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Assessment of COD and AOX Removal in a Sequential Bio-ozone-Bio treatment of a Pulp Factory Wastewater Treatment System

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Abstract. In this research AOX and COD removal in treatments of a contaminated wastewater with Phenolic Chlorine combinations in a sequential bio-ozone-bio treatment were studied. Reduction of the chloration activity, and existance of oxidation reaction in a bio-ozone- bio treatment system were the two major reasons of such a study in order to reach an acceptable removal of COD and AOX. Because of high molecular weight of these poisonous combinations it was necessary to perform in a way that in a sequential process these combinations could be changed to smaller and dissolvable substances in the environment. In continuous treatment at first wastewater producer source had to be considered biologically and then it was ozonated. After the first considerable COD reduction in primary(A-B) biological treatment (about 20 to 30 percent), in the next stage of biological aerobic to anaerobic treatment (C-D-E), this decrease after ozonation treatment showed itself in a very large scale. AOX removal value in anaerobic reactors was also high about 25g/m^3 which had been rarely seen.

Keywords: Phenolic chlorine, AOX, COD, Sequential treatment, Bio-ozone-bio treatment.

1. Introduction

Wastewater of chlorine whiteners which are by-products of cellulose causes a hazardous water vapour that is dangerous because of containing different combinations of chlorophenolic. This is known as a pollutant factor in the environment which is even not possible to be solved by treating wastewater in traditional ways [1]. The most hazardous part of these substances is monomers of chlorophenolic combinations [2]. These monomers and especially monomers with high molecular weights are seen in such wastewater treatment systems. All monomeric combinations of chlorophenolic were removed completely in both aerobic and anaerobic ways. Concentration of each one of these monomers among treated wastewaters was usually less than 100nm, and most of them were less than 50 nm. By this research it became obvious that the production of such substances is variable, but it never reaches to more than 30%, it is necessary to mention that COD and AOX and particularly AOX of absorbable chlorine were possible to be calculated. It has been proved that left combinations of chlorine will remain in the environment for a long period of time [3]. Ozonated wastewater provides necessary substances for bio-treatment in both aerobic and anaerobic stages [4]. For providing the essential substances for final biological treatment, sufficient solution which is

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ozonated wastewater was produced in some groups. Because of that which is high number of groups and the number of adding ozone, calculation of final value and real value of added ozone to the solution was very difficult.

2. Materials and Methods

Two main methods of bio-ozone-bio treatment and professional biological treatment were done continuously. In continuous treatment at first wastewater producer source should be considered biologically. One of the main purposes of this research was a comparison of artificial ozonation and biological natural ozonation for treating wastewater. The time that the system needed to reach to a spesific fixed limit was about 90 hours which is 3 times more than the total time or 4.5 times more than the total time in aerobic systems. The most error percent in the final stage was less than 0.5 %, and this value even became less in aerobic reactors.

First the wastewater entered the BFB (bio-fluidized bed) system with a water vapour which had been formed by biological dissolvable substances, in the next step it entered a gas reservoir tank which included ozone gas, and extra air [5]. Ozone had been dissolved by UV. The environment`s PH was kept about 7 in the whole reaction time. The concentration of ozone in the BFB system cycle was measured and controlled by an electrode called Amprometric electrode. Such a kind of system was modelled from anaerobic reactors which were used in the 1990`s. This kind of system could be designed for dyeing industries` wastewater treatment for about 2 years. The treatment process began by removing salts and other harmful combinations [6], and increasing the concentration of dissolvable substances, and it continued by extracting 200ml of Di-ethil from the acidified sample [7]. The standard temperature began in 70^0C for 2 minutes, and reached to 240^0C, and the final temperature of 240^0C continues for 3 minutes. The concentration of the liquid phase was also measured. The brown colour of wastewater which was removed during ozonation was because of a medium existence. Moreover the mentioned electrode was used for measurement that made the ozone value to be limited to about 20 mg/l.

3. Findings

The time that the system needed to reach to a spesific fixed limit was about 90 hours which is 3 times more than the total or 4.5 times more than the total time in aerobic systems. The most error percent in the final stage was less than 0.5 %, and this value even became less in aerobic reactors. After the first considerable COD reduction in primary(A-B) biological treatment (about 20 to 30 percent), in the next stage of biological aerobic to anaerobic traetment (C-D-E) this decrease after ozonation traetment showed itself in a very large scale and more than the two previous stages. Ofcourse in this stage if ozonation process is omitted, COD reduction will definitely show itself very much less than this amount. Table 1 shows the ozone consumption (injection) in gm^{-3} in 3 different cases for 5 samples in order to remove COD and AOX and the value of the two mentioned parameters during the treatment process.

