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Experimental Study on Important Variables Treatment Process of Effluent Wastewater

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Abstract

The pre-treatment of wastewater with mineral coagulant of ferric oxide is investigated experimentally in this work. Non-volatile suspended solids (NVSS) and volatile suspended solids (VSS) beside other important parameters, total hardness, and chemical oxygen demands, and biochemical oxygen demands, pH value after sedimentation and pH after coagulation in aerobic treatment are surveyed due to the changes in fast mixing rate. Fast mixing rate in first coagulation tank changes in values of 50, 60, 70, 80, 90, 110, 140, 160, 190 and 200 rpm. Results show the different values of parameters according to different values of fast mixing rates.

Keywords

Treatment, Non-volatile Suspended, Volatile Suspended, Chemical Oxygen Demand, Biochemical Oxygen Demand, Coagulation

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1. Introduction

The Scientifics have been developing impellers and various head constructions for years to efficiently cope with most processes and to ensure extended reliability of the mixers. Agitators are mostly installed in the following applications such as; Petroleum storage, refined product, bioethanol fermentation, edible oil storage, bitumen, alcohol storage, pulp and paper [1-5]. Water and wastewater mixers are critical components of the multi-step process of water and wastewater treatment [6-8]. Water treatment requires precise control at each stage in its process from rapid flash mixing to polymer and chemical addition [9]. This control requires specific wastewater mixers designed by engineers focused on this process and industry. Mixing solutions for water and wastewater treatment must address the intricacies of our processes, from G value specifications to tank and baffle geometries [10-14]. While some chemicals simply need to be dissolved, others, such as lime slurries, require that solids be kept in suspension. Similarly, floc / agglomerated particles formed in a flocculator tank are highly sensitive to shear. That's why it's critical to have a low shear polymer mixer that creates an axial flow pattern that won't damage the particles [15-18]. One of the famous treatment methods to reduce suspended solids and turbidity is the coagulation and flocculation. Coagulation uses salts such as aluminium sulphate (alum) or ferrous of ferric (iron) salts, which bond to the suspended particles, making them less stable in suspension, i.e., more likely to settle out. Flocculation is the binding or physical enmeshment of these destabilized particles, and results in flocs that is heavier than water, which settles out in a clarifier [19-21]. The Scientifics stated that removal of very small particles by gravity sedimentation requires excessively long retention periods. Typically these solids are bacteria, viruses, colloidal organic and fine mineral [22-25]. Chemical treatment of wastewater containing these solids results in the precipitation of chemical agents which

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cause flocculation and rapid settling [26-29]. In addition to solids removal, chemical treatment can help the reduction of organic pollution. A study was made to determine the effectiveness of various mixers on the removal of organic pollutants [30-33]. The researchers studied mixing, coagulation and flocculation process with a standard jar test procedure with rapid and slow mixing of a kaolin suspension (aluminium silicate), at 150 rotate per minute and 30 rpm, respectively, in which a cation Al (3+), acts as a coagulant and pectin acts as the flocculent and found that maximum flocculating activity and turbidity reduction are in the region of pH greater than 3, cation concentration greater than 0.5 mM, and pectin dosage greater than 20 mg/L, using synthetic turbid wastewater within the range. The flocculating activity for pectin and turbidity reduction in wastewater is at 99% [34-37]. The other Scientifics investigated the feasibility of mixing rate and ferric coagulant recovery from chemical sludge and its recycle in chemically enhanced primary treatment (CEPT) and found that the efficiency of coagulant recovery had a linear relationship with sludge reduction [38-40]. Experiments verify that it would be a sustainable and cost-effective way to recover ferric coagulant from coagulation sludge in water treatment and chemical wastewater treatment and then recycle it to CEPT, as well as reduce sludge volume [32-38]. The biological and treating parameters such as non-volatile suspended solids, suspended solids, biological oxygen demand, chemical oxygen demand, the amount of acidity, and also, the effect of fast mixing reactor are evaluated in this paper.

