore oil and gas development, drilling wastes were generally discharged from the platforms directly to the sea. Until several decades ago, the seas and oceans were considered as limitless dumping grounds. However, during the 1970s and 1980s, it has evidenced that some types of drilling waste discharges could have undesirable effects on local ecology, particularly in shallow water. Offshore platforms can impact environment in three ways: the physical presence of the platforms, waste discharges from the platforms and accidental discharges. The impact of offshore oil & gas exploration and production on the marine ecosystem varies from disturbance of sea mammals during acoustic exploration research activities to chemical, physical and toxicological effects of residual waste streams [1]. The residual waste streams from offshore platforms can be distinguished into the following categories: A). Operational discharges, B) [2]. Cuttings contaminated with oil and chemicals (from drilling platforms), C). Production water contaminated with oil and chemicals (from production platforms), D). Rainy-, scrub- and cleaning water contaminated with oil and chemicals, E). Sanitary waste and refuse, F). Accidental discharges (e.g. as a consequence of blowouts and damage of pipelines, discharges due to flaring) [3]. In terms of volume and toxicity, drilling fluids and drill cuttings are among the most significant waste streams from E&P activities in the oil and gas industry. Accidental

* Corresponding author
E-mail address: mf_fche@yahoo.com (F. Farahbod)

discharges are not permitted or planned. They are usually shorter in duration but can produce a more intense impact on the environment. The drilling fluid -mud - is usually composed of water, clay, weighing material and a few chemicals [4]. Sometimes oil may be applied instead of water, or oil added to the water to give the mud certain desirable physical properties [5]. Drilling fluid is used to increase the cuttings made by the bit and lift them to the surface for disposal [6]. 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 [7]. 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 [8]. 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 [9]. The results of these risk assessments require to be made available to all employers whose workers may become exposed to the drilling fluid system. 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 [10]. Today it is recognized the drilling fluid has at least ten important functions [11]: 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 [12, 13]. 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 [14-16].

The drilling fluid contains contaminants like sulfur after usage and is drained under the ground. So, surveying treatment methods to remove the contaminants from mud by nano ZnO particles is considered in this research. Two mixing reactors are used utilizing ZnO, NaOH and Na_2CO_3 as coagulants and related parameters are reported in this paper.

2. Materials and Methods

A water-based fluid is a suspension of particulate minerals, dissolved salts, and organic compounds in freshwater, seawater, or concentrated brine. When water-based fluids (WBFs) are used, only limited environmental harm is likely to occur. WBF ingredients can be divided into 18 functional categories. Each category of additives may contain several alternative materials with slightly different properties. The main composition of this fluid is water and is considered for treatment. The main parameters such as acidity and cations and ions are measured in this research. The pH meter and zeta meter are used for measuring of acidity and ions of this fluid. WBF and cuttings solids settle to and accumulate on the sea floor. If discharged at or near the sea surface, the mud and cuttings disperse in the water column over a wide area and settle as a thin layer of a large area of the sea floor. If mud and cuttings are discharged just above the sea floor the drilling solids may accumulate in a large, deep pile near the discharge pipe. The accumulation of mud and cuttings on the bottom, the cutting pile, may contain higher concentrations of several metals, particularly barium (from drilling mud barite), and sometimes petroleum hydrocarbons than nearby uncontaminated sediments. Chromium, lead, and zinc are the metals, in addition to barium, that are most often enriched in cutting pile sediments. The metals associated with drilling mud barite or cutting piles have a low bioavailability to marine animals; they do not accumulate in the tissues of bottom-living animals. WBF are non-toxic or partially non-toxic to marine animals, unless they contain elevated concentrations of petroleum hydrocarbons, particularly diesel fuel. Most drilling mud ingredients are non-toxic or used in such small amounts in WBF that they do not contribute to its toxicity. Chrome and ferrochrome lignosulfonates are the most toxic of the major WBF ingredients. Although used frequently in the past, these deflocculates are being replaced in most WBF by non-toxic alternatives to reduce the ecological risk of drilling discharge.

