**Scholars Academic Journal of Biosciences (SAJB)**
**Sch. Acad. J. Biosci., 2017; 5(1):16-20**
**ISSN 2321-6883 (Online)**
**ISSN 2347-9515 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com
DOI : 10.36347/sajb.2017.v05i01.005

Original Research Article

# Parametric study of main parameters in the treatment process of drilling wastewater

**Mahmood Atefatdoost[1], Farshad Farahbod[2], Abdolhamid Ansari[3]**
[1]Department of Petroleum Engineering, Lamerd Branch, Islamic Azad University, Lamerd, Iran
[2]Department of Chemical Engineering, Firoozabad Branch, Islamic Azad University, Firoozabad, Iran
[3]Department of Petroleum Engineering, Lamerd Branch, Islamic Azad University, Lamerd, Iran

***Corresponding author**
Farshad Farahbod
Email: f.farahbod@iauf.ac.ir

**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 evaluated in two pretreatment reactors.
**Keywords:** Environmental pollution; Nano ferric oxide; Coagulation; Treatment.

## INTRODUCTION

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 [1-3]. 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 [4-5]. The results of these risk assessments require to be made available to all employers whose workers may become exposed to the drilling fluid system [6].

### 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 METHOD

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 Na2CO3 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.

Three auxiliary mineral coagulants, Aluminum Sulfate, $Al_2(SO_4)_3$, Ferric Sulfate, $Fe_2(SO_4)$ and Ferric Chloride, $FeCl_3$, 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 Na2CO3 solution, 10 gr Na2CO3 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. Nano ferric oxide (5 to 20 gr/lit) is as coagulant and gathers the sulfur and salts which are situated around the structure. The first reactor is for coagulation and the second is for flocculation and sedimentation process. After sedimentation and at the constant final pH, the clear water is withdrawn from the tank.

**Operating functions for prediction of treatment performance**

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

**Fourier transforms 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 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

**Effect of concentration of Nano ferric oxide and time on the pH of solution**

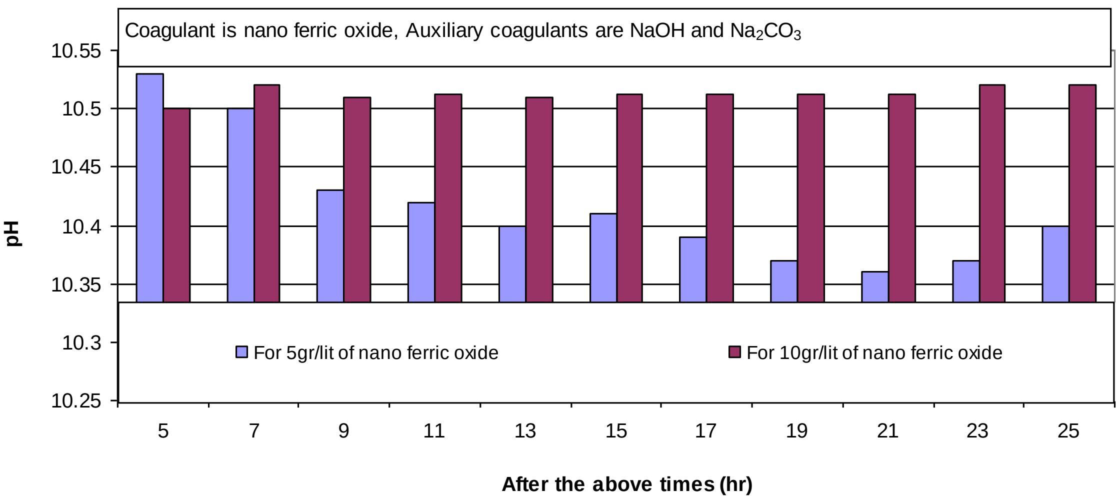


**Fig 1: pH versus time in different concentration of Nano ferric oxide**

The Figure 1 shows the effect of amount of nano ferric oxide flocculants (5 and 10 g/lit) on values of pH. The pH values changes during time if the reactions weren't completed. So, according to the experimental results, the lower amount of nano ferric oxide, 5 gr/lit, presents unstable conditions during times. The pH decreases to 10.37 till 21 hr and then increases to 10.4 till 25 hr. However, the amount of 10 g/lit of nano ferric oxide presents more stable pH condition during 5 hr to 25 hr with value of about 10.5. This seems that 10 gr/lit is the proper amount of nano ferric oxide to complete flocculation reaction so this produces stable compounds with magnesium and calcium.

