ISSN (O) : 2582-3271
PubMed-National Library of Medicine - ID: 101766917

International Journal of Dental Science and Clinical Research (IJDSCR)

Dr. Angel Vaidic Publication

Available Online at: http://www.ijdscr.org

Volume – 2, Issue – 3, May – June – 2020, Page No. : 01 - 04

Wastewater Use In Treatment Of Advanced Oxidation Process

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Citation Of This Article: Dr. Chandan Thakur, Dr. Pappu Yadav, "Mucