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Investigation of Wastewater Treatment by Novel Method as Main Stage in the Treatment Process

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

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

Abstract

The huge amount of waste water from refineries is produced daily. The drainage of wastewater into soil and sea will be disturbed the environment in times. The techniques of wastewater treatment have been considered, recently. The commercial mineral coagulants, Zinc oxide as nano coagulants are used in the pretreatment process. The main items for treatment of oily wastewater is investigated in this section. The practical variables such as ammonia removal, heavy metals removal, sulfide removal, SVI and phenol removal are evaluated in this research. Moreover, in softening process, the Sodium Carbonate and Sodium Hydroxide must be added to the wastewater. The performance of usage of nano zinc oxide as coagulant is evaluated in this work, experimentally. The coagulants are the matters used to decrease total hardness of wastewater. The pretreatment process includes 3 steps: coagulation, flocculation and sedimentation. Improving the efficiency of pretreatment process depends on water specifications and also the operating parameters. The results show the lower consistency with the coagulant structure or don't react well and so don't show much increase in the percentage of sulfide removal. The empirical results show the effect of usage of nano coagulant in reduction of slug volume index. The changes in the amount of nano coagulant from 1 to 2.5 gr show the increase in the amount of reduction ratio of slug volume index from 20 to 32, respectively.

Keywords

Pre-treatment, Waste Stream, Petroleum, Environmental Problems, Performance

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1. Introduction

The coagulants are the matters used to decrease total hardness of wastewater [1]. The pretreatment process includes 3 steps: coagulation, flocculation and sedimentation [2]. Improving the efficiency of pretreatment process depends on water specifications and also the operating parameters [3]. The optimum mixing rate of first pretreatment reactor, type of coagulant, ratio of sodium carbonate to coagulant and sodium hydroxide to coagulant are some of the important factors in operating conditions [4]. Polyelectrolytes or mixture of coagulants can be used to improve the efficiency of total hardness removal [5-7]. In this research various binary mixtures of three mineral coagulants were investigated quantitatively and qualitatively [8-12]. The optimum amounts of Sodium Carbonate to coagulant ratio and Sodium Hydroxide to coagulant ratio were studied for each coagulant, individually. This shows that the best ratio for Sodium Carbonate to coagulant is three and for Sodium Hydroxide to coagulant are four. Conventional sedimentation, the major process in primary wastewater treatment, normally removes 60 to 70 percent of the suspended matter containing 30 to 40 percent of the BOD present in municipal waste waters, leaving 150 to 200 mg/L and about 200 mg/L SS in the primary effluent. Discharge of effluent of this quality without exceeding the assimilative capacity of the receiving environment is only possible where very large volumes of

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

water are available for dilution, or where the effluent may be irrigated over a large land area. For discharge to inland streams or lakes, a considerably higher quality is necessary. This calls for secondary treatment, usually in the form of some biological treatment. The plant nutrients, nitrogen and phosphorus, can lead to the enrichment of receiving waters (eutrophication). Additional treatment of wastewater, tertiary treatment, may be required to avoid this problem, which can result in serious ecological disturbances. The alternative to all these sophisticated treatment technologies would be to keep sewage on site and let every household take care of its own wastes. While this avoids all the above problems, it creates new ones and could become a serious health hazard if not properly controlled. Sufficient area would also be required to dispose of all products on site. This topic is covered in the second half of this module. Successful biological treatment depends on the development and maintenance of an appropriate, active, mixed microbial population in the system. This microbial population may be present as either a fixed film attached to some form of support medium, as in the trickling filter and rotating biological filter processes, or a suspended growth, as in activated sludge processes and anaerobic digestion. The organic waste matter is used as a food source by the microbial population in each of these treatment systems. In their life processes, these microorganisms use some of the organic matter in order to synthesize new cell material, and they obtain the energy from their synthesis and cell maintenance functions by degrading some of the organic matter to simple compounds. Thus, biological growth involves both cell synthesis and bio degradation processes. The empirical results show the effect of usage of nano coagulant in reduction of slug volume index in this research. The changes in the amount of nano coagulant from 1 to 2.5 gr show the increase in the amount of reduction ratio of slug volume index from 20 to 32, respectively.