2. Materials and Methods

The treatment processes in two pre-treatment reactors are evaluated in this study. The mixing rate of mixer in the first and second reactors are effective on the biological and treating parameters such as biological oxygen demand, chemical oxygen demand, the acidity value, the volatile suspended solids, the non-volatile suspended solids and the other quality of wastewater. This has led to a marked increase in the general use of mixers for mixing and contacting operations in the treatment units. The objective of this work is evaluation of NVSS and VSS parameters of effluent waste water of aerobic treatment unit by usage of mineral nano coagulant in pre-treatment unit. This will be happen using coagulation, flocculation and sedimentation process, respectively. The mixing rate of mixer in the second reactor must be lower than the first reactor. Because of the coagulants which are made in the first reactor needing a low vortex to grow up and change to the bigger core which is named flocculants. Components like aluminium sulphate, Ferric sulphate and Ferric chloride are three common commercial nano coagulants which are applied in this experimental study. Some of related reactions are presented by relations 1, 2 and 3.

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 \leftrightarrow 2Al(OH)_3 + 3CaSO_4 + 6CO_2 \quad (1)$$

$$Fe_2(SO_4)_3 + 3Ca(HCO_3)_2 \leftrightarrow 2Fe(OH)_3 + 3CaSO_4 + 6CO_2 \quad (2)$$

$$FeCl_3 + {}^3\!/_2\, Ca(HCO_3)_2 \leftrightarrow Fe(OH)_3 + {}^3\!/_2\, CaCl_2 + 3CO_2 \quad (3)$$

3. Results and Discussion

The amount of mixing rate in coagulation step in the first tank is changed in value of 50, 60, 70, 80, 90, 120, 140, 160, 180 and 200 rpm. This step is important since the coagulant structure is decomposed and the produced ions are connected to the ions of contaminants and all this is progressed by the proper mixing. So, the more coagulation is obtained by the proper mixing rate.

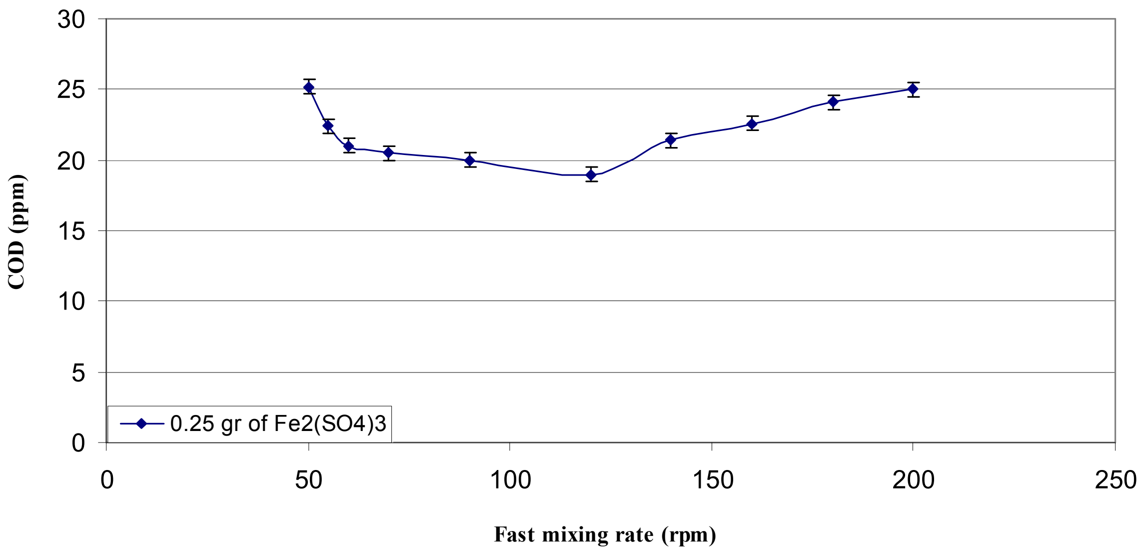

Figure 1. Value of COD versus fast mixing rate.

Figure 1 shows the effect of fast mixing rate on the COD. The chemical oxygen demands of wastewater in an aerobic lagoon are important to describe the performance of treatment briefly. Addition of ferric sulphate introduces the oxygen ions if the sulphate ions don't react with the hardness ions. Also all carbonate and sulphate may be hydrated and releases the oxygen. The decrease in the amount of COD from 25.2 ppm to 19 ppm is obtained by the increase in the amount of fast mixing rate from 50 rpm to 120 rpm. Then the increase in the COD value to 25 ppm is obtained by the increase in the amount of fast mixing rate to 200 rpm. So, comparing the results of contaminant elimination with Figure 10 shows that the lowest amount of TH, calcium hardness, CO_2 and EC value between 90 rpm and 120 rpm occurs not only since of formation of complexes with oxygen but also other ions are interpreted in formation of flocs. The flocs must be growing up. So, the mixing rate in the second pre-treatment reactor is lower than the first mixing reactor.

