International Journal of Environmental Planning and Management
Vol. 4, No. 2, 2018, pp. 30-33
http://www.aiscience.org/journal/ijepm
ISSN: 2381-7240 (Print); ISSN: 2381-7259 (Online)

Experimental Investigation of Quality Indexes in Treatment of Wastewater by Proposed Producer

Behnam Rahimi[1], Farshad Farahbod[2, *]

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

Abstract

Zero discharge (Z. D.) is a best solution to decrease the amount of contaminants. The treatment of waste drilling fluid by two mixed flow reactors is studied in this paper. 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. 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 rig. So, the basic parameters which are affected on the properties of drilling fluid are discussed in this paper. The obtained results are shown in the results and discussion section. Results show the turbidity removal percentage can reach to the 95%, approximately.

Keywords

Environmental Pollution, Nano, Coagulation, Treatment, Reactor

Received: June 22, 2018 / Accepted: July 23, 2018 / Published online: August 31, 2018

1. 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. Wastewater engineers and ground water remediation specialists are constantly confronted with the presence of fats, oils and greases (FOGs) in the water, which must be removed either to conform to discharge permit limits, or because it coats other media or elements such as in an evaporator. Removing FOG can be simple if it is not emulsified, i.e. it floats as sheen on water. After all, oil and water do not mix, right? Yes and no. It can be mechanically emulsified; in which case

* Corresponding author
E-mail address: farahbod.f@srbiau.ac.ir (F. Farahbod), farshad.farabod@yahoo.com (F. Farahbod)

letting the wastewater sit in a tank for a while will cause most of it to rise to the surface. But some of it may stay in the water, if the oil globules are small enough. What do we do now? If the oil contains an "emulsifier" that was added to cause it to dissolve in water, it is chemically dissolved/emulsified, and requires addition of chemicals to remove it from water. FOGs can potentially be an expensive nuisance if they are not removed, because they coat pipe(s), filtration media such as granular activated carbon, sand filters, ion exchange resins, air stripper media, and the membranes of ultra-filtration and RO (reverse osmosis) units. The coating from FOGs creates the need for frequent change-outs and/or cleaning. However, the newest membranes have a cross flow mechanism mad consequently the oil does not blind the pores, i.e. cause fouling! Yet, one must still deal with the concentrate that now accumulates during the operation, which may involve costly water hauling ($0.15-1.-/gal). This concentrate also coats the heating elements of evaporators, resulting in frequent clean-up and disposal of this oil [7, 8]. One may find themselves in the following scenario: You find yourself in compliance with the discharge permit for oil (say 50 ppm) [9, 10]. The oil content of your water is only 30 ppm. You have nothing to worry about, right? Wrong! You are in violation of your permit with your COD (chemical oxygen demand), the limit is 50 ppm, but you are discharging 65 ppm [11, 12]. Oil is part of the COD, which encompasses any organic compound that can be oxidized. Therefore, if you remove half of the oil you are in compliance. The COD could be a result of the presence of ethyl alcohol or some other volatile compound that is difficult to remove [13, 14]. The COD is defined as the amount of oxygen, expressed in ppm, consumed under specific conditions in the oxidation of organic and inorganic matter contained in a wastewater or ground water. The BOD, biochemical oxygen demand, also includes oil [15, 16]. It estimates the degree of contamination of water supplies, particularly those contaminated by sewage and industrial waste. It is expressed as the quantity of dissolved oxygen (in mg/l) required during stabilization of the decomposable organic matter by aerobic biochemical action, usually measured before and after a five day incubation period. Several states have lowered the discharge limit for oil into surface waters to 10 ppm, and the prospects for even lower limits are likely. Any facility that wants to recycle its water, and shoots for zero discharge, will have to deal with its oil in the wastewater. So, it is desirable to learn how to deal with it. To do this successfully requires some basic knowledge about oil, its sources, chemical composition, and the technologies required to remove it from water [17, 18]. It is the purpose of this guide to supply this information [19-21]. The first question the engineer should always ask when confronted with the presence of oil is [22]: “What kind of oil is it?” If he does not attempt to answer this question, he may be lucky and choose the proper removal method, or he will get stumped fight from the beginning [23-25].

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, 9 and 10].

1.2. 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.

1.3. 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].

