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Original Research Article

Empirical investigation of treatment of wastewater by using of mineral nano coagulant

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Abstract: Pretreatment of wastewater with mineral coagulant of ferric oxide is investigated experimentally in this work. Nonvolatile suspended solids and volatile suspended solids beside other important parameters, total hardness, calcium hardness, CO2 content, Total dissolved solids, electrical conductivity, sedimentation time, chemical oxygen demands, biochemical oxygen demands, pH value after sedimentation and pH after coagulation in aerobic treatment are surveyed due to the changes in fast mixing rate.

Keywords: Wastewater; Temperature; Fast Mixing; Oxygen; pH; Hardness.

INTRODUCTION

Water treatment requires precise control at each stage in its process – from rapid flash mixing to polymer and chemical addition [1]. 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 [2]. 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 [3].

One of the famous treatment methods to reduce suspended solids and turbidity is the coagulation and flocculation. Coagulation uses salts such as aluminum sulfate (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 [4].

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 [5]. Chemical treatment of wastewater containing these solids results in the precipitation of chemical agents which cause flocculation and rapid settling [6].

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 [7].

Researchers studied mixing, coagulation and flocculation process with a standard jar test procedure with rapid and slow mixing of a kaolin suspension (aluminum 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% [8].

MATERIALS AND METHODS

In the field of water treatment, mixing and contacting are important unit operations having a fundamental influence on the performance of individual process stages or even on the results of the complete process itself. The ever increasing demands on water quality call for continuous improvement of the cleansing processes. This has led to a marked increase in the general use of mixers for mixing and contacting operations in the treatment units.

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. At the same conditions of material and operation condition of second tank the mixing rate of fist tank is changed. 0.25 gr of ferric sulfate is added in the first tank. The lower amount of contaminant in the supernatant liquid at the end of treatment process indicates on the proper coagulation, flocculation and sedimentation. The contaminant may make bonds with coagulant directly and may be trapped in the complex structures of flocs. So, the final analyze is not distinct to show the accurate mechanism. The resulted graphs are helpful to determine the whole performance.

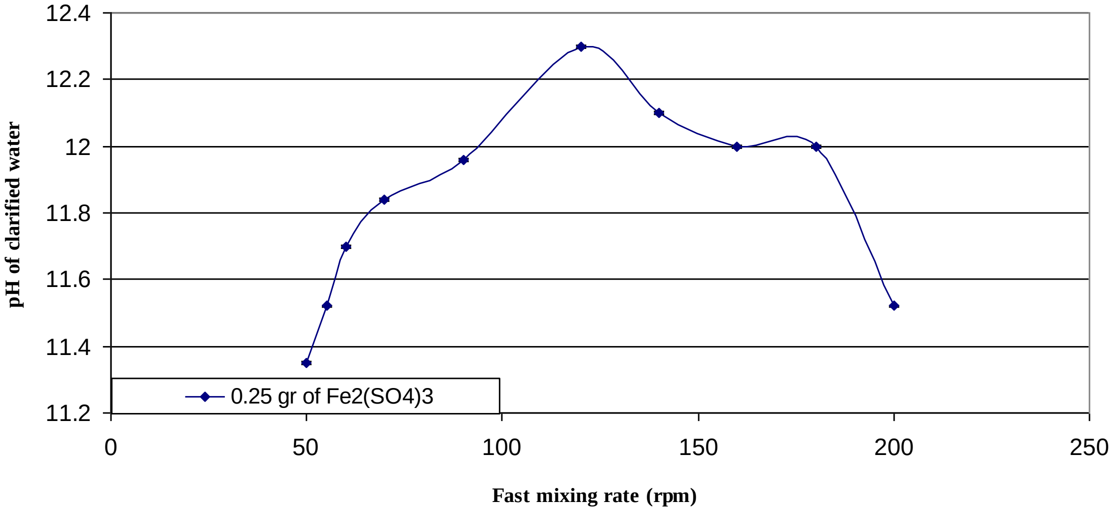

Fig 1: Value of pH of clarified water versus fast mixing rate.

After sedimentation step, the quality of clear supernatant shows the quality of treatment process. Figure 1 shows the relation between the pH value of clear water and the fast mixing rate. The fast mixing rate from 50 rpm to 120 rpm increases the pH value of clear water and the higher value of fast mixing rate to 200 rpm decreases the pH value to 11.5. This shows the best pH value of clear water is 12.3 of all which is in 110 rpm and the lowest values of contaminant are in the treated water.