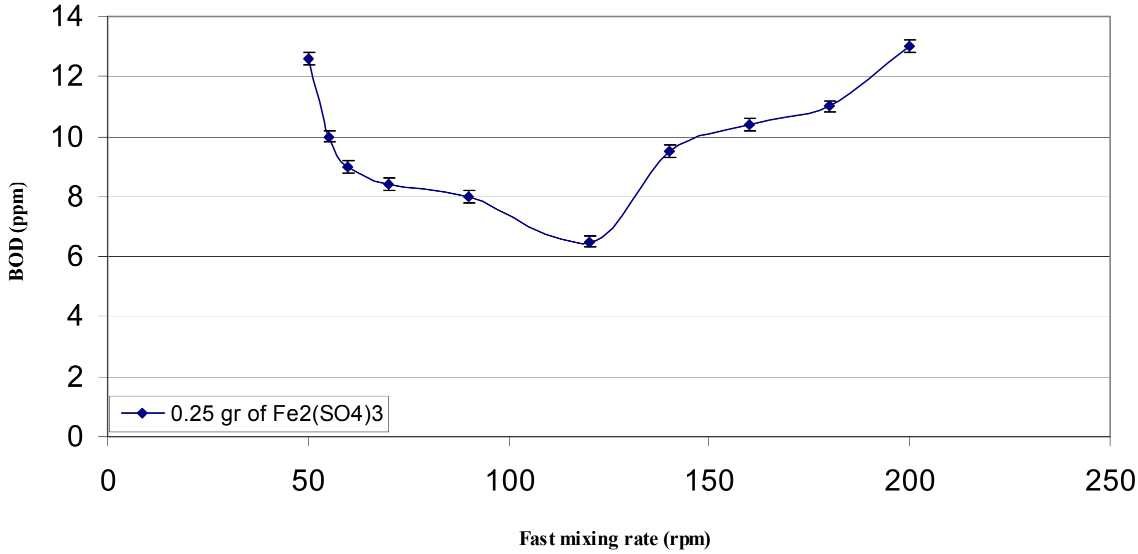

Figure 2. Value of BOD versus fast mixing rate.

Figure 2 shows the value of BOD versus the values of fast mixing rate. Biochemical oxygen demands are one criterion to show the amount of microorganisms in the wastewater. This value may lead to the amount of volatile compounds. The best value of fast mixing rate which obtain 6.5 ppm as minimum amount of BOD is 120 rpm. The decrease – increase trend in BOD values is obtained. Lowest amount of BOD may show the higher amount of microorganisms which trapped in the flocs. This leads to the more stable condition in wastewater. Although, the values of BOD, (8 to 9 ppm), are obtained at 60 to 90 rpm.