2. Materials and Methods

2.1. Materials

The experiments are managed for the brine wastewater of Tehran petroleum refinery which exits from desalination unit. The commercial mineral coagulants, Zinc oxide as nano coagulants are used in the pretreatment process. Moreover in softening process, the Sodium Carbonate and Sodium Hydroxide must be added to the wastewater. The previous researches in this field are focused on finding the optimum ratio of Sodium Carbonate to coagulant and also Sodium Hydroxide to coagulant and these ratios are used in this work too. These proper values are 3 and 4, respectively. The experiments are held in two pretreatment reactors. The capacity of each reactor is 8 liter and each of them equipped by a mixer. The speed of the mixers can be changed by a control box.

2.2. Experimental Setup

Two reactors are used in this research. Both of reactors are mixed type. The rotation of the mixer in the first reactor is more than the other one. So, the coagulants can change to flocculants. The reactors are made from PVC and the mixers are stainless steel-314. The reactors are situated on the table. So, the height of the reactors is 50 cm, approximately from the ground. The length of each mixer is 15 cm and have 3 parts. So, the angles between the parts of the mixer is 120 degrees.

3. Results and Discussion

The main items for treatment of oily wastewater is investigated in this section. The practical variables such as ammonia removal, heavy metals removal, sulfide removal, SVI and phenol removal are evaluated in this research.

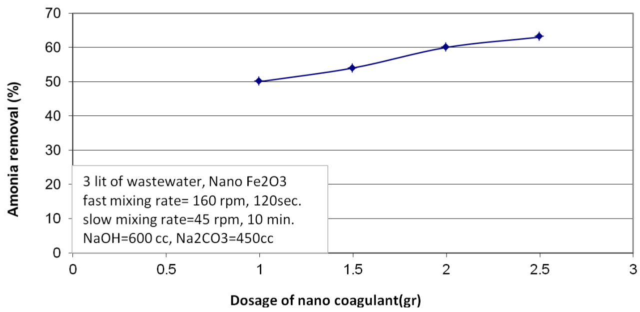

Figure 1. The effect of nano coagulant zinc oxide on ammonia removal percentage.

The amount of ammonia is the other important compounds which affect the acidity of wastewater and also the nitrogen element can be used as nutrient for microorganisms. Figure 1 shows the increase in the value of ammonia removal percentage with the increase in the value of used nano zinc oxide coagulant. The value of ammonia removal (%) changes from 50% to 63%. Ammonia is consistent with the structure of coagulant and can bond with coagulant.

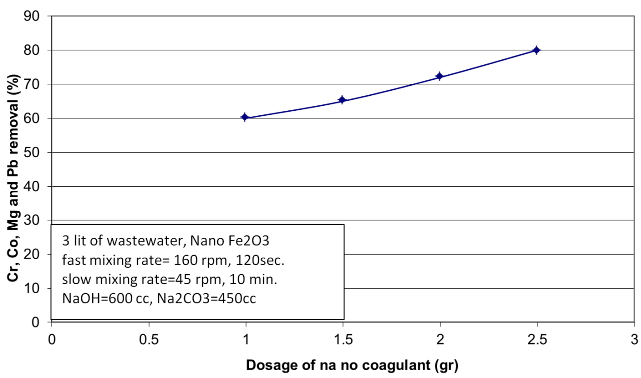

Figure 2. The effect of amount of nano coagulant on heavy metals removal.

Heavy metals are so dangerous for ecosystem safety. The amount of heavy metals of Cr, Co, Mg and Pb removal is considered in Figure 2. The increase in the amount of coagulant shows positive effect in removal of heavy metals. Sum of the amounts of these elements changes and the removal percentage of them is from 60% to 80%. These elements can bond, trap or react in the flocs.

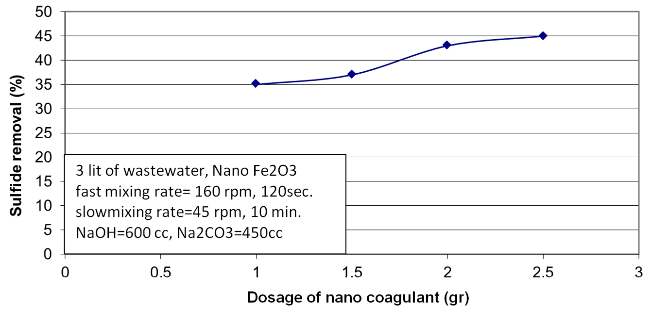

Figure 3. The effect of amount of nano coagulant on sulphide removal.