**The effect of initial pH and time on the final pH of solution**

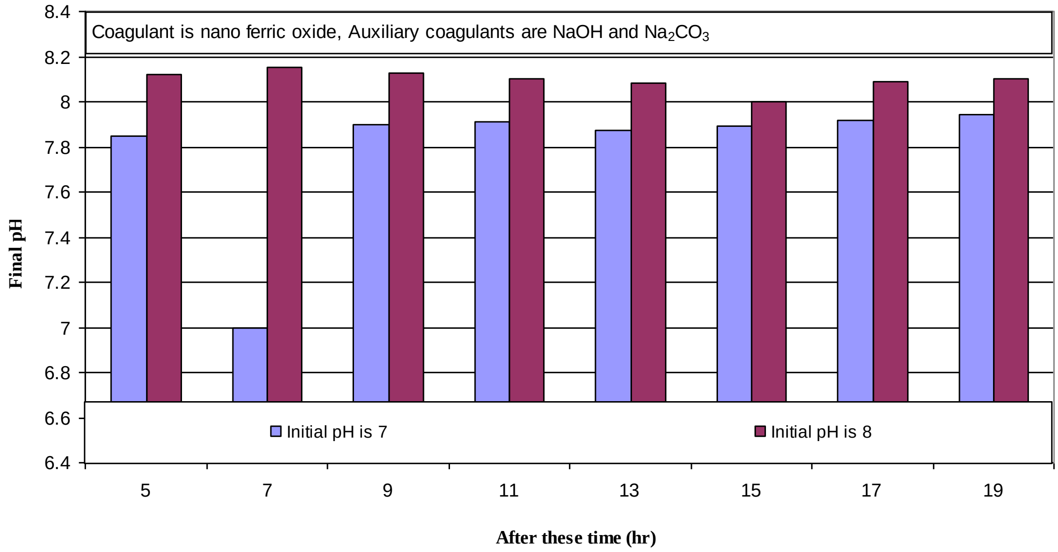


**Fig 2: pH versus time in different initial pH value.**

The pH values are important keys in chemical reactions such as flocculation and cogulation. The separation and formation of flocs complexes depends on initial pH value of solution and time. Figure 2 shows the amount of final pH versus sedimentation time. The final pH of solution then can show the produced compounds and the quality of treatment. The solutions with initial value of pH of 7 and 8 during 19 hr, are examined. Solutions with initial pH value of 8 shows the more stable compounds with final pH value around 8. The pH value around 7.8 is obtained applying solutions with initial value of 7 however; there is fluctuation in pH value of final solution after 7 hr and the value of final pH decreases to 7 which may be an error of experiment.

**Zeta potential versus pH**

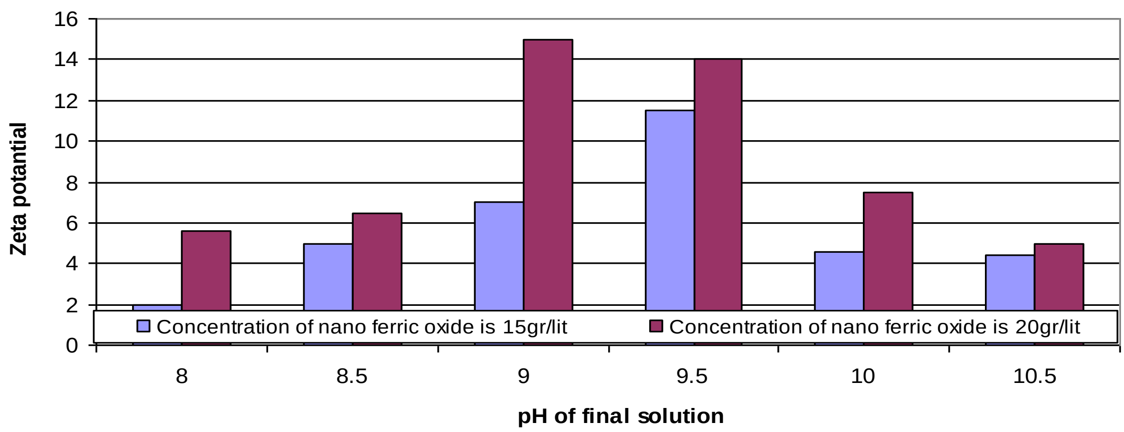


**Fig 3: Zeta potential versus final pH.**

The effect of flocculants on value of zeta potential is shown in the Figure 3. Two different amount of nano ferric oxide 15 and 20 gr/ lit is used. The higher amount of nano ferric oxide, 20 g/lit, shows the higher value of zeta potential at the same value of final pH. Final pH values change in amounts of 8, 8.5, 9, 9.5, 10 and 10.5. Zeta potential values in final pH of 9 and 9.5 are higher than those are obtained at the other pH values. Minimum value of zeta potential is 2 at pH value of 8.

## 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. 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. Minimum amount of turbidity of 4.5 NTU , amount of poly cyclic aromatic hydrocarbon of 10 mg/gr and amount of total petroleum hydrocarbon of 20 mg/gr is resulted using 20 gr/lit of this poly coagulant, individually. The lowest molecular weight and amount of ion charges of ferric chloride influences the performance of it in combined mixtures. The increase in the coagulation power of combined coagulant is affected by amount of ferric chloride in lowest amount of it, 5 gr/lit. The pH, zeta potential and transmittance are also investigated in this work.

