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Assessment of Hazardous Chemical Pollutants Removal in Industrial Wastewater Treatment by Comparing Ozonation, Active Sludge and Aquatic Ferns Usage

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Abstract— *One of the most dangerous sources for water pollution is chemical fertilizers such as phosphor and nitrogen contents as well as petroleum contaminations via aromatics, heavy metals, grease, phenols and etc. These aforementioned compounds and some other chemical contaminants should be removed before uploading the wastes to the environment regarding to their dangerous and poisoning navigates. The aim of this research is providing suitable data for industrial application of economic useful absorbent for chemical and physical treatments. So, three different methods of ozonation, aquatic ferns usage and active sludge was considered, experimented and compared in order to remove the hazardous chemical contaminants, specifically NO_2^-, NO_3^-, PO_4^{3-}, NH_4^+ and C_6H_5OH. All the three methods showed acceptable removals, but it should be mentioned that aquatic ferns illustrated great power as an environmental friendly absorbent in the contaminants removal.*

Keywords— *Active Sludge, Aquatic Ferns, Chemical Pollutants, Ozonation, Wastewater*.

I. INTRODUCTION

Biological absorbents can overcome most of the unfavorable outputs of wastewaters while represent great performance capabilities. The importance of using such substances was recommended wildly because of high efficiency and low volume of biological and chemical sludge, revival of biological mass and recovery of heavy metals [1].

Although their removal efficiency is definitely affected by reactor structure, wastewater properties and type of absorbent, it should be mentioned that acceptable quality levels of water in any industry refer to the one that has the lower treatment costs with respect of remedy costs because of its impurity effects [2].

On the other hand lack of adequate research studies is sense wildly and still needed for more clarifications in this field of research especially in semi-industrial scale [3]. This research expounded real operational characteristics of aquatic ferns and active sludge for treatment of an industrial wastewater and compared ozone usage for treating the same wastewater in order to remove NO_2^-, NO_3^-, PO_4^{3-}, NH_4^+ and C_6H_5OH.

Advanced wastewater treatment is defined as the methods and processes that remove more contaminants from wastewater than the conventional treatment. The term advanced treatment may be applied to any system that follows the secondary, or that modifies or replaces a step in the conventional processes. In this research for the advance treatment the three mentioned methods were used and compared in order to choose the most efficient one for treating such a wastewater.

II. MATERIALS AND METHODS

The wastewater used in this research comes from an industrial wastewater. According to the ratio of products in this wastewater two third of it is achieved from chlorination stage and one third from alkaline extraction stage. Moreover, this wastewater includes the common materials that can be found in a household or industrial wastewater [4].

Aquatic Ferns and active sludge (non-greasy) as biological adsorbents were used for hazardous chemical pollutants removal from wastewater. The presence of these two absorbents created disturbances for the ecosystem [5]. For example, aquatic fern is a water plant that, due to the rapid growth and coverage of water resources, jeopardizes aquatic life. The activated sludge is also a waste product of the purification plant. With the help of these two materials, the environment can also be used for purification.

In the first step, the above biological preparations were prepared and then experiments were conducted to optimize the factors affecting the removal of contaminants on a laboratory scale. In the second phase, it was designed and built in larger dimensions, and the field for the industrialization of this method was provided [6, 7].

In this research a method of consuming ozone for treatment of wastewater arising from industrial sector which has hazardous environmental problems was also considered to be compared with the above mentioned methods as well. In this system that liquids are flowing between the oznation phase and biological treatment process in a rotating way and it is also repeated, no poisonous materials were seen [8, 9,10].

A simple reactor performance for treatment of model and real wastewater on laboratory and industrial scale was investigated [11]. This refining process proceeded with special

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attention to the effect of solution pH-value, pollutant concentration, absorbent concentration and reaction time. The batch industrial scale reactor represented over 90 % removal efficiency under pH-value of 6, 6 and 5-5.5 for aquatic ferns, active sludge and ozonation respectively. Effective reactions times represented various durations for ferns and active sludge with respect of 120 minutes and 90 minutes.

III. Results and Discussion

A. Comparison of NO_2^- and NO_3^- removals by the three methods

The removal of NO_2^- and NO_3^- was one of the purpose of such a research. The treatment was accomplished according to the three considered methods and the recorded results for the removal of both of the mentioned parameters showed a remarkable removal, but the target of this study was to compare and choose the most beneficial method for treating this wastewater where all the data in the three advanced treatment methods in 6 steps were recorded and compared.

It can be seen in table I that the content of two hazardous matters in treatment with active sludge, ozonation and aquatic ferns decreased. It is seen that the treatment with aquatic ferns has the most removal amount.