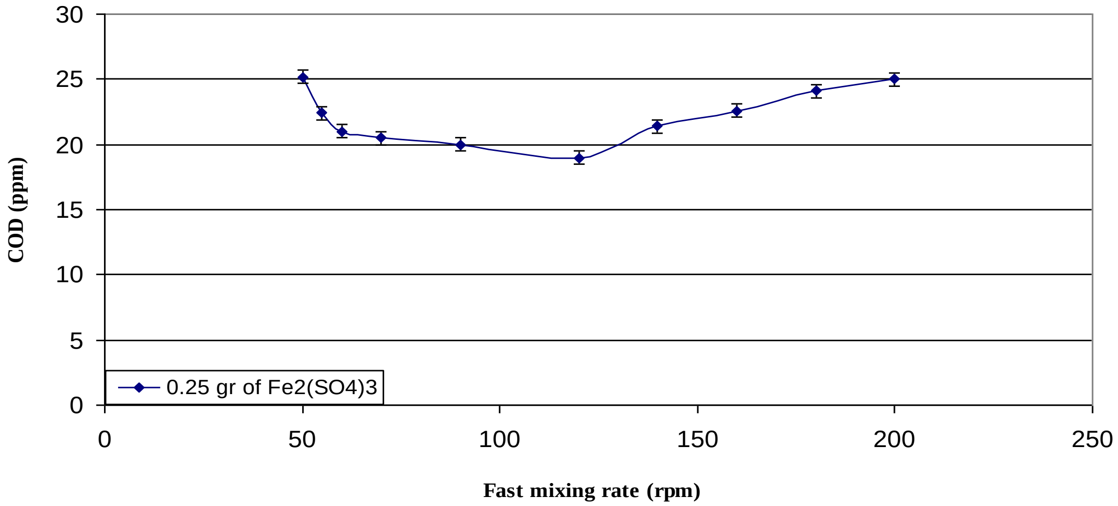

Fig 2: Value of COD versus fast mixing rate.

The chemical oxygen demands of wastewater in an aerobic lagoon are important to describe the performance of treatment briefly. Addition of ferric sulfate introduces the oxygen ions if the sulfate ions don't react with the hardness ions. Also all carbonate and sulfate 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 2 shows that the lowest amount of TH, calcium hardness, CO2 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.

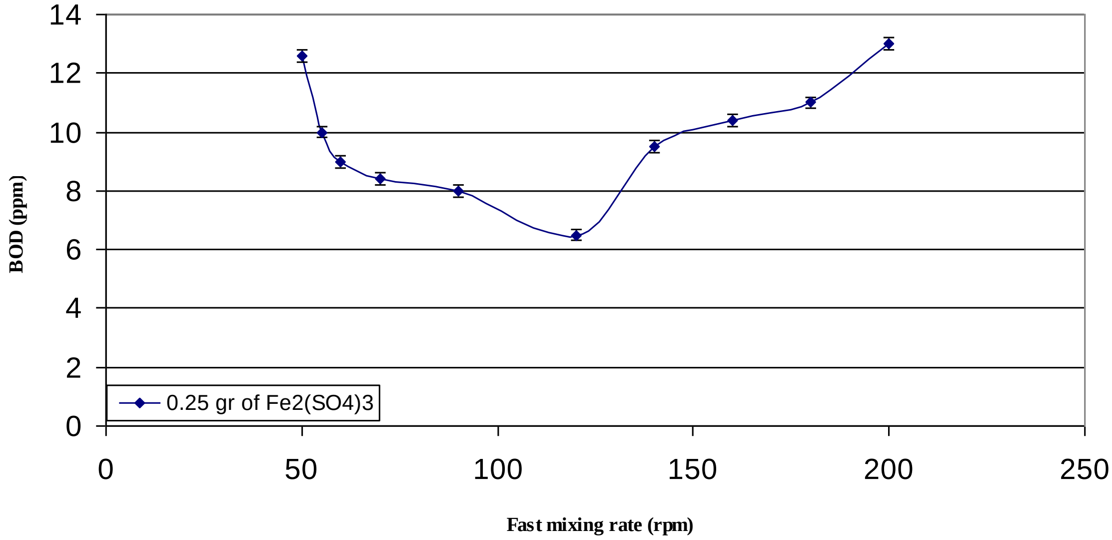

Fig 3: Value of BOD versus fast mixing rate

Figure 3 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 8 to 9 ppm are obtained at 60 to 90 rpm.

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, nonvolatile 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 below results are obtained. Nano ferric oxide shows acceptable performance as mineral coagulant to reduce the contaminant in the anaerobic pretreatment unit. 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 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.

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