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Evaluation of Soluble BOD and Suspended Particles BOD Removal without and with Sediment in Different Velocities before and after Ozonation in an Industrial Wastewater Treatment

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Abstract**—***In this research, removing the values of BOD with and without sediment in two different methods in treatment of an industrial wastewater was experimented in order to evaluate the use of ozone in industrial wastewater treatment systems. Such wastewaters contain specific poisonous chlorinated phenolic combinations, which in biological reactors in a liquid phase could be absorbed much easier and with a high velocity. After the treatment, the measured soluble BOD and suspended particles BOD contents in the cyclic ozonation-biotreatment system compared to the soluble BOD and suspended particles BOD values in effluent from anaerobic bioreactor (without ozonation) with the consideration of three different sediment velocities (2.18, 1.09,0.73 cm/min.) and also without sediment. The comparison revealed that the removals in both were dramatically different and proved the remarkable efficiency of the cyclic ozonation-biotreatment system. By bio-ozone-bio treatment the value of consumed ozone was considerably increased, but through this way the quality of treatment and the value of dissolvable substances increased. In cyclic ozonation-biotreatment reactors liquids were passed sequentially and according to bio-ozone-bio-treatment method, and it showed when ozone is consumed very quickly, no ozone can enter the reactor.*

Keywords— *BOD, Ozonation, Sediment, Soluble Solids, Suspended Solids, Wastewater.*

I. INTRODUCTION

In the well-known activated sludge systems, domestic sewage, wastewater from industrial plants such as dyeing industries which was studied here, or a combination of the two, is treated with air or other oxygen-containing gas in the presence of the micro-organisms furnished by the recycled activated sludge, to effect degradation of organic biologically degradable material, designated BOD [1], [2].

Following such oxidative treatment in one or more stages, the mixed liquor is introduced into a settler or clarifier [3], from which a portion of the settled solids are recycled to provide the activated sludge containing the microorganisms effective in consuming and digesting the organic matter (BOD) in the waste.

The supernatant liquor from the settler or clarifier is returned to receiving waters generally after some further purification or disinfection treatment [4]. While earlier commercial activated sludge plants employ air to furnish the oxygen needed to sustain the metabolic function of the microorganisms, more recent commercial installations employ, in one or more of the oxidation stages, aeration gas having a higher oxygen content than the 21% contained in atmospheric air**.**

Ozone usage for sludge causes a remarkable increase in existing of bio situation related to organic materials which has been bio analyzed smoothly [5], [6]. Both solubility effects and facility increase for maintenance cause increasing of an organic material to be mineral in biological treatment [7], and it can explain the effect of an ozonation treatment on reduction of sludge production [8], [9].

II. MATERIALS AND METHODS

The treatment process began by removing salts and other harmful combinations [10], [11] and increasing the concentration of dissolvable substances [12], and it continued by extracting 200ml of Di-ethyl from the acidified sample [13], [14].

The standard temperature began from 19°C to 22°C for 2 minutes, and reached to 26°C in the input wastewater, of course this occurred gradually and in different steps the temperature varied from 19 °C to 26°C at the beginning [15]. The trend of temperature changes continued almost the same in the wastewater treatment with anaerobic digester.

Temperature has a notable effect on the efficiency of ozone for Total and Suspended Solids removal [16], [17]. Another reason for ozone efficiency evaluation at elevated temperatures was the fact that dyeing effluents were typically discharged at elevated temperatures. Temperature for the raw and bio-ozone-biotreated wastewater was maintained from 26 to 60°C. Both Total and Suspended Solids removal gradually increased with an increase in temperature from 30 to 60°C for raw as well as bio-ozone-biotreated wastewater [18]. This was the result of the two simultaneous effects, increase in the rate constant of the reaction and the indirect effect through the variation of ozone solubility with temperature.

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Due to an increase in temperature, ozone solubility decreased, thereby reducing the amount of ozone available for the reaction, which may result in decreased degradation.

The average BOD removing before and after ozonation and the percentage of removing were recorded in a period of 30 minute ozonation. In all steps 54±3 mg/lit ozone was consumed in this period and the consumption of ozone in each step changed a bit.

III. Results and Discussion

Results of the experiments showed that ozone can be effective for solving most organic materials in activated sludge or for making them mineral. Furthermore bio dissolubility increase related to the solved materials was reported. Experimental studies revealed that BOD content removed in general, but in order to evaluate and assess this removal and study the efficiency of ozonation the removals were compared.

The average wastewater`s BOD removing before and after ozonation with and without sediment was 45 mg/lit before the ozonation process while it decreased to 25 mg/lit after ozonation which shows an average of 20 mg/lit more removal. This trend of reduction was recorded when there were maximum sediments with maximum velocity of 2.18, 1.09 and 0.73 cm/min with the average BOD removal of 24, 16, and 22 mg/lit respectively (Table I).

TABLE I. Average wastewater`s BOD removing before and after ozonation with and without sediment.

Wastewater`s BOD/ Maximum Sediment Velocity (cm/min)	Average BOD contents Before Ozonation (mg/lit)	Average BOD contents after Ozonation (mg/lit)	Removed BOD (mg/lit)	Removing Percentage (%)
Total BOD without Sediment	45	25	20	44.5
Maximum Sediment Velocity of 2.18	47	23	24	51
Maximum Sediment Velocity of 1.09	36	20	16	44.5
Maximum Sediment Velocity of 0.73	38	16	22	58

The same removal efficiency was witnessed with Soluble BOD removal without sediment with the removal of 12% after ozonation in comparison with its content before the ozonation. And the average soluble BOD removal with maximum sediment velocity of 2.18, 1.09 and 0.73 cm/min revealed removal efficiencies of 34.5 %, 0% and 20 % respectively (Table II).