1.4. Review of the Study

Two pre-treatment reactors are used as basic unit in the treatment unit in this paper. Types of reactors are selected as mixed flow reactor and coagulation, flocculation and sedimentation are occurred in this paper. The concentration of nano coagulant can effective on the turbidity of treated waste water. So, the turbidity of treated waste water is evaluated in the results and discussion section. In addition, the mixing rate of impeller in the first reactor is so effective on the breaking or collapse of coagulants and also flocculants, finally. The results are stated with correlations, ultimately.

Detailed investigation of experimental study about the usage of nano ferric oxide in pre-treatment of waste drilling fluid is reported in this survey.

2. Material and Method

2.1. Drilling Waste Water as Entrance Feed

Waste drilling fluid with watery base in volume of 3000 cc is used in the tests. At each run coagulation, flocculation and sedimentation steps is performed. The nano coagulant and auxiliary coagulants are used for making coagulants. The coagulation step, flocculation step and the sedimentation step are done, finally. The bonds of Sodium and hydroxide and also Sodium and Carbonate are broken and the new bonds are made by using nano coagulant and auxiliary coagulants. Finally, the contaminants content are decreased in the three steps of treatment.

2.2. The Proposed Pilot of Pre-treatment Reactors

Two reactors with volume of 4000 cc which are made of poly vinyl chloride are joined in series through pipelines. The second tank is in lower level from the first tank and the outlet fluid flows to the second one thoroughly. There is one globe valve which connects the two tanks. The main nano coagulant and also auxiliary coagulants are applied in the first and second mixed flow reactors.

3. Results and Discussion

Experiments are held to qualify the pre-treatment performance of drilling fluid in the proposed pilot scale two series reactors. Since the drilling fluid is in water base so the coagulation mechanism is chosen in pre-treatment unit. Coagulation is handled by addition of nano mineral oxides to waste drilling fluid. Coagulation performs chemically and physically to agglomerate the dispersed colloids in waste drilling water to form flocs and improve the sedimentation. Figures 1, 2, 3 and 4 show the amount of turbidity versus concentration of nano coagulant. The mixer rate of firs reactor is changed during the experimental tests. 90. 100, 120 and 140 rpm are selected as mixing rate in the first reactor of pre-treatment unit. As mentioned in the above, the mixing rate of impeller in the first reactor can appear or disappear the coagulants, so changing of mixing rate is investigated in this work. Also, the concentration of injected nano coagulants to the waste water sample is very important in the cost estimation in the scale up process. The turbidity is a basic item in determination of quality of drilling wastewater treatment. So, the turbidity of treated drilling wastewater after coagulation, flocculation and sedimentation steps are evaluated in the Figures 1, 2, 3 and 4, experimentally. The obtained results show the positive effect of nano concentration at the initial time of treatment process. The experimental results illustrate the optimum mixing rate of agitator in the reactor, also.

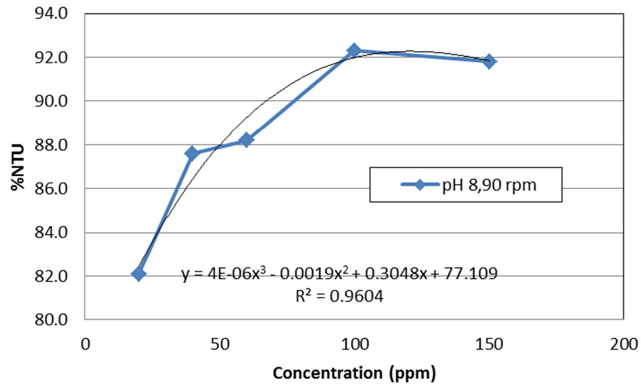

Figure 1. Turbidity versus concentartion at 90 rpm and pH=8.

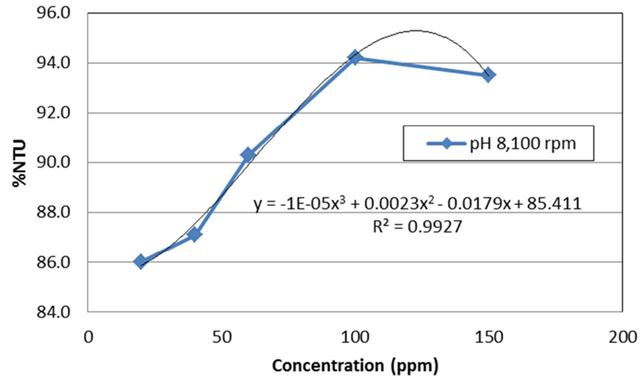

Figure 2. Turbidity versus concentartion at 100 rpm and pH=8.