Figure 3 shows the amount of sulfide removal percentage according to the amount of nano zinc oxide coagulant. The value of sulfide decreases and the percentage of sulfide removal increases from 35% to 45%. The results show the lower consistency with the coagulant structure or don't react well and so don't show much increase in the percentage of sulfide removal.

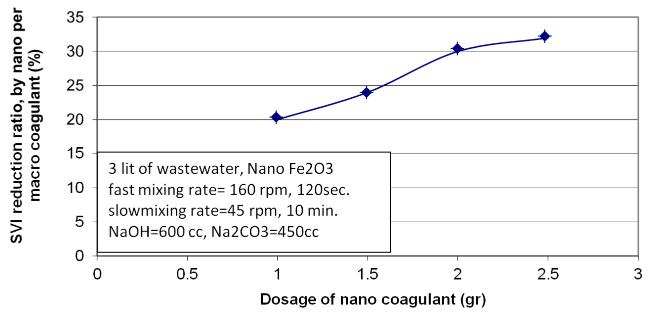

Figure 4. The effect of amount of nano coagulant on amount of SVI.

Slug volume index is another parameter in evaluation of the quality of treatment. The lower volume of slug is favorable totally. The Figure 4 shows the effect of usage of nano coagulant in reduction of slug volume index. The changes in the amount of nano coagulant from 1 to 2.5 gr show the increase in the amount of reduction ratio of slug volume index from 20 to 32, respectively. This shows the compact flocs which low enough amount of water inside them. So, the reacted compounds in flocs are more possible than the trapped compounds in the flocs.

Figure 5 shows the amount of the other dangerous parameters as phenol reduction versus the amount of nano coagulant. The increase in the amount of nano zinc oxide coagulant increases the removal percentage of phenol. Values of phenol removal change from 20% to 26% when the nano coagulant is added from 1 to 2.5 respectively. There is not high effect of nano coagulant on phenol reduction comparing with the other components. This may be since of the lower reaction ability of phenol with zinc oxide.

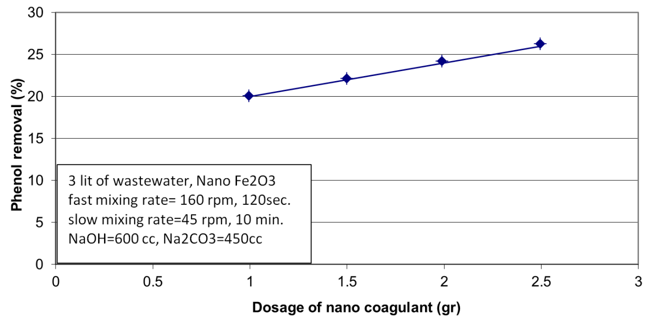

Figure 5. The amount of phenol removal versus nano coagulant.

4. Conclusion

In this research various binary mixtures of three mineral coagulants were investigated quantitatively and qualitatively. The optimum amounts of Sodium Carbonate to coagulant ratio and Sodium Hydroxide to coagulant ratio were studied for each coagulant, individually. This shows that the best ratio for Sodium Carbonate to coagulant is three and for Sodium Hydroxide to coagulant are four. Conventional sedimentation, the major process in primary wastewater treatment, normally removes 60 to 70 percent of the suspended matter containing 30 to 40 percent of the BOD present in municipal waste waters, leaving 150 to 200 mg/L and about 200 mg/L SS in the primary effluent. The amount of ammonia is the other important compounds which affect the acidity of wastewater and also the nitrogen element can be used as nutrient for microorganisms. The experimental results show increase in the amount of coagulant shows positive effect in removal of heavy metals. Sum of the amounts of these elements changes and the removal percentage of them is from 60% to 80%. These elements can bond, trap or react in the flocs. The value of sulfide decreases and the percentage of sulfide removal increases from 35% to 45%. The results show the lower consistency with the coagulant structure or don't react well and so don't show much increase in the percentage of sulfide removal. The empirical results show the effect of usage of nano coagulant in reduction of slug volume index. The changes in the amount of nano coagulant from 1 to 2.5 gr show the increase in the amount of reduction ratio of slug volume index from 20 to 32, respectively.

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