Although the difference between the ozonation and ferns methods is little, since financial issues must be considered, for removing these two items, usage of aquatic ferns is recommended. The Biological Oxidation Conditions were:
PH= 2.5-8.05 Temperature=22-25.5 Degree Centigrade
The Bio-Ozone-Bio Oxidation Conditions were:
PH= 2.5-8.05 Temperature=22-25.5 Degree Centigrade

TABLE I. Concentration of NO_2^- and NO_3^- in the output wastewater with ozonation, aquatic ferns and active sludge

STEPS	Treated Effluent by Biological Method		Treated Effluent by Active Sludge		Treated Effluent by Ozonation		Treated Effluent by Aquatic Ferns	
	NO_3^- (g/m^3)	NO_2^- (g/m^3)	NO_3^- (g/m^3)	NO_2^- (g/m^3)	NO_3^- (g/m^3)	NO_2^- (g/m^3)	NO_3^- (g/m^3)	NO_2^- (g/m^3)
1	6	0.58	5	0.47	3.9	0.36	2.8	0.29
2	5.5	0.80	2.5	0.68	2	0.58	1.2	0.49
3	15	0.41	9	0.32	7.6	0.22	5.7	0.19
4	14.5	0.55	8.1	0.44	6.9	0.34	5.2	0.28
5	12.5	0.42	7.3	0.32	6	0.27	4.6	0.21
6	10.5	0.39	5.9	0.31	4.8	0.25	3.8	0.18

B. Comparison of PO_4^{3-} removals by the three methods

As it seen in table II after the common treatment, PO_4^{3-} content was 16, 18, 14, 17.5, 20.6 and 19.1 mg/l in all the 6 experimented steps while after using the active sludge, ozonation and aquatic ferns in all the 6 mentioned steps there were considerable decline and this reduction was more in the method using aquatic ferns where its content became 7.1, 8.2, 6, 8.1, 6.3 and 7 mg/l respectively. It should be considered that the removal percentage with the ozonation method was more in comparison with the active sludge usage in all steps. The Biological Oxidation Conditions were:
PH= 2.5-8.05 Temperature=22-25.5 Degree Centigrade
And the Bio-Ozone-Bio Oxidation Conditions were:
PH= 2.5-8.05 Temperature=22-25.5 Degree Centigrade

TABLE III. Concentration of PO_4^{3-} in the output wastewater with ozonation, aquatic ferns and active sludge

STEPS	Treated Effluent by Biological Method	Treated Effluent by Active Sludge	Treated Effluent by Ozonation	Treated Effluent by Aquatic Ferns
	PO_4^{3-} (mg/l)	PO_4^{3-} (mg/l)	PO_4^{3-} (mg/l)	PO_4^{3-} (mg/l)
1	16	12.4	8.9	7.1
2	18	13.8	10	8.2
3	14	10.1	7.6	6
4	17.5	12	9.2	8.1
5	20.6	13.4	8.8	6.3
6	19.1	12.8	9	7

C. Comparison of of NH_4^+ and C_6H_5OH removals by the three methods

NH_4^+ and C_6H_5OH were also experimented in the studied wastewater treatment methods. The average of their contents in the treated effluent is presented in tables III and IV.

For these two also the final content was less in the system with aquatic ferns for both, where 21 mg/l in NH_4^+ versus 24.33, 25.41 and 28.43 mg/l for treatment with ozonation, active sludge and the simple form of treatment was achieved and 0.295 mg/l for C_6H_5OH versus 0.380, 0.460 and 0.570 for treatment with ozonation, active sludge and simple form was recorded as well.

TABLE IIIII. Concentration of NH_4^+ in the output wastewater with ozonation, aquatic ferns and active sludge

Average of Treated Effluents	NH_4^+(mg/l)
Average of Treated Effluent by Biological Method	28.43
Average of Treated Effluent by Active Sludge	25.41
Average of Treated Effluent by Ozonation	24.33
Average of Treated Effluent by Ferns	21.7

TABLE IV. Concentration of C_6H_5OH in the output wastewater with ozonation, aquatic ferns and active sludge

Average of Treated Effluents	C_6H_5OH (mg/l)
Average of Treated Effluent by Biological Method	0.570
Average of Treated Effluent by Active Sludge	0.460
Average of Treated Effluent by Ozonation	0.380
Average of Treated Effluent by Ferns	0.295

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IV. CONCLUSION

Overcoming to many dangerous effects of introducing hazardous chemical pollutants to the environment can be carried out by applying different applicable treatment methods as done in this research. Hence, based on the capabilities of the three biological absorbents and methods, aquatic ferns and active sludge and ozonation were investigated and optimized. By the results, NO_2^- and NO_3^- could be removed effectively in a more time consuming process by aquatic ferns under agitation speed of 50 rpm and better results were attained in comparison with active sludge and ozonation, this reduction trend was recorded in PO_4^{3-}, NH_4^+ and C_6H_5OH too. All in all, it can be mentioned that the two biological absorbents and ozonation treatment had suitable efficiencies while they were economic environmentally friendly approaches, but the aquatic ferns removal was considerably more in all contaminants removals and based on the kind of industrial wastewater as well as its location where financial costs must be considered the kind of treatment system can be chosen in order to treat and remove the studied chemical pollutants

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