TABLE II. Average soluble BOD removing before and after ozonation with and without sediment.

Wastewater`s BOD/ Maximum Sediment Velocity (cm/min)	Average BOD contents Before Ozonation (mg/lit)	Average BOD contents after Ozonation (mg/lit)	Removed BOD (mg/lit)	Removing Percentage (%)
Soluble BOD without sediment	25	22	3	12
Maximum Sediment Velocity of 2.18	32	21	11	34.5
Maximum Sediment Velocity of 1.09	18	18	0	0
Maximum Sediment Velocity of 0.73	20	16	4	20

In Suspended Particles BOD removal the increasing trend of removal was the result in all cases, without sediment there was an 85 % removal and with maximum sediment velocities of 2.18, 1.09 and 0.73 cm/min the removal efficiencies were 87%, 89%, and 100% respectively. By reducing of maximum sediment velocity the suspended particle BOD reduced too (Table III).

TABLE III. Average suspended particles BOD removing before and after ozonation with and without sediment.

Wastewater`s BOD/ Maximum Sediment Velocity (cm/min)	Average BOD contents Before Ozonation (mg/lit)	Average BOD contents after Ozonation (mg/lit)	Removed BOD (mg/lit)	Removing Percentage (%)
Suspended Particles BOD without Sediment	20	3	17	85
Maximum Sediment Velocity of 2.18	15	2	13	87
Maximum Sediment Velocity of 1.09	18	2	16	89
Maximum Sediment Velocity of 0.73	18	0	18	100

It should be noted that in sediment velocity of 2.18 cm/min, the soluble BOD might not be added to the whole BOD because the amount of soluble wastewater`s BOD was performed only on 2 steps of the 3. The value of BOD is the difference between the whole measured BOD and the measured soluble BOD. A great achievement during the experiment was that a part of BOD had resistance against ozone oxidation. In this step ozonation continued for about 65 minutes, and 117 mg/lit ozone was consumed. In general, resistant part of BOD against ozone was 10 mg/lit to 20 mg/lit of the total BOD which was based on the ozonated sample. As it was recorded, BOD decreased a lot in a 30 minute ozonation. It was also vivid that the resistant BOD against ozone existed in soluble wastewater while it didsn`t exist in suspended particles BOD (Fig.1).

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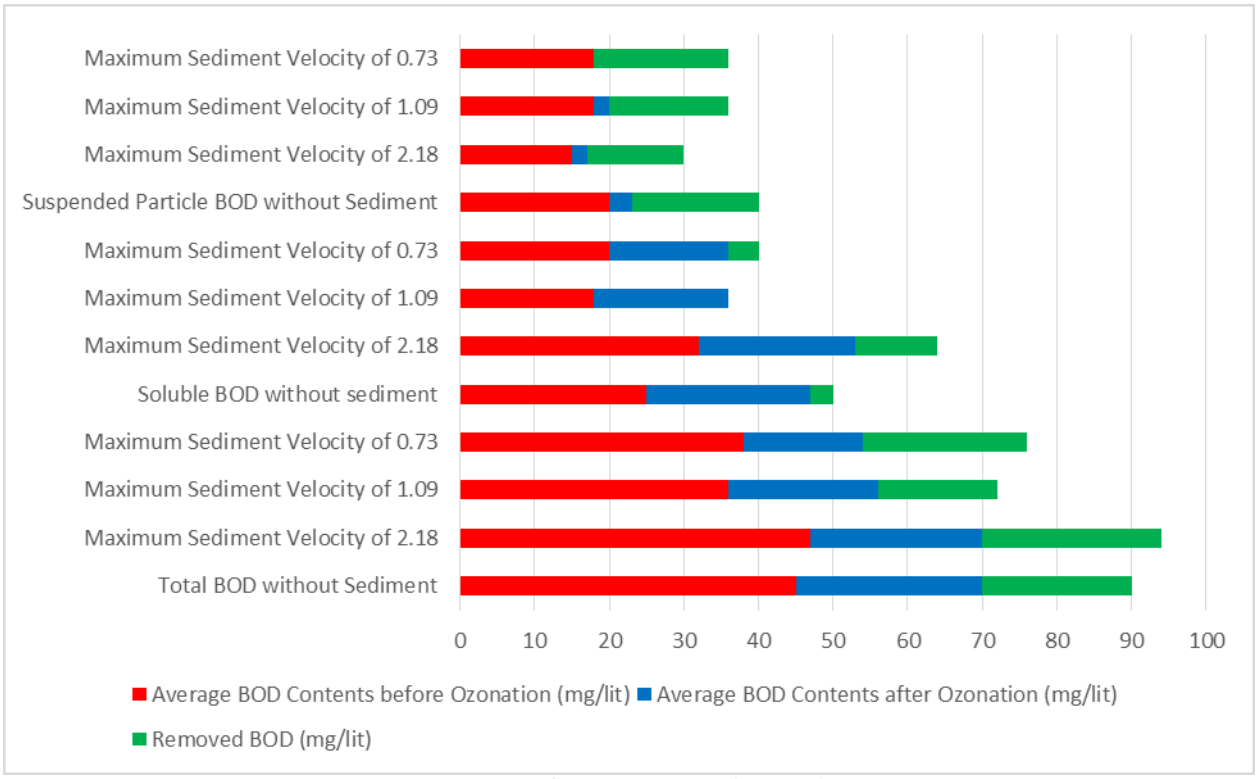

Fig. 1. Average wastewater`s BOD removing before and after ozonation.

IV. Conclusion

Experimental evaluations were carried out to determine real effect of cyclic ozonation bio-treatment in treatment of dyeing industries for Soluble BOD and Suspended Particles BOD 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 items, which was the aim of the research, indicated the efficiency of using ozone for treating this kind of industrial wastewater.

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