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A Brief Insight into Advanced Oxidation Processes for Wastewater Treatment: A Keen and Farsighted Short Overview

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Abstract:
Environmental engineering is undergoing remarkable and awesome challenges. The vision and purpose in writing this review is challenging and groundbreaking. Wastewater and effluent treatment has undergone innovative changes over the years. Traditional wastewater treatment has yielded to modern and path-breaking procedures which are more efficient and effective. The world of difficulties and unknown has opened new avenues and paths to highly feasible effluent treatment procedures. So the vigorous importance of advanced oxidation procedures. Our review will delineate the increasing importance of various advanced oxidation processes including ozonation of textile wastewater. It will open up wide avenues of visionary importance's. Advanced oxidation processes (AOP's) , which involve and includes the in-situ generation of highly potent chemical oxidants such as the hydroxyl radical , have emerged as an important avenue of technologies to accelerate the non-selective oxidation and thus the destruction of a wide range of non-degradable organic contaminants in wastewater which cannot be eliminated biologically. Our review will delineate the difficulties and intricacies of advanced oxidation processes of wastewater particularly textile industry wastewater. Actually, recently, an increasing application of various AOP's for textile wastewater has been observed in contrast to traditional treatment methods. So our urge to investigate this domain of knowledge. A holistic view of the advanced oxidation processes is deliberated and delivered with scientific rigour.

Keywords: oxidation, advanced, dyes, bubble.

1.0 Introduction:
The world of environmental engineering and water research is undergoing dramatic changes and positive challenges because of strict and stringent challenges. A scientist's challenges are growing and demanding. These challenges are growing in the field of wastewater treatment, water treatment and desalination. Pure water shortages are increasing day by day. The contribution of environmental engineer to our society is overcoming the boundaries of scientific rigour and scientific endeavour.The increasing shortage of water resources around the world and in our society increases the demands on the use of secondary sources, such as wastewater effluent. In this perspective water recycling and re-use of treated effluent in high water consuming industrial sectors seem to be a viable alternative to save valuable resources. Advanced wastewater and effluent treatment by ozone and other oxidation technologies has a number of advantages compared to other technologies (Palit,2012, Palit,2012; Pesoutova,2011).

Although some oxidation processes –use of ozone for disinfection of drinking water have been known since the 19th century, the rapid development and application of advanced oxidation processes(AOP's) is a matter of serious concern and an inevitable development in the last decades. AOP's found application mainly in the oxidation of complex organic compounds which are impossible to degrade into simpler organic compounds by biological treatment, primary and secondary treatment. AOP's are based on generation and use of powerful but relatively non-selective highly reactive oxidizing species(primarily the hydroxyl radical $OH^{\prime}$ having high oxidation potential and low selectivity)(Ramesh

Babu,2007,Pesoutova,2011). These radicals are able to oxidize compounds that are not degradable by conventional oxidizing agents as oxygen O_2, ozone O_3 or chlorine Cl_2. The important and vital fact that the OH' radical attack is characterized by low selectivity which is an important factor for a wide and broad application of Advanced Oxidation Processes.(Torabion,2007,Pesoutova,2011). The vision of this paper is to give an indepth and insightful overview of the recent use of ozone and selected AOP in textile wastewater.

2.0 Textile Industry and Its Far-Reaching Vision:

The important fact of the textile industry is that it is water intensive. Water is used through the whole textile production from cleaning of raw material to many washing processes through textile production or as a principal medium in various processes. Processes in the textile industry can be divided into mechanical and finishing operations. During the ongoing mechanical operations fabrics are manufactured from fibres by spinning, weaving and knitting. Sizing is one of the technological steps of weaving of cotton and its blends. In terms of water intake and consumption, mechanical operations are not very demanding. The second process is finishing(wet processing) providing the textiles with the main functional characteristics(appearance, feel, absorbency, softness, water repellance, crease resistance). During finishing a significant amount of water is consumed and also a significant amount of water and pollution are produced. According to the material composition these processes are used – desizing, scouring, bleaching, mercerization, carbonizing,fulling, washing, dyeing, finishing.(Palit,2010,Pesoutova,2011).

3.0 Wastewater Management in Textile Industry:

The main environmental issues arising from textile manufacturing regard primarily emissions to water and air and energy consumption. However , the major environmental concern, challenge and vision in textile industry is the amount of water being discharged as well as its chemical content and load. Water is the principal medium for removing impurities, applying dyes and finishing agents and for steam generation. The primary water consumption reaches 80-100 m^3/ton of finished textile and wastewater discharge 115-175kg of COD/ton of finished textile; a large range of organic chemicals, low biodegradability, colour and salinity in discharged water are also of environmental concern.(Palit,2009,Pesoutova,2011).

4.0 Vision of wastewater management with respect to advanced oxidation process:

Wastewater management is a concerning and disturbing issue to our society and the scientific community as a whole. Advanced oxidation process has a vision which is powerful and pathbreaking. The human society's benefit is scientist's primary goal. In that respect advanced oxidation process is surpassing one frontier over another. Wastewater management is a mind-boggling issue for the environmental scientist anticipating an inevitable breakthrough in the scientific domain and scientific research in environmental engineering. The world of unknown is surely unfolding into an invigorating and innovative vision.(Palit,2011,Pesoutova,2011).