The most considerable removal is seen in AOX volume which is because of gradual ozone adding to the system. To explain the relationship between magnificent AOX reduction and biological treatment without ozonation existance is very hard and to some how impossible. A comparison between previous observations and the gained information in this study showed that a separate biological treatment could have a very important role in reduction of AOX value. The ratio of separated AOX on separated COD ($\Delta AOX / \Delta COD$) in the ozonation period (B-C) was about 0.11 in sample number 2, and 0.22 in sample number 3. This ratio for the total bio-ozone-bio treatment was 0.15 for sample number 2, and 0.14 for sample number 3 at the beginning. This more ratio in sample number 3 might exist because of more concentration of ozone in this sample.

4. Results and Discussion

In this reactor liquids were passed sequentially and according to bio-ozone-bio-treatment method, and it showed that when ozone was consumed very fast, no ozone could actually enter the reactor. Experiments showed that the ozone value never could reach the ozone value in the new comer wastewater to the system

when wastewater of the system was consumed again. It means that if new wastewater is entered, the ozone value is more than the previous one in the system.

Table 1: General variables during Bio-ozone-biotreatment

Measured Variables	**Sample**	**Ozone Consumption (ΔO),gm^{-3}**		
		Case 1	***Case 2***	***Case 3***
COD	A	593	594	1880
	B	436	472	1390
	C	436	346	1178
	D	432	328	1085
	E	406	264	1009
AOX	A	47.6	49	121
	B	36.6	36.6	90.2
	C	36.6	22	43
	D	27.4	17.2	41
	E	24	15.1	38.1

It is essential to mention that reducing the ΔAOX/ΔCOD ratio could be caused by improved biological COD removal or by reduced AOX removal efficiency by ozone.

As it can be seen in Fig. 1 the value of COD in g/m^3 decreased from 593 in sample A in the first case and fell down to 436, 436, 432 and 406 in samples B,C,D, and E respectively. Although this demonstrated a little trend of decrease, the two other samples completed the success in such an experiment. This reduction trend with different measures could be seen in the second sample where again from 594 g/m^3 in sample A the COD value declined to 472, 346, 328, and 264 in other sample points. In this case the reduction rate was more considerable in comparison with the primary case.The most remarkable fact could be seen in case 3, where an almost 500 g/m^3 difference or fall explained the great amount of reduction from sample A to B. Then an approximate 200 g/m^3 dcrease from B to C, and nearly 100 g/m^3 decline from C to D, and finally a 76g/m^3 fall from sample D to E were reached. This removal value was the result of sequential bio-ozone-bio treatment .

