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Advance oxidation processes for textile waste water treatment - At a glance

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ABSTRACT

Effluent Quality has became more restrictive day by day as the world wide water authorities has became more aware with this respect. Use of conventional treatment such as biological treatment discharge will no longer be tolerated as 53% of 87 colours are identified as non-bio-degradable. Advance oxidation processes provide great alternatives for better treatment of textile effluent and for the protection of environment. In this paper an overview is considered in respect of basis and treatment efficiency of different AOPs with their special features.

Key words: H_2O_2/UV; 0_3/UV; $0_3/H_2O_2$, $0_3/H_20_2$/UV.

INTRCODUCTION

Main pollution in textile wastewater came from dyeing and finishing processes. These processes require the input of a wide range of chemicals and dyestuffs, which generally are organic compounds of complex structure. Because all of them are not contained in the final product, became waste and caused disposal problems. Major pollutants in textile wastewaters are high upended soilds, chemical oxygen demand, colour, acidity. and other soluble substances (Da -Hee *et al*. 1999).

In addition. only 47 % of 87 of dyestuff are biodegradable (Pagga and, Brown, 1986). Conventional oxidation treatment have found difficulty to oxidize dyestuffs and complex structure of organic compounds at low concentration if they are especially refractory to the oxidants. To ease the stated problems advanced oxidation processes (AOPs) have been developed to generate hydroxyl tree radicals by different techniques. AOPs processes are combination of' ozone O_3 hydrogen peroxide (H_2O_2) and UV irradiation, which showed the greatest promise to treat textile wastewater. These oxidants effectively decolorized dyes, however did not remove COD completely (Ahmet *et al.* 2003 ; Lidia et ill:. , 200 I; Stanislaw *et al.,* 2001 ; Tzitzi *et al*.,1994).

Textile Wastewater Characteristics

Typical characteristic of textile industry

Wastewater are presented in Table I. Results, in Table I show a large extent of variation from plant- to - plant and sample-to-samples. In most cases cases BOD/COD ratio of the composite textile wastewater is around 0.25 that implies that the wastewater contains large amount of non-biodegradable organic matter. Advanced Oxidation Process (AOPs) Advanced oxidation processes are characterized by production of HO. radicals and selectivity of attack which is a useful attribute for

an oxidant. A list of the different possibilities offered by APOs is given in Table3.

Ultraviolet lamp

Since the maximum absorption of ozone molecules is at 253.7 nm, the light source commonly used is a medium-pressure mercury lamp. (Zhou and Smith, 2002).

Application of UV lamp for textile wastewater treatment has been reported by Stanis Law and Monika (1999). They have applied two different UV radiations; 150 W, *11.*= 254-578 om and 15W, A=254 lim, to the synthetic textile wastewater for I to 3 h. They have recorded significant reduction (47 to 30 %) in microbial inhibitory action for optimum radiation time of I hour.

Ozone

Ozone is a powerful oxidant agent for water and wastewater. According to Mehmet and Hassan (2002), (300mg/dm^3) increased the biodegradability of textile wastewater by 1.6 times. Jinaging and Tingwei (2001) documented 11-66 times increase in biodegradability index for wastewater containing azo dye, while this increment reached to 80 times for wastewater containing simulated reactive dye and reactive yellow 84 (Koch *et al*., 2002). These findings revealed that increase in biodegradability index was influenced by type and concentration of dye.

Results presented by a few researchers revealed that ozone decolorize all dyes, except non-soluble disperse and vat dyes which react slowly and take longer time (Namboodri et al., 1994; Marmagne and Coste,1996; Rajeswari, 2000). High colour removal can be achieved on wastewater, which contain high initial dye concentration and low initial COD. Alkaline pH and high temperature were also found as favorable conditions for high TOC and COD removals. In spite of having high colour removal efficiency limited COD and TOC removal efficiencies were obtained. This could be explained by incomplete oxidation of organic materials and production of small organic molecular fragment along with destruction of dyestuff that not being completely oxidized.

O_3/UV

According to Rein (2001), conventional ozonation of organic compounds does not completely oxidize organics to CO_2 and H_2O in many cases. Remaining intermediate products in some solution after oxidation may be as toxic as or even more toxic than initial compound and UV radiation could complete the oxidation reaction by supplement the reaction with it. Hung-Yee and Ching-Rong (1995) documented O_3/UV as the most effective method for decolorizing of dyes comparing with UV oxidation by UV or ozonation alone. Azbar et al. (2004) documented that using O_3/UV process high COD removal would be achieved under basic conditions (pH=9).

H_2O_2/UV

Oxidization of the textile wastewater with hydrogen peroxide alone has been found ineffective at both acid and alkali values (Olcay et al. 1996), while under UV irradiation, H_2O_2 are photolyzed to form two hydroxyl radicals (2OH*) that with organic contaminants (Crittenden et al., 1999). Application of UV to synthetic textile wastewater for one hour with addition 2 ml/L of H_2O_2 decreased the inhibitory of microbial growth during subsequent

Table 1: Composite textile industry wastewater characteristic

Parameters	Values
pH	7.0-9.0
Biochemical Oxygen Demand (mg/L)	80-6000
Chemical Oxygen Demand (mg/L)	150-12000
Total Suspended Solids (mg/L)	15-8000
Total Dissolved Solids (mg/L)	2900-3100
Chloride (mg/L)	1000-1600
Total Kjeldahi Nitrogen (mg/L)	70-80
Colour (Pt-Co)	50-2500

*Sheng and Chi, 1993; Tzitzi *et al.,* 1994; Venceslau *et al.,* 1994; Altinbas *et al.,* 1995; Olcay *et al.,* 1996; Stansilaw and Monika,1999; Gianluca and Nicola, 201; Arslan and Isil, 2002; Arslan *et al.,* 2002; Cleaner Production Program-CPP,2002; Georgiou *et al.,* 2002; Mehmet and Hassan, 2002)

biodegradation of taxtile wastewater form 47 to 26% (Stanislaw and Monike, 1999; Stanislaw; et al., 2001). The relationship between UV light intensity and dye decomposition in UV/H_2O_2 process has been investigated by Shen and Wang (2002). The with increasing UV light intensity. They documented that more than 90% of the dye was decomposed at 82 Wm^{-2}. But for the UV light intensity higher than 102 Wm^{-2}, further increase of UV energy only slightly improved the decomposition efficiency of dye indicating the photons provided was excessive.

O_3/H_2O_2 (PEROXONE)

The addition of both hydrogen peroxide and ozone to wastewater accelerates the decomposition of ozone and enhances production of the hydroxyl radical. At acidic pH, H_2O_2 reacts only very slowly with O_3 whereas at pH values above 5 a strong acceleration of O_3 decomposition by H_2O_2 has been observed (Staehlin and Hoigne, 1982).

At higher pH, even very small concentration of H_2O_2 will be dissociated into HO^{2-} ions that can initiate the ozone decomposition more effectively than OH-ion (Staehlin and Hoigne, 1982; Glaze and Kang, 1989). Tanja et al. (2003) have documented that same dyes achieved decolourisation in 20 min when treated using H_2O_2/Fe^{2+}. This could be due to difference in medium pH. Decolourisation with H_2O_2/Fe^{2+} was performed in an acidic medium (pH=3), whilst for H_2O_2/O_3 in pH= 12. Hydrogen peroxide in alkaline medium react with sodium hydroxide, as a result lower concentrations of hydrogen peroxide are available for the formation of hydroxyl radicals. The inhibitory performance of H_2O_2/O_3 process on microbial growth depended on the H_2O_2 to O_3 mass ratio.

Table 2: Oxidizing potential for conventional oxidizing agents*

Oxidizing agent	Electrochemical oxidation potential (EOP),V	EOP relative to chorine
Fluorine	3.06	2.25
Hydroxyl radical	2.80	2.05
Oxygen (atomic)	2.48	1.78
Ozone	2.08	1.52
Hydrogen peroxide	1.78	1.30
Hypochorite	1.49	1.10
Chlorine	1.36	1.00
Chlorine dioxide	1.27	0.93
Oxygen (molecular)	1.23	0.90

*(Carely, 1992; Teccommentary, 1996; Zhou and Smith 2002; Metcalf and Eddy, 2003)

Table 3: Advanced oxidation processes

H_2O_2/Uv/Fe^{2+} (photo assisted Fenton)
H_2O_2/Fe^{2+} (Fenton)
Ozone/UV (also applicable in the gas phase)
Ozone / H_2O_2
Ozone/UV/H_2O_2
Ozone/TiO_2/Electron-beam irradiation
Ozone/TiO_2/H_2O_2
Ozone+electron-beam irradiation
Ozone/ultrasonics
H_2O_2/UV

$O_3/H_2O_2/UV$

The addition of H_2O_2 to the O_3/UV process accelerates the decomposition of ozone, which results in an increased rate of OH generation (Teccommentary, 1996). Among all AOPs, for dye house wastewater and acetate, polyester fiber dying process effluent combination of HzOz/03/UV appeared to be the most efficient in terms of decolouration (Azbar *et al.,* 2004; Perkowski and Kos, 2003).

In the case of biotreated textile effluent a preliminary ozonation step increased TOC removal trom 0% to 34% but did not appear to be effective than applying a single ozonation process in terms of TOC abatement rates. Increasing dose of H_2O_2 to 32 cm3dm-3 increased the inhibitory to 80% where the optimum ozone dose was about 100 mg dm-3 for effective biodegradation (StanisLaw and Monika, 1999).

CONCLUSIONS

Advanced -Oxidation Processes represent a powerful treatment for refractory and/or toxic pollutants in textile wastewaters. By properly combining ozone, hydrogen peroxide and UV different AOP techniques have been developed thus allowing to make choice the most appropriate for the specific problems. Taking into consideration that the efficiency of AOPs is compound specific, the final choice of the AOP system can be made only after preliminary laboratory tests. There are many research needs to be done in field of AOPS for textile wastewater to provide:

- Study the efficiency of different candidates' process under different controlled conditions.
- Study the sequences operation effect of the AOPs agents.
- Identification of scale-up parameters and criteria for cost effectiveness.

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