5.0 Use of ozone and other advanced oxidation processes for textile industry wastewater treatment:

Textile industry produces large quantities of highly colored effluent, which is highly toxic and resistant to destruction by conventional treatment methods. Low biodegradability of many fibre acid, direct and reactive dyes allows them to pass untreated through the sewerage works due to their high water solubility and relatively low molecular weight. Important advantage of using AOP and their combinations is the destructive character of AOP to conventional processes such as activated carbon adsorption, coagulation, flocculation or precipitation. Ozonation is relatively effective in decreasing colorization of various dye origins and also reducing toxic effects of textile effluents which is the main environmental concern related to textile wastewater effluent discharge. Ozone dissolved in water reacts with many organic compounds in two different ways: by direct oxidation as molecular ozone or by indirect reaction through formation of secondary oxidant like hydroxyl radical. Use of ozone for wastewater treatment in textile industry to remove coloration and lower toxicity has been documented in several studies; however sufficient effect on BOD/TOC removal was not detailed or confirmed.(Pesoutova,2011).

6.0 Dye and Its Composition:

Commercial dyes used in textile industry can be classified according to their chemicalnature and composition(azo, anthrachinone, sulphur, triphenilmethane, indigoid, phthalocynanine etc), or according to their application class(acid, direct, disperse, metal complex, chrome, reactive etc). Azo dyes are the most commercially used dyes and comprise of a nitrogen double bonds(-N=N-) and when attached to molecules they become monoazo, diazo or polyazo dyes. Azo dyes, with the exception of few simply structured dyes, resist biodegradation under aerobic conditions.(Pesoutova,2011). On the other side , azo bond is vulnerable to reductive cleavage and its degradation products include colourless aromatic amines which are known to be toxic and potentially carcinogenic.

7.0 Vision and Purpose of Ozonation Process:

The main factors affecting ozonation performance are pH, the nature and concentration of oxidisable organics, applied ozone dose, competition between the target compound and biodegradable by-products, the presence of oxidant scavengers and the efficiency of ozone mass-transfer. Although increased ozone doses has a positive effect on decolourisation of acid dye solution effluents and the efficiency of the treatment increases with higher pH(pH range 5-9), an adverse effect on buffered solutions was reported. Increase of the mass transfer rate of ozone and enhancement of efficiency of the ozonation process was achieved by using a microbubble generator that enabled high intensity microbubble solution , utilization of almost all input ozone and faster decolourisation and organic reduction.(Pesoutova,2011).

8.0 Usefulness of Ozone and Hydrogen Peroxide for Textile Industry Wastewater Treatment:

Hydrogen peroxide is comparatively inexpensive, readily available chemical oxidant that accelerates decomposition of ozone and enhances formation of hydroxyl radical. The addition of both hydrogen peroxide and ozone to wastewater accelerates decomposition of ozone and enhances production of hydroxyl radical.H_2O_2 acts as a catalyst and accelerates the decomposition of ozone to hydroxyl radical. Rapid and total decolourisation of textile industry effluent can be achieved, however this combination like use of ozone alone is not able to bring complete mineralization either (Pesoutova,2011).

9.0 Ozone with UV light:

UV-based advanced oxidation processes are based on formation of hydroxyl radicals OH' through the direct ozonation and photolysis reactions and hydroxyl radical oxidation. Ozone combined with UV light demonstrated to be effective mean for textile wastewater treatment.

10.0 Vision of Advanced Oxidation Process as an Effective Dye Degradation Procedure:

Advanced oxidation process as well as ozonation is one of the most path-breaking ventures of environmental engineering science. Innovation and intuition are the hallmarks of scientific and engineering research pursuits. Research endeavours in this domain of engineering science is vast and versatile. The world of unknown in this domain of engineering is slowly unfolding. It has been proved scientifically that dye wastewater removal and degradation is effective with the application of advanced oxidation process and ozone as a catalyst. Scientific rigours are opening up new avenues of innovation and success. The vision of this area of science is immense and groundbreaking.(Palit,2009,Palit,2011,Pesoutova,2011).

11.0 Doctrine and Ultimate Vision of Advanced Oxidation Processes:

A scientist's vision is so far-reaching and path-breaking. It is crossing one frontier over another. The vision of advanced oxidation is creating miracles in our scientific endeavour. The journey is versatile, groundbreaking and inspiring. The awe is widening the path of vision and path of innovation. Environmental pollution control is the next generation science and technology. With stringent regulations, environmental engineering and its tertiary treatment procedures such as advanced oxidation processes is opening up the windows of scientific struggle and scientific endeavour. Literature research and scientific rigour has proved the vitality and relentless boundaries of advanced oxidation processes. The world of environmental engineering will be witnessing miracles in the years to come.

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