3. Results and Discussion

Usually the drilling mud drains in the pool under the ground, so the sulfur contaminates in the mud penetrate into the soil and affect the quality of soil in view of agricultural applications. Coagulation mechanism in softening process using zinc oxide nano particles with mineral coagulant is investigated, experimentally.

3.1. The Effect of Concentration of ZnO and Time on the pH of Solution

The changes in pH is investigated for two low concentrations of 1 mg/lit and 2 mg/lit of the ZnO in the solution when

NaOH and Na_2CO_3 are added. The time duration is from 5 to 25 hours to obtain the pH variation. Figure 1 shows an unstable trend of pH variation for 1 gr/lit of ZnO nanoparticle from 10.53 to 10.36 after 21 hours and the increase in pH from 10.36 to 10.4 after 25 hours. So, in this concentration the coagulation reactions seem not to be completed and continue even after 25 hrs. However, the smooth trend is seen in pH changes for 2 gr/lit of ZnO nanoparticles and the pH value increase from 10.5 to 10.52 after two first hours and then the pH variations are between 10.53 and 10.54. So, the concentration of 2 gr/lit of ZnO nano particles shows more stable coagulation reactions in the solution than concentration of 1 gr/lit.

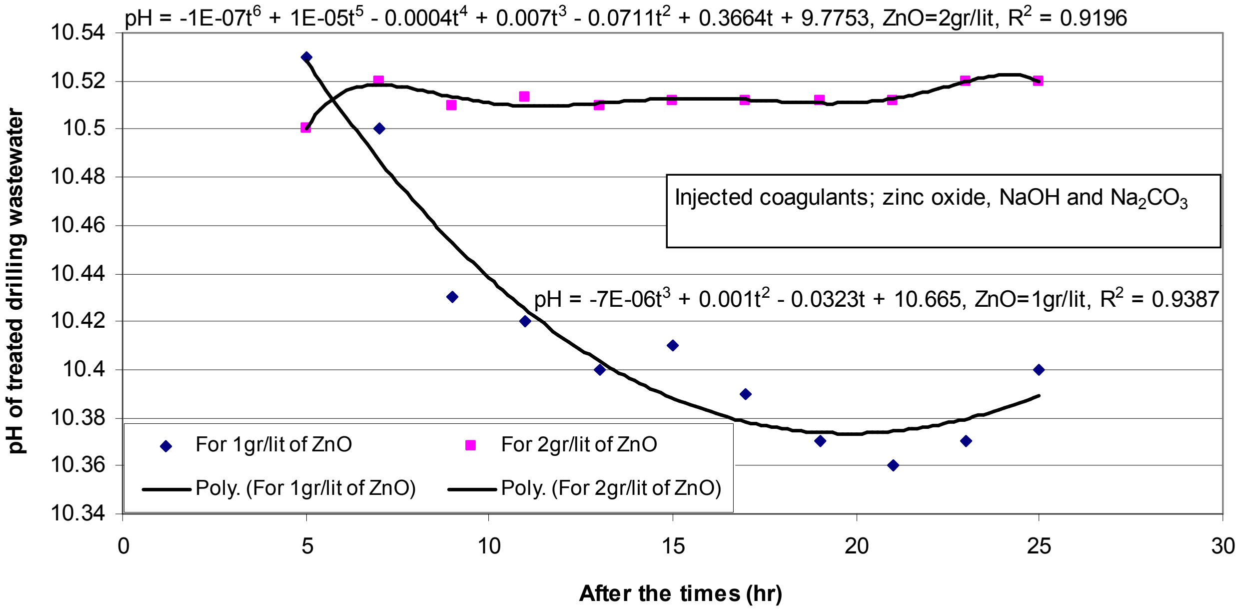

Figure 1. pH versus time in different concaentration of ZnO nanoparticles.

3.2. The Effect of Initial pH and Time on the Final pH of Solution

Figure 2 shows the effect of initial pH of the solution on the final solution pH during the time. The stable conditions after treatment is considered in this Figure.