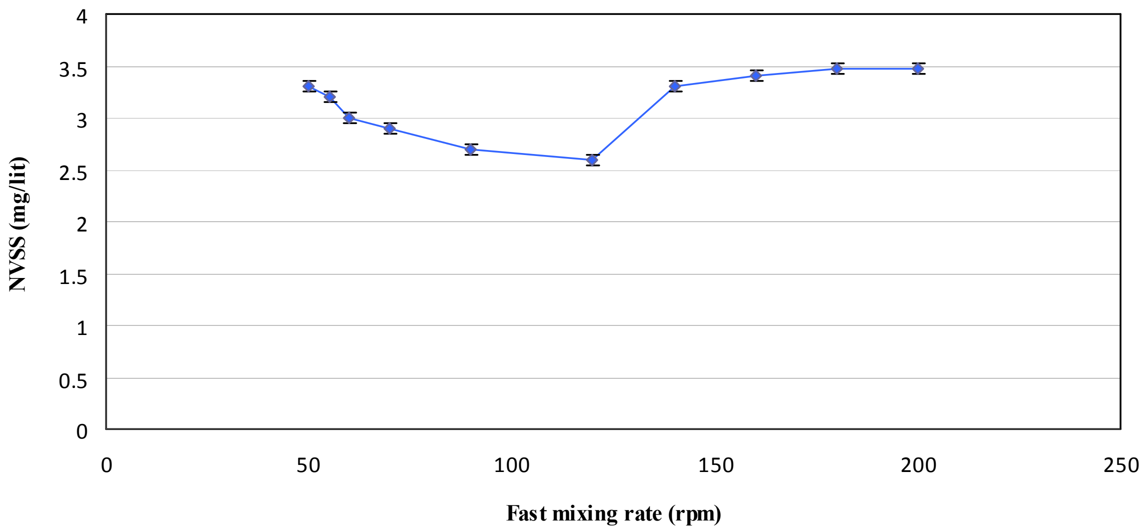

Figure 3. Value of NVSS versus fast mixing rate.

Figure 3 shows the values of non- volatile suspended solids versus fast mixing rate. The values of NVSS decrease from 3.3 ppm to 2.6 ppm when fast mixing rate changes from 50 rpm to 120 rpm. This shows the effective fast mixing rate to trap the non-volatile suspended solids in complexes. The increase in the amount of fast mixing rate to 200 rpm increases the amount of non-volatile solids to 3.48 ppm. So, the fast mixing of 120 rpm is the best of all to form the complexes which contain non-volatile suspended solids.

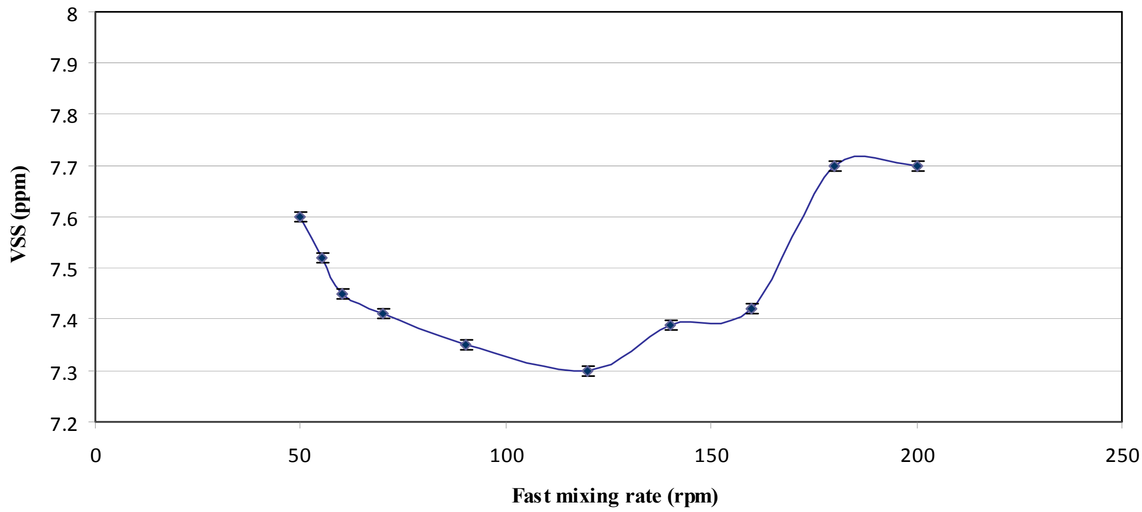

Figure 4. Value of VSS versus fast mixing rate.

Figure 4 shows the effect of first mixing rate on the volatile suspended solids. The values of volatile suspended solids decrease from 7.6 ppm to 7.3 ppm when the fast mixing rate increases from 50 rpm to 120 rpm. The value of VSS increases to 7.7 ppm when the mixing rate increases to 180 rpm and is constant to 200 rpm. This indicates on the best mixing rate is 120 rpm. May be in that values some compounds containing the volatile suspended solids forms flocs and some are released as gas from liquid.

