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Evaluation of Non-Organic Solids Removal in Wastewater Treatment of Pulp Factories with Ozonation

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***Abstract*— *In this research, evaluation, assessment and comparison of Non-Organic solids removal with and without ozonation in treatment of a pulp factory`s wastewater with and without sediments were accomplished. Wastewater of pulp factories which are by-products of cellulose causes a hazardous water vapor that is dangerous because of containing different combinations of chlorophenol. This is known as a pollutant factor in the environment which is even not possible to be solved by treating wastewater in traditional ways. The most hazardous part of these substances is monomers of chlorophenolic combinations which in biological reactors in a liquid phase could be absorbed much easier and with a high velocity. Once the treatment was done, the non-organic solved and suspended solids removal through an ozonation treatment system compared to the same parameters in the without ozonation treatment method. The evaluation proved that the cyclic ozonation-biotreatment system had more effective results in removing the non-organic solids with and without sediments. Experiments showed that the ozone value never reached the ozone value in the new comer wastewater to the system when wastewater of system was consumed again. It means that if new wastewater is entered, the ozone value is more than the previous one in the system.*

***Keywords*—*Pulp Factories, Non-Organic Materials, Ozonation, Solids Removal, Wastewater Treatment.*

I. Introduction

In a growing world, it is increasingly more necessary to treat municipal and industrial wastewaters using environmentally green technologies [1]. Current technologies often employ man-made chemicals as the primary treatment agent, but there are growing concerns and problems associated with the residual effects of putting more chemicals in wastewater [2]. Displacing these chemicals with economic, environmentally friendly processes offers a significant market opportunity.

Among primary manufacturing industries, paper manufacturing is the fourth largest user of energy and the largest generator of wastes, measured by weight [3]. In treatment of such a wastewater, decreasing or removing the value of suspended and solved solids seems to be more complicated and difficult by using the simple biological methods of treatment [4].

The Ozonated wastewater provides necessary substances for bio-treatment in both aerobic and anaerobic stages [5], [6]. And as a result, a very significant improvement in removing solved and suspended solids could be achieved.

To provide the essential substances for final biological treatment, sufficient solution -ozonated wastewater- was produced in some groups [7]. Because of high number of groups and the number of adding ozone, calculation of final value and real value of added ozone to the solution was also very difficult ,but done successfully [8], [9].

In fact ozone usage for sludge causes a remarkable increase in existing of bio situation related to organic materials which is being bio analyzed smoothly. Both solubility effects and facility increase for maintenance cause increasing of an organic material to be mineral in biological treatment, and it can explain the effect of an ozonation treatment on reduction of sludge production [10], [11].

II. Materials and Methods

Recent studies [12], [13] investigated ozonation to increase the biodegradation of resistant pulp wastewaters containing dyes and whiteners. Another recent study [14] summarized potential options for improvement of wastewater treatment plant effluents using ozone and integration of ozone technology to existing and conventional plants. Pre-ozonation has also been considered to enhance the biodegradability of recalcitrant compounds prior to biological treatment of wastewater [15]. In addition, the applicability of ozone to treatment and mass reduction of wastewater sludge has been studied [16].

In this study, for the solved and suspended solids removal horizontal roughing filters were selected as the pretreatment filters. Horizontal roughing filters perform better than other treatment filters, like Vertical roughing filters. Horizontal roughing filters also have advantage of simplicity in design, cleaning, and operation. To conduct this study, a pilot plant was constructed.

To enable a comparative study, two horizontal roughing filters were constructed. The design and sizing of the pilot plant was guided by the Wegelin design criteria [17], [18].

This study aimed at verifying these criteria based on gravel as a filter medium and other local available possible filter media, namely charcoal due to, it can serve as an alternative where gravel is not available. The filter medium was placed in different filters that consist of a chamber.

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The compartment was filled up of medium sizes of 15mm – 5mm decreasing in size in the direction of flow. The filter bed was provided with under drain system, so that it allows cleaning of the filters after a certain period. A constant filtration rate of 1m/h was used. Standard methods were adopted and analysis of the selected performance monitored the parameters. The filter inlet and outlet values of this parameter were monitored with the aim of analyzing the removal efficiency of the roughing filters at the set field operating conditions. Monitoring was done on a daily basis due to development of excessive filter resistance and to prevent algal growth in the filter.

When the ozone is dissolved in water, there is a need of measuring the ozone concentration at the inlet [19]. The concentration level of the applied ozone depends on the kind of microorganisms or inorganic pollutants to be destroyed, and on the required reduction ratio [20]. This level also depends on the designed treatment time; the disinfection standards take into account both factors (e.g. exposure to 4 ppmw ozone concentration for 4 minutes is required) [21], [22].