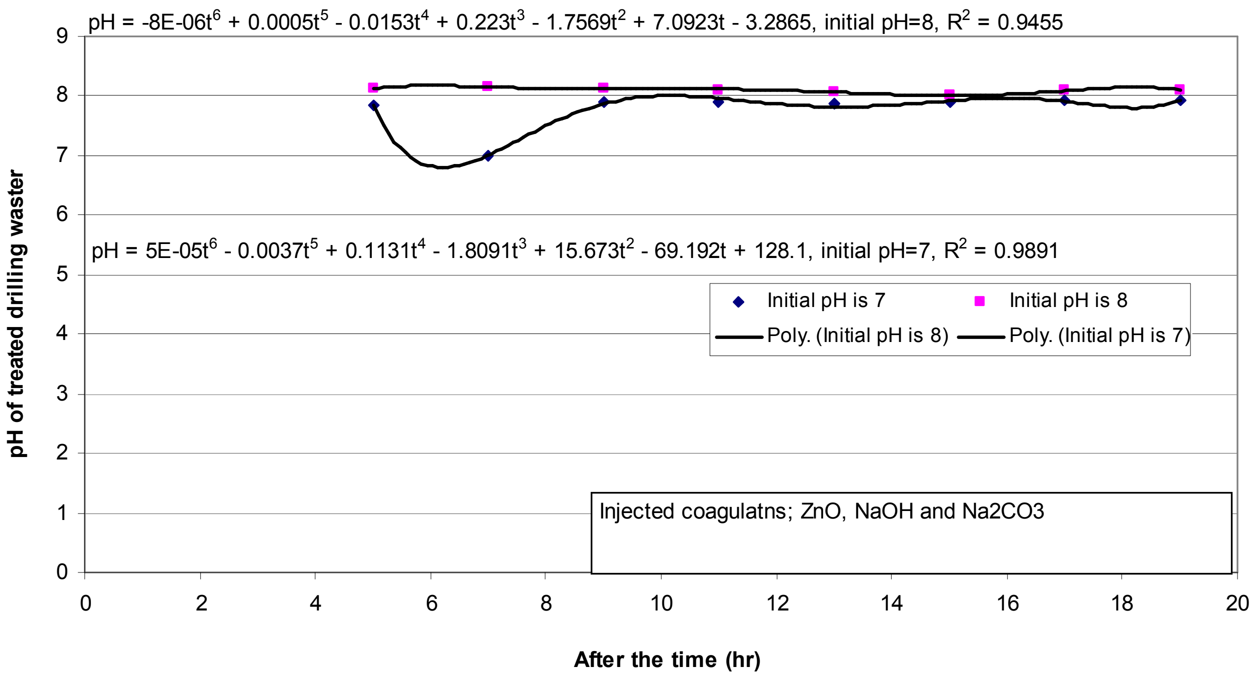

Figure 2. pH versus time in different initial pH value.

According to the Figure 2, higher initial pH =8 shows the small changes in final pH during 14 hours from 5 to 19 hours. For initial pH=7 the trend of final pH is also approximately smooth from 9 hr to 19 hours, but from 5 to 9 it shows a minimum amount of 7 for pH after 7 hr.

3.3. Zeta Potential Versus pH

The relation between the amounts of zeta potential and pH values is illustrated in Figure 3. Two different concentrations of ZnO (3 gr/lit and 4 gr/lit) are used to survey the stability of the suspension. The higher amounts of zeta potential result the poor coagulation process and stable suspension. So, the higher amount of ZnO with higher amounts of zeta potential show more stable suspension. Also, the changes in pH values make different stability behavior in the suspension. The optimum value of pH seems to be 8 and the best concentration of ZnO is 3 gr/lit which lead to effective coagulation and flocculation.

