ADVANCED OXIDATION TECHNOLOGIES FOR WASTE WATER REUSE: A REVIEW

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ABSTRACT

Water scarcity, rapid industrialization, growing human population and related issues have seriously affected human health and environmental sustainability. Advanced Oxidation Processes (AOPs) show a promising approach to meet specific objectives of municipal wastewater treatment (MMW).Among all of AOP technologies only ozone/UV, ozone/hydrogen peroxide, ozone/UV/hydrogen peroxide, and hydrogen peroxide/UV are being used on a commercial scale. The germicidal properties of the ultraviolet (UV) light sources have been used in a wide variety of applications. With proper dosage, ultraviolet radiation has proved to be an effective bactericide and virucide for wastewater. In this study, various advanced oxidation combinations are reviewed and discussed.

Keywords –Advance Oxidation Processes, Combinations, Wastewater Reuse

I. INTRODUCTION

Water availability is a challenging problem in some regions all over the world. This problem is aggravated when the lack of rainfall extends over an unusually long period of time. Drought usually results in water shortage that seriously interferes with human activity. Wastewater as a resource should be integrated in the natural cycle of the water use in the near future. [1]

Chemically enhanced methods, in conjunction with, Advanced Oxidation Processes (AOPs) provides an efficient and promising alternative to conventional methods for the treatment of municipal waste water(MWW). These techniques can be used in combination with the conventional methods to increase the overall performance of the wastewater treatment plant (WWTP). [2]The environmental protection of surface and groundwater, including artificial and heavily modified bodies of water, has been urged upon globally.[3]

Continued population growth, contamination of both surface water and ground water, uneven distributions of water resources and periodic droughts have forced water agencies to search for new sources of water supply. [4] In many parts of globe the water reuse is an important element in water resource planning and implementation.

II. PREVIOUS STUDIES

The recycling of domestic wastewater using hydrogen peroxide oxidation, therefractory organic substances in wastewater were decomposed. COD, offensive odor and foaminess in the effluents were reduced with increasing dose. Hydrogen peroxide oxidizes both organic and inorganic pollutants which contribute to BOD and COD. [1]

In Spain, A secondary effluent from a municipal wastewater plant has been treated by means of several processes based on the use of ozone.The system Ozone/hydrogen peroxide(O_3/H_2O_2) slightly enhances COD removal albeit it is capable of significantly increasing the mineralization level up to 70% (35 ppm of ozone at a flow rate of 40 $Lh^{-}1$ in the presence of 0.01 M of H_2O_2).The study was done in Pakistan to compare the effectiveness of used and fresh $H_2O_2$to treat the MWW and to reduce the alum dosefor chemical sedimentation and its effect on COD removal. The combination of H_2O_2 with Ultraviolet light was investigated to observe the effectiveness of integrated treatment of organic matter and coliform bacteria in wastewater.[2]

A study was done on the removal of 22 selected micropollutants in an effluent from amunicipal wastewater treatment plant (MWTP) at pilot scale. Treatments included UV_{254} light alone, UV_{254} + H_2O_2 and UV_{254} +H_2O_2 + Fe^{3+}. Chemicals removal rates were greater than 80% for the majority of the flow rates tested. [5]

Another study focuses on the removal of 32 selected micropollutants(pharmaceuticals, corrosion inhibitors and biocides/pesticides) found in an effluent coming from a municipal wastewater treatment plant (MWTP) based on activated sludge. Iron and H_2O_2 concentrations were also changed in photo-Fenton experiences in order to evaluate its influence on the degradation. As the H_2O_2 concentration increased (10, 25 and 50 mg L^{-1}), best degradations were observed.[6] The role of advanced wastewater treatment in wastewater reclamation and reuse is reviewed in a study. Most of the current wastewater reclamation and reuse technologies are essentially derived from those used in water and wastewater treatment.The reclaimed water can be used in industrial purposes like cooling-system make-up water, process waters, boiler feed water, construction activities and wash-down waters. [7] An ozone and ozone/peroxide oxidation process was evaluated at pilot scale for trace organic contaminant (TOrC) mitigation and N-Nitrosodimethylamine NDMA formation in both drinking water and water reuse applications.[8]

Conductivity measurements can be used to monitor the processes in wastewater treatment that causes changes in conductivity. The processes that in many treatment plants cause changes in conductivity are mainly biological nitrogen removal. Conductivity measurements from two WWTP in a study show no reduction of conductivity in the presedimentation and activated sludge process as 21% and 28% respectively. High conductivity causes corrosion problem in the sewer network. [9]

III. ADVANCED OXIDATION PROCESSES

Advanced Oxidation Processes (AOPs) represent a group of techniques characterized by the generation of radicals, such as the hydroxyl radical (-OH). AOPs are considered competitive water treatment technologies for the degradation of those organic micropollutants which are not removed by biological Treatments. AOPs can be employedin combination with biological treatments for wastewaterremediation, as a pre-treatment, chasing a partial oxidationand an increase of the biodegradabilityor as a post-treatment for the degradation of persistentcompounds

The technologies used to produce the reactive hydroxyl free radical, HO* are as follows:

1. Hydrogen peroxide
2. Ozone/UV
3. Ozone/hydrogen peroxide
4. Ozone/UV/hydrogen peroxide

5. Hydrogen peroxide/UV

The ozone, ultraviolet radiations and hydrogen peroxide are used for producing hydroxyl free radical. The combinations can be given as:

3.1 Hydrogen peroxide

Hydrogen peroxide only can be used for oxidation of wastewater. The process show good results only if wastewater is treated previously by biological proceesess like activated sludge process, trickling filters etc. Hydrogen peroxide had shown good results COD removal. But as compaired to the other combinations hydrogen peroxide only have lower oxidation efficiency.

3.2Ozone + UV

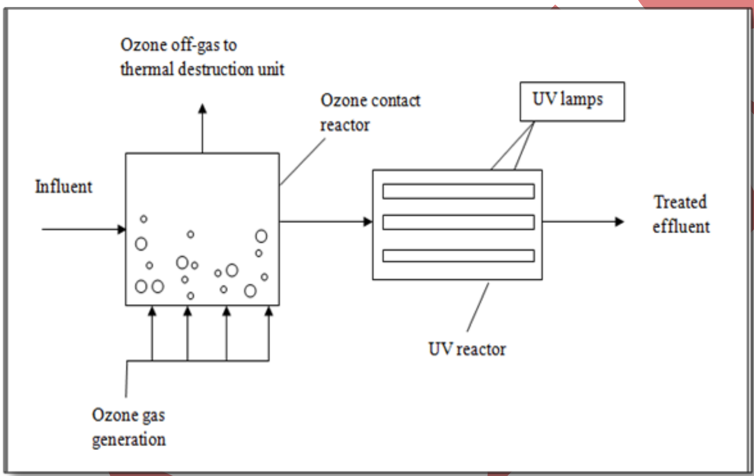

Fig 1: Advanced oxidation process using ozone and UV radiation

Sample collected from municipal wastewater treatment plant. To remove particulate matter coagulation and flocculation alum treatment will be given. The ozone gas will be passed through ozone contact reactor. UV disinfection will be then done by passing water over the UV lamps in UV reactor. Treated effluent then will be collected for testing.

3.3Ozone/Hydrogen peroxide

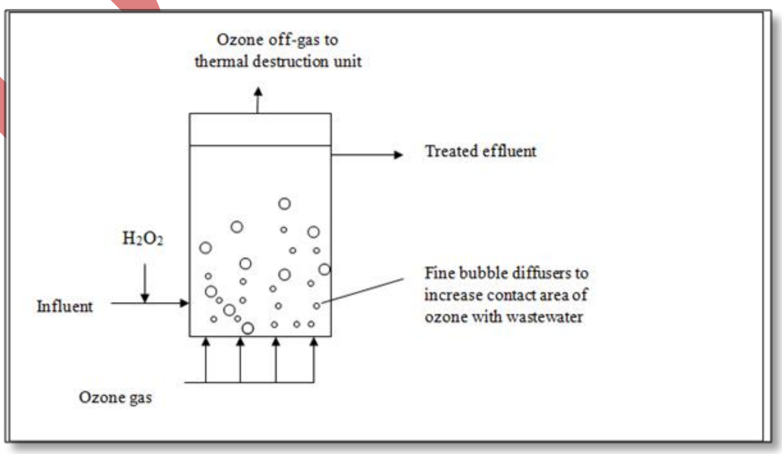

Fig 2:Advanced oxidation process using ozone andHydrogen peroxide

Sample collected from municipal wastewater treatment plant. To remove particulate matter coagulation and flocculation alum treatment will be given. Hydrogen peroxide (H_2O_2) will be directly added. Then ozone gas will be passed through ozone contact reactor. Treated effluent will then be collected for testing.

3.4 Ozone + UV + hydrogen peroxide

Sample collected from municipal wastewater treatment plant. To remove particulate matter coagulation and flocculation alum treatment will be given. Hydrogen peroxide (H_2O_2) will be added in sample. The ozone gas will be passed through ozone contact reactor. UV disinfection will then be done by passing water over the UV lamps in UV reactor. Treated effluent will then be collected for testing.

3.5Hydrogen peroxide/UV

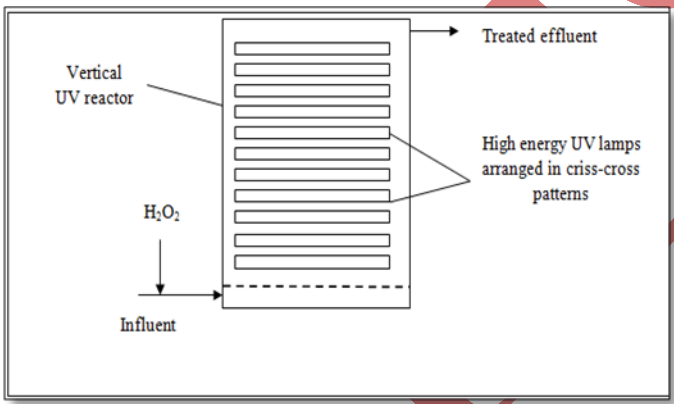

Fig 3:Advanced oxidation process using UV and Hydrogen peroxide

Sample will be collected from municipal wastewater treatment plant. To remove particulate matter coagulation and flocculation alum treatment will be given. Hydrogen peroxide (H_2O_2) will be added in sample. UV disinfection will be then done by passing water over the UV lamps in UV reactor. Treated effluent will then be collected for testing.

IV. WASTEWATER REUSE STANDARDS

Tertiary treatment provides only the additional treatment necessary to meet the desired end use. It is therefore, very important that clear-cut specifications of the reusable water first obtained. The domestic wastewater characteristics are given in table 1.

It is proposed that the methods I will be using to reduce the decided parameters should match with the standard values which are given in the manual.

Some standard values from manual are given below.

Table 1: Cooling water quality guidelines

SN	Parameter	Recommended Value
A)	In makeup water	
1.	pH	6.8-7
2.	Average TDS value With various of 25% per 8 hrs	
	3000mg/L	2
	1000 mg/L	3.5
	500 mg/L	6
3.	BOD (5 day, 20°C)	Less than 5 mg/L
B)	In recirculating water	
1.	Silica (as SiO_2)	Less than 150 mg/L
2.	Phosphates, sulphates	Not to increase solubility limit

The main purposes of reusing waste water are as follows:

- Make up water required for cooling towers.
- Boiler feed water for raising steam or hot water
- Water for selected unit processes and unit operations in the industry.

Reuse as a cooling tower is one of the most common industrial applications of reclaimed sewage water. Typical guidelines for cooling water quality are given in table 2.

Table 2: Requirement of feed water for low and medium pressure

Sr. No	Characteristics	Requirement for boiler pressure Nm/sq. m		
		Up to 2	2.1-3.9	4-5.9
1.	Feed water			
	pH value	8.5-9.5	8.5-9.5	8.5-9.5
	Dissolved Oxygen mg/L, max	0.1	0.02	0.01
2.	Boiler Water			
	pH value	11-12	10-12	10.5-11
	Total alkalinity ($CaCO_3$) mg/L	700	500	300

IV. CONCLUSION

In summary, advanced oxidation technologies can be effectively used in combination with other primary and secondary treatment can help in resolving the problems associated with the availability of water in various purposes as an environmentally. Sustainable solution. Detailed laboratory studies with various combination of advance oxidation process can guide in understanding the economics and efficiencies of the process combinations.

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