## REFERENECES


1. Santosa SJ, Kunarti ES. Synthesis and utilization of Mg/Al hydrotalcite for removing dissolved humic acid. Applied Surface Science. 2008 Sep 30; 254(23):7612-7.
2. Cheng WP. Comparison of hydrolysis/coagulation behavior of polymeric and monomeric iron coagulants in humic acid solution. Chemosphere. 2002 Jun 30; 47(9):963-9.
3. Abrahamson A, Brandt I, Brunström B, Sundt RC, Jørgensen EH. Monitoring contaminants from oil production at sea by measuring gill EROD activity in Atlantic cod (Gadus morhua). Environmental Pollution. 2008 May 31;153(1):169-75.
4. Esmaeilzadeh F, Goodarznia I. Supercritical extraction of phenanthrene in the crossover region. Journal of Chemical & Engineering Data. 2005 Jan 13; 50(1):49-51.
5. Beyer J, Jonsson G, Porte C, Krahn MM, Ariese F. Analytical methods for determining metabolites of polycyclic aromatic hydrocarbon (PAH) pollutants in fish bile: a review. Environmental Toxicology and Pharmacology. 2010 Nov 30;30(3):224-44.
6. Bohne-Kjersem A, Skadsheim A, Goksøyr A, Grøsvik BE. Candidate biomarker discovery in plasma of juvenile cod (Gadus morhua) exposed to crude North Sea oil, alkyl phenols and polycyclic aromatic hydrocarbons (PAHs). Marine environmental research. 2009 Dec 31; 68(5):268-77.
7. Duan J, Gregory J. Coagulation by hydrolysing metal salts. Advances in colloid and interface science. 2003 Feb 28; 100:475-502.
8. Jiang JQ, Lloyd B. Progress in the development and use of ferrate (VI) salt as an oxidant and coagulant for water and wastewater treatment. Water research. 2002 Mar 31; 36(6):1397-408.
9. Abdou MI, Al-Sabagh AM, Dardir MM. Evaluation of Egyptian bentonite and nano-bentonite as drilling mud. Egyptian Journal of Petroleum. 2013 Jun 30; 22(1):53-9.
10. Zouboulis AI, Moussas PA, Vasilakou F. Polyferric sulphate: Preparation, characterisation and application in coagulation experiments. Journal of Hazardous materials. 2008 Jul 15; 155(3):459-68.
11. Cheng WP. Hydrolytic characteristics of polyferric sulfate and its application in surface water treatment. Separation Science and Technology. 2001 Aug 31; 36(10):2265-77.
12. Fan M, Sung S, Brown RC, Wheelock TD, Laabs FC. Synthesis, characterization, and coagulation of polymeric ferric sulfate. Journal of environmental engineering. 2002 Jun; 128(6):483-90.
13. Leprince A, Fiessinger F, Bottero JY. Polymerized iron chloride: an improved inorganic coagulant. Journal (American Water Works Association). 1984 Oct 1:93-7.
14. Zouboulis AI, Moussas PA. Polyferric silicate sulphate (PFSiS): Preparation, characterisation and coagulation behaviour. Desalination. 2008 Apr 15; 224(1):307-16.
15. Gao B, Yue Q, Zhao H, Song Y. Properties and evaluation of polyferric-silicate-sulfate (PFSS) coagulant as a coagulant for water treatment. InChemical water and wastewater treatment VI 2000 (pp. 15-22). Springer Berlin Heidelberg.
16. Goodarznia I, Esmaeilzadeh F. Treatment of oil-contaminated drill cuttings of South Pars gas field in Iran using supercritical carbon dioxide. Iranian Journal of Science and Technology, Transaction B: Engineering. 2006 Jan 1; 30:607-11.
17. Fu Y, Yu SL. Exterior shapes and coagulation performance of solid poly-ferric-silicic sulfate. ENVIRONMENTAL CHEMISTRY-BEIJING-. 2006; 25(4):476.
18. Fu Y, Yu SL. Characterization and coagulation performance of solid poly-silicic–ferric (PSF)

coagulant. Journal of Non-Crystalline Solids. 2007 Jul 1; 353(22):2206-13.
19. Ghazi M, Quaranta G, Duplay J, Hadjamor R, Khodja M, Amar HA, Kessaissia Z. Life-Cycle Impact Assessment of oil drilling mud system in Algerian arid area. Resources, Conservation and Recycling. 2011 Oct 31; 55(12):1222-31.
20. Issoufi I, Rhykerd RL, Smiciklas KD. Seedling growth of agronomic crops in crude oil contaminated soil. Journal of Agronomy and Crop Science. 2006 Aug 1; 192(4):310-7.
21. Amuda OS, Amoo IA. Coagulation/flocculation process and sludge conditioning in beverage industrial wastewater treatment. Journal of Hazardous Materials. 2007 Mar 22; 141(3):778-83.