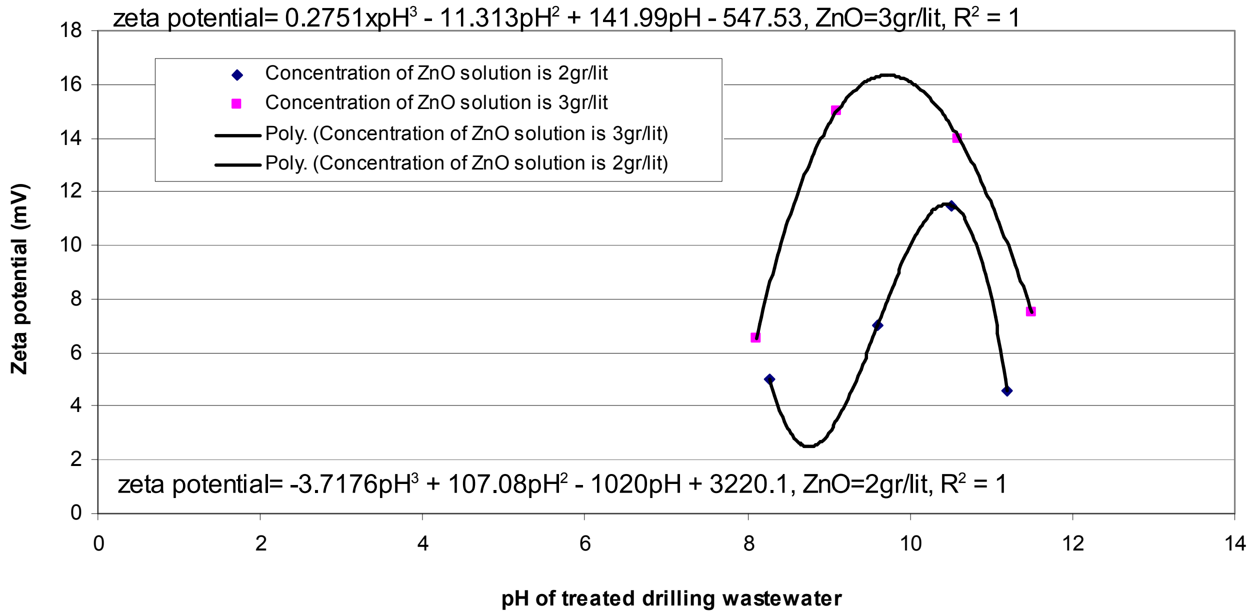

Figure 3. Zeta potential versus final pH.

The drilling fluids (muds) consist of a continuous liquid phase, to which various chemicals and solids have been added to modify the operational properties of the resulting drilling system. Because of that the composition of drilling fluids is complex and varies widely depending on the specific down-hole conditions such as downhole temperature and pressure, geology, and other factors. Drilling fluids fall into one of three types depending on their principal liquid-phase component: water-based fluids (WBFs), oil-based fluids (OBFs), and synthetic-based fluids (SBFs).

4. Conclusion

Drilling mud treatment by coagulation and flocculation applying ZnO nano particles is investigated, in this work. Drilling mud contains contaminants like sulfur after usage and is drained under the ground. So, surveying treatment methods to remove the contaminants from mud by nano ZnO particles is considered in this research. Two mixing reactors are used utilizing ZnO, NaOH and Na_2CO_3 as coagulants and related parameters are reported in Figures. Turbidity, pH, settling time, amount of ZnO, effect of axillary coagulants ($FeCl_3$, $Fe_2(SO_4)_3$, $Al_2(SO_4)_3$) are measured. Experimental results show an unstable trend of pH variation for 1 gr/lit of ZnO nanoparticle from 10.53 to 10.36 after 21 hours and the increase in pH from 10.36 to 10.4 after 25 hours. So, in this concentration the coagulation reactions seem not to be completed and continue even after 25 hrs. According to the results, higher initial pH =8 shows the small changes in final pH during 14 hours from 5 to 19 hours. For initial pH=7 the trend of final pH is also approximately smooth from 9 hr to 19 hours, but from 5 to 9 it shows a minimum amount of 7 for pH after 7 hr. Also, the changes in pH values make different stability behavior in the suspension. The optimum value of pH seems to be 8 and the best concentration of ZnO is 3 gr/lit which lead to effective coagulation and flocculation. Results show, if time duration will change from 5 to 25 hours the trend of pH for 1 gr/lit of ZnO nanoparticle will vary from 10.53 to 10.36. In addition, this factor after 21 hours will be 104, approximately. So, in this concentration the coagulation reactions seem not to be completed and continue even after 25 hrs.

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