INTRODUCTION

The burgeoning world population with growing industrial and manufacturing demands has led to a scenario where the protection and safeguarding of the environment has become a burning issue. It has become a critical factor for several industrial processes which will have to meet the requirements of a sustainable society. In such a situation, Green technology will play a crucial role. Chemical processes where there is best available technology not involving costs will substitute classical processes. This environmentally friendly strategy minimizes the use or generation of hazardous substances in the design and manufacture of chemical products. The objective of this article is to present the role played by environmental chemistry and environmental engineering is discovering environmentally friendly strategies and to discuss the potentialities of ozone applications and advanced oxidation processes.

Advanced oxidation process (AOP’s) and ozonation

The goal and objective of any AOP’s design is to generate and apply hydroxyl free radical (HO•) as strong oxidant to destroy compound that cannot be oxidized by conventional oxidant. The goal and vision of advanced oxidation processes is radicals and the selectivity- selectivity of attack which is a useful positive side for an oxidant. AOP is very much versatile and intensive scientific endeavour since they provide possible and different ways for OH• radicals.

Advanced oxidation processes are pathbreaking areas of environmental science and technology. Its visionary importance can be exemplified by the fact that dye degradation with the help of ozonation can be highly increased. This particular example is that of ozone- oxidation or ozonation of dye effluents in textile industries. 53% of 87 colours are identified as non-biodegradable. Here ozonation or advanced oxidation process plays a crucial role. Ozone is a powerful oxidant agent for water and wastewater. Once dissolved in water, ozone reacts with a great number of organic compounds in two different processes; by direct oxidation as molecular ozone or by indirect reaction through formation of secondary oxidants like hydroxyl radical. This brings us to the importance of bubble column reactor or conventional bubble contactor. This is because of its high ozone transfer efficiency (90%) and high performance.

Advanced Oxidation Technologies and its visionary importance

The appearance of compounds that are difficult to degrade and destroy by conventional chemical and/or biological methods (toxic, mutagenic, carcinogenic pollutants) in natural waters recently created a pressing need for the development of efficient water treatment processes. The search for a solution to this problem has involved extensive examinations in the field of advanced oxidation(AOP’s). In chemical oxidation processes, reaction mechanisms change structure, and chemical properties of the organic substances. Molecules break in

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smaller fragments; higher percent of oxygen appears in these molecules in form of alcohols, carboxylic acids etc. Oxidation of organic compounds with oxidation such as ozone or OH radicals usually yields more oxidized ones which are in most cases more easily biodegradable than the former ones. This is the general idea that yields to the combination of a chemical oxidation processes. Oxidation with ozone or hydrogen peroxide has been found to be an alternative to chlorination, because the oxidation does not result in toxic chlorinated organic compounds.

Review of research work done in the domain of ozonation or ozone-oxidation (advanced oxidation processes)

Saras et al (1998) delineated the treatment of a wastewater resulting from dyes manufacturing with ozone and chemical coagulation. The degradation of the compounds present in a previously chlorinated wastewater resulting from the production of azoic dyes has been studied in this project. Towards this end, the first step developed was the characterization of the spillage water by GC/MS and GC/FID. Secondly, a combined ozone + Ca(OH)2 treatment was carried out determining its efficiency on this wastewater. Chu et al (2000)7 dealt with the advanced oxidation process of ozonation of dye and its kinetics. A quantitative estimation of direct ozonation and indirect free radical oxidation of dyes with assorted chromophores was studied through the examination of reaction kinetics in the ozonation procedure. The reaction kinetics of dye ozonation under different conditions was determined by adjusting the ozone doses, dye concentration and reaction pH. According to their research, the ozonation of dyes was found dominant by pseudo-first order reaction and the rate constants decreased as the dye/ozone ratio increased. They made a quantitative prediction of direct and indirect dye ozonation kinetics. In 2001 Ciardelli et al (2001)8 studied on the treatment and reuse of wastewater in the textile industry by means of ozonation and electroflocculation. Two different oxidation treatments, ozonation and electroflocculation, were experimented on a pilot scale to test their efficiency in removing polluting substances from wastewaters of textile industries. Both pilot plants used reproduced very closely a full –scale treatment in order to obtain indications about the feasibility of a transfer on industrial scale. By means of ozone treatment very high colour removal (95-99%) was achieved and treated waters were reused satisfactorily in dyeing even with light colours. Talarposhti et al (2001)3 delineated on the topic of colour removal from a simulated dye wastewater using a two-phase anaerobic packed bed reactor. According to them, the treatment alternatives applicable for the removal of colour vary, depending upon the type of dye wastewater. A synthetic simulated mixed dye waste (Basic Yellow 28, Basic Yellow 21, Basic Red 18.1, Basic Violet Red 16, Basic Red 46, Basic Blue 16, Basic Blue 41) representing a known waste from a fibre production factory, was investigated. The biological process of anaerobic digestion has been recognised as a simple and energy-efficient means of treating and stabilising a wide range of organic industrial wastewaters. Their study sets out to demonstrate the effect of different loading rates, dye concentrations and hydraulic retention times (HRTs) on colour removal efficiency under mesophilic anaerobic conditions. Wu et al (2001)5 studied the ozonation of aqueous azo dye in a semi-batch reactor. Results showed that the rate of ozone transfer increased with increases in the initial dye concentration, the applied ozone dose and temperature. A model was developed to predict the enhancement factor of ozone mass transfer. This model which they developed enables the prediction of mass transfer coefficient of ozone from the following parameters: initial dye concentration, applied ozone dose, temperature and concentration of dissolved in the organic-free water. The present model was also valid for reactors of larger sizes. The results of kinetic studies showed that ozonation of the azo dye was a pseudo-first-order reaction with respect of dye. The apparent rate constant increased with the applied ozone dose and temperature. In addition, ozonation reduced chemical oxygen demand and enhanced the biodegradability of the wastewater.

Vision behind ozonation and advanced oxidation process

A scientist’s vision is massive, instinctive and innovative. He is surpassing one frontier over another. The vision and objective of environmental engineering of today is a vision of tomorrow. The world of environmental engineering and environmental chemistry is opening up new frontiers every day. Both ozonation and advanced oxidation processes are innovative areas of science and technology. It has been found to be extremely efficient in treating dye effluents from textile industries7, 8. Conversion levels are also found to be very high. High level research is being pursued in every country of the world. Research in new areas of innovation will open up new domains of science and innovation in our wider future. A scientist’s vision will be widened if we pursue rigorous research in these areas.

Future vision in the path of success

Man’s vision is absolutely great and path-breaking. The fruits of science and technology should reach grassroots level. That is scientist’s sole objective. The fruits of science or environmental engineering will reach the common mass or the society as a whole if the procedure is effective and visionary. Ozonation or advanced oxidation processes will open up new vistas in the area of environmental engineering science. It has been scientifically proved that ozonation or other advanced oxidation processes are effective and bore fruits to the scientific community and the society. New innovations and new advances in this research domain will usher in a new dawn of scientific progress.

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Reference

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