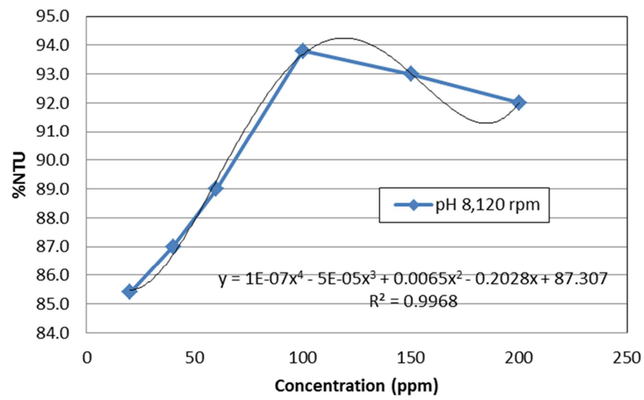

Figure 3. Turbidity versus concentartion at 120 rpm and pH=8.

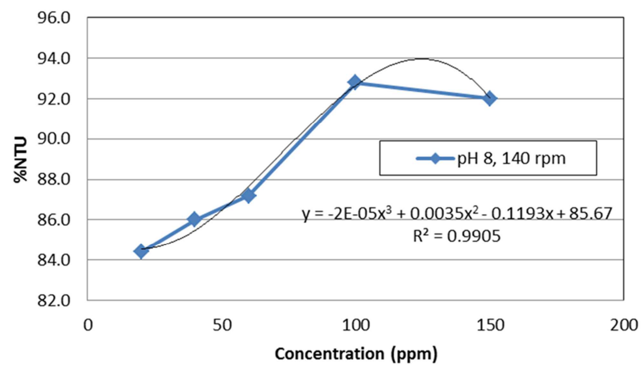

Figure 4. Turbidity versus concentartion at 140 rpm and pH=8.

4. Conclusion

Detailed investigation of experimental study about the usage of nano ferric oxide in pre-treatment of waste drilling fluid is reported in this survey. Contaminant removal from waste drilling fluid by coagulation- flocculation- sedimentation mechanisms is considered here. The effect of coagulant concentration and fast mixing rates on turbidity is investigated in this paper. Some correlations are presented to predict the relation between the pre-treatment condition and pre-treatment results. Results show the turbidity removal percentage can reach to the 95% in the pH=8, rpm=100 and the concentration of nano coagulant=100 ppm. In addition, the experimental formulas are shown in the Figures. The regression of each of curves are calculated by soft were, finally.

References

[1] Santosa, Sri Juari, Kunarti, Eko, Karmanto, Sri, 2013. Synthesis and utilization of Mg/Al hydrotalcite for removing dissolved humic acid, Applied Surface Science 254, 7612–7617.

[2] W. P. Cheng, 2013. Comparison of hydrolysis/coagulation behavior of polymeric and monomeric iron coagulants in humic acid solution, Chemosphere 47, 963–969.

[3] Abrahamson, A. B. I., Brunstrom, B., Sundt, R. C., Jorgensen, E. H., 2008. Monitoring contaminants from oil production at sea by measuring gill EROD activity in Atlantic cod (Gadus morhua). Environ. Pollut. 153, 169-175.

[4] Farshad Farahbod, Sara Farahmand, 2017. Empirical Investigation of Heating and Kinematic Performance of ZnO Nano Fluid in a Heat Pipe, Journal of Nanofluids 6, 128–135.

[5] Esmaeilzadeh, F., Goodarznia, I., 2005. Supercritical extraction of phenanthrene in the crossover region, J. Chemical Engineering Data 50, 49–51.

[6] Beyer, J., Jonsson, G., Porte, C., Krahn, M. M., Ariese, F., 2010. Analytical methods for determining metabolites of polycyclic aromatic hydrocarbon (PAH) pollutants in fish bile: a review. Environ. Toxicol. Pharmacol. 30, 224-244.