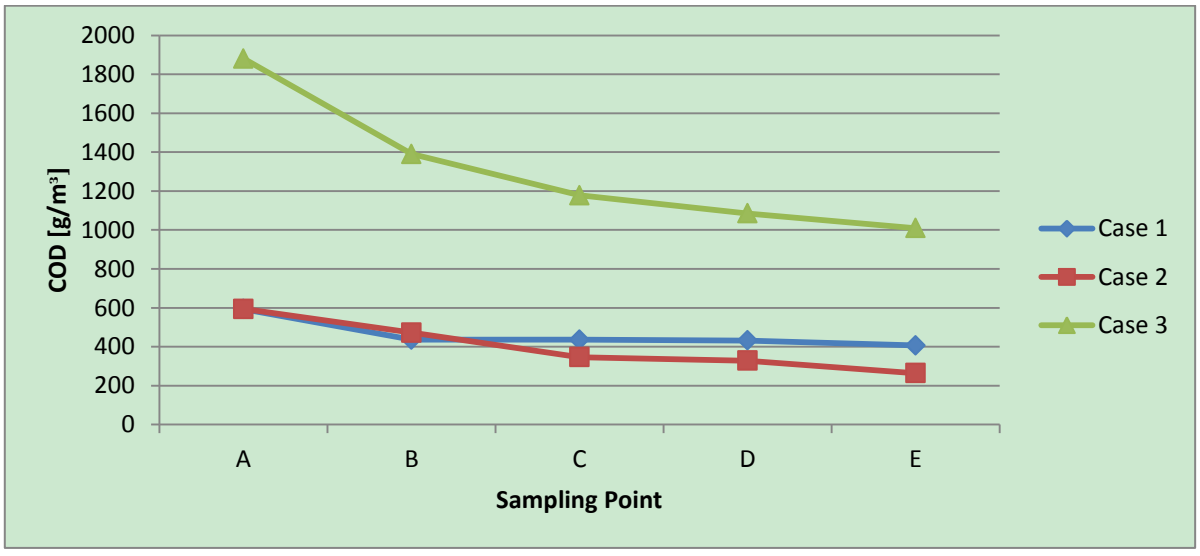

Fig. 1: COD removal in the sequential bio-ozone-biotreatmnet

In Fig. 2 the AOX content (g/m^3) is shown in 3 cases in 5 samples. According to the achieved data in the first case an overall 23.6 g/m^3 reduction from A to E , and a 33.9 g/m^3 decrease in the second case (Case 2) and a more considerable removal in case 3 (82.9g/m^3) were reported. It must be taken into consideration that except in case one and in samples B and C where the achieved result was the same value (36.6 g/m^3) in other steps the reduced trend of removal was obvious. One more important fact which must be mentioned is the final value in all the three cases where the AOX contents were less than 40 g/m^3.

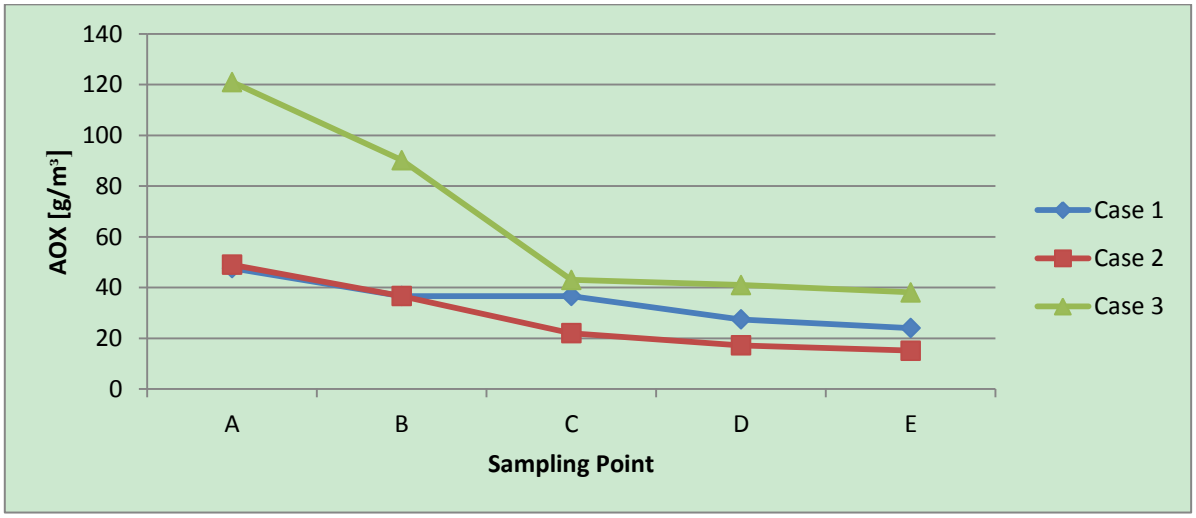

Fig. 2: AOX removal in the sequential bio-ozone-biotreatment

5. Conclusion

In this research, calculations and estimations in bio-ozone- biotreatment made it possible to achieve the efficient COD and AOX removal in treatment of an industrial wastewater which was contaminated by phenolic chlorine combinations. And it showed that ozonation allowed the wastewater to be treated easily with better efficiencies in comparison with the biological treatment system only. For better treatment of poisonous substances and also simultaneous treatment of the combinations we could complete the system with excessive and other perfect systems [8]. $\Delta AOX/\Delta COD$ ratio was just 0.14 when oznation was done,where as if it is completed with bio-ozone- biotreatment, this ratio reduces to 0.08. Further more, the two main reasons could be mentioned for the above achievement are: reduction of the chloration activity [9], and existance of oxidation reaction in bio-ozone- biotreatment system.

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