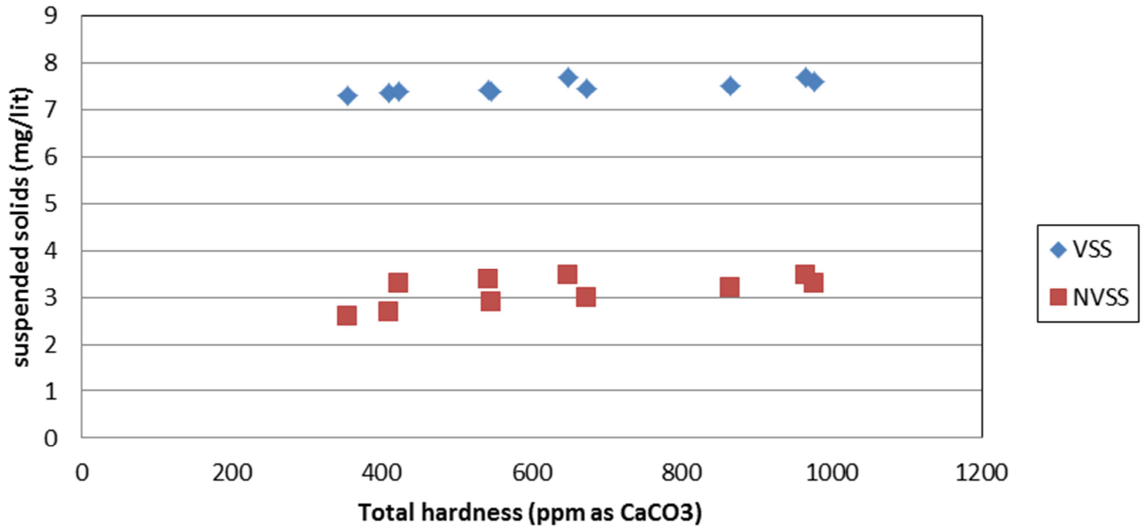

Figure 5. Value of suspended solids versus TH.

Figure 5 shows the relation between amounts of suspended solids and values of total hardness. Non- volatile suspended solids which represent inorganic materials and volatile suspended solids which represent organic material in wastewater are evaluated by gravimetric method. Values of both VSS and NVSS increase with the increase in the amount of total hardness. This shows that some components which make total hardness of wastewater are as volatile and non-volatile components.

4. Conclusion

The usage of nano metal oxides is considered in recent years in treatment processes. In this research the application of nano ferric oxide as a mineral coagulant is studied to treat the wastewater in an aerobic lagoon. Experimental tests are conducted in two series tanks. Total amount of volatile suspended solids, non-volatile suspended solid, total hardness, chemical oxygen demand, biochemical oxygen demand, total hardness, calcium hardness are the investigated parameters. The effect of mixing rate in the first tank which coagulation mechanism is occurred on the parameters is surveyed. The different values of fast mixing rate from 50 rpm to 200 rpm, obtain different values of electrical conductivity, volatile suspended solid, total hardness, chemical oxygen demands, bio chemical oxygen and other effective parameters in quality of waste water. In addition, Nano ferric oxide shows acceptable performance as mineral coagulant to reduce the contaminant in the anaerobic pre-treatment unit. Experimental results show, Value of non - volatile suspended solid shows decreasing- increasing trend from 3.3 mg/lit to 3.48 mg/lit and the minimum value of 2.6 mg/lit is obtained at 120 rpm of fast mixing rate. Also, the value of volatile suspended solid shows decreasing-increasing trend from 7.6 mg/lit to 7.7 mg/lit and the minimum value of 7.3 mg/lit is obtained at 120 rpm of fast mixing rate. In addition, the value of chemical oxygen demands shows decreasing- increasing trend from 25.2 ppm to 25 ppm and the minimum value of 19 ppm is obtained at 120 rpm of fast mixing rate. The obtained results show, the value of biochemical oxygen demands shows decreasing-increasing trend from 12.6 ppm to 13 ppm and the minimum value of 6.5 mg/lit is obtained at 120 rpm of fast mixing rate. The empirical results show, the value of electrical conductivity shows decreasing- increasing trend from 53700 µs/cm to 28150 µs/cm and the minimum value of 300 µs/cm is obtained at 120 rpm of fast mixing rate. In addition, the minimum values of TH, 354 ppm, calcium hardness, 195 ppm, pH of clear supernatant, 12.3, pH after coagulation, 6.7, CO_2, 0.17 ppm is obtained at 120 rpm. Also, the results show that 120 rpm as fast mixing rate using nano ferric oxide in an anaerobic lagoon is proper condition to remove contaminant of wastewater.

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