[7] Bohne-Kjersem, A., Skadsheim, A., Goksoyr, A., Grosvik, B. E., 2009. Candidate biomarker discovery in plasma of juvenile cod (Gadus morhua) exposed to crude North Sea oil, alkyl phenols and polycyclic aromatic hydrocarbons (PAHs). Mar. Environ. Res. 68, 268-277.

[8] Duan, J., Gregory, John a, 2010. Coagulation by hydrolyzing metal salts, Advances in Colloid and Interface Science 100, 475–502.

[9] Jiang Jia-Qian, Loyd Barry, 2013. Progress in the development and use of ferrate (VI) salt as an oxidant and coagulant for water and wastewater treatment, Water Research 36, 1397–1408.

[10] Abdou, M. I., Al-sabagh, A. M., Dardir, M. M., 2013. Evaluation of Egyptian bentonite and nano-bentonite as drilling mud, Egyptian J. Petroleum 25, 53–59.

[11] Zhang Na, Wei Mingzhen, Bai Baojun, Statistical and analytical review of worldwide CO_2 immiscible field applications, Fuel, Volume 220, 15 May 2018, Pages 89-100.

[12] Zouboulis A. I., Moussas P. A., Vasilakou F., 2013. Polyferric sulphate: preparation, characterization and application in coagulation experiments, Journal of Hazardous Materials 155 (3), 459–468.

[13] Cheng, W. P., 2012. Hydrolytic characteristics of poly ferric sulphate and its application in surface water treatment, Separation Science and Technology 36 (10), 2265–2277.

[14] Fan M., Sung S., Brown R. C., Wheelock T. D., Laabs F. C., 2013. Synthesis, characterization and coagulation of polymeric ferric sulphate, Journal of Environment Engineering 128 (6), 483–490.

[15] Leprince A., Flessinger F., Bottero J. Y., 1987. Polymerised iron chloride: an improved inorganic coagulant, Journal of the American Water Works Association 76, 93–97.

[16] Zouboulis A. I., Moussas P. A., 2013. Polyferric silicate sulphate (PFSiS): preparation, characterisation and coagulation behaviour, Desalination 224, 307–316.

[17] Gao B., Yue Q., Zhao H., Song Y., 2013. Properties and evaluation of poly ferric silicate sulfate (PFSS) coagulant as a coagulant for water treatment, in: H. H. Hahn, E. Hofmann, H. Odegaard (Eds.), Chemical Water and Wastewater Treatment VI, Springer-Verlag, Berlin, 342, 15–22.

[18] Goodarznia, I., Esmaeilzadeh, F., 2006. Treatment of oil-contaminated drill cuttings of south pars gas field in Iran using supercritical carbon dioxide, Iranian J. Science & Technology, Transaction B, Engineering 30, 607–611.

[19] Fu, Y., Yu, S. L., 2011. Exterior shapes and coagulation performance of solid poly ferric silicic sulfate, Environmental Chemistry 25 (4), 471–476.

[20] Rached Ben-Mansour, Pervez Ahmed, Habib M. A., Simulation of Oxy-fuel combustion of heavy oil fuelin a model furnace, J. Energy Resour. Technol. 2015, 137: 032206.

[21] Fu, Y., Yu, S. L., 2010. Characterization and coagulation performance of solid poly silicic ferric (PSF) coagulant, Journal of Non-crystalline Solid 353, 2206–2213.

[22] Ghazi M., Quaranta G., Duplay G., Hadjamor R., Khodja M., Amar H. A., Kes-saissia Z., 2011. Life-cycle impact assessment of oil drilling mud system in Algerian arid area, Resources, Conservation and Recycling 55, 1222–1231.

[23] Issoufi, I., Rhykerd, R. L., Smiciklas, K. D., 2006. Seedling growth of agronomic crops in crude oil contaminated soil. Journal of Agronomy and Crop Science 192, 310–317.

[24] Amuda O. S., Amoo I. A., 2013. Coagulation/flocculation process and sludge conditioning in beverage industrial wastewater treatment, Journal of Hazardous Materials 141, 778–783.

[25] Zhang Yuan, Yu Wei, Li Zhiping, Sepehrnoori Kamy, Simulation study of factors affecting CO_2 Huff-n-Puff process in tight oil reservoirs, Journal of Petroleum Science and Engineering, Volume 163, April 2018, Pages 264-269.