Dissolved oxygen, pH, and temperature were measured using a Hach HQ40d Intellical TM portable field kit [23],[24].

In practice, the applied ozone exhibited concentrations from 0.2 ppmw to 10 ppmw; only some processes in water technology require ultra-pure water treated with 30 ppmw ozone.

The treatment process began by removing salts and other harmful combinations, and increasing the concentration of dissolvable substances, and it continued by extracting 200ml of Di-ethyl from the acidified sample. The environment`s PH was kept about 7 to 8.5 in the whole reaction time.

In this system liquids were passed through the treatment system sequentially in specific periods of time, and oznation and oxidation were done intermittently, that means in each liquid passing through the system only a little amount of ozone was added. And it was expected that the combinations existed in liquids react with ozone acceptably and being treated well.

III. Results and Discussion

Experimental studies revealed that the total Non-organic solids without sediment was 483 mg/lit before the ozonation process while it decreased to 400 mg/lit after ozonation which shows an average 83 mg/lit more removal. This trend of reduction could be recorded when there were maximum sediments with maximum velocity of 2.18, 1.09 and 0.73 cm/min with the Non-organic solids removal of 70, 46, and 54 mg/lit respectively (Table I).

TABLE I. Averagetotal non organic solids of wastewater before and after ozonation with / without sediment.

Wastewater Solids/ Maximum Sediment Velocity (Cm/Min)	Removed Non-Organic Solids (Mg/Lit)	Average Non-Organic Solids After Ozonation (Mg/Lit)	Average Non-Organic Solids Before Ozonation (Mg/Lit)	Removing Percentage (%)
Total Non-Organic Solids without Sediment	83	400	483	17.2
Maximum Sediment Velocity of 2.18	70	425	495	14.1
Maximum Sediment Velocity of 1.09	46	369	415	11
Maximum Sediment Velocity of 0.73	54	392	446	12.1

The same increasing removal efficiency was measured with Non-Organic Suspended Solids removal without sediment with the removal of 61.5% after ozonation in comparison with its content before the ozonation. Furthermore, the Non-Organic Suspended Solids removal with maximum sediment velocity of 2.18, 1.09 and 0.73 cm/min revealed removal efficiencies of 44%, 33% and 69% respectively (Table II).

TABLE II. Average non organic suspended solids of wastewater before and after ozonation with / without sediment.

Wastewater Solids/ Maximum Sediment Velocity (Cm/Min)	Removed Non-Organic Solids (Mg/Lit)	Average Non-Organic Solids After Ozonation (Mg/Lit)	Average Non-Organic Solids Before Ozonation (Mg/Lit)	Removing Percentage (%)
Non-Organic Suspended Solids without sediment	8	5	13	61.5
Maximum Sediment Velocity of 2.18	7	9	16	44
Maximum Sediment Velocity of 1.09	4	8	12	33
Maximum Sediment Velocity of 0.73	9	4	13	69

Considering the Non-Organic solved solids removal, the increasing trend of removal was the result in without sediment after ozonation where there was a 16 % removal efficiency in comparison with the treatment without ozonation and with maximum sediment velocities of 2.18, 1.09 and 0.73 cm/min, the measured removals were 13.1%, 10.4%, and 10.4% respectively. It shows that by reducing of maximum sediment velocity the Non-Organic solved solids removal decreased too (Table III).

TABLE III. Average non organic solved solids of wastewater before and after ozonation with / without sediment.

Wastewater Solids/ Maximum Sediment Velocity (Cm/Min)	Removed Non-Organic Solids (Mg/Lit)	Average Non-Organic Solids After Ozonation (Mg/Lit)	Average Non-Organic Solids Before Ozonation (Mg/Lit)	Removing Percentage (%)
Non-Organic Solved Solids without Sediment	75	395	470	16
Maximum Sediment Velocity of 2.18	63	416	479	13.1
Maximum Sediment Velocity of 1.09	42	361	403	10.4
Maximum Sediment Velocity of 0.73	45	388	433	10.4

IV. CONCLUSION

Experimental evaluations were carried out to determine real effect of cyclic ozonation bio-treatment in treatment of pulp factories for Non-Organic Solids removal and to make comparisons with the achieved results through biological treatment. Such a wastewater treatment system not only saved both energy and time, but also met the standards of the treated wastewater to be used in agriculture, irrigation and leaching pits. Besides, the removal of the mentioned parameters which was the aim of the research indicated the efficiency of using ozone for treating this kind of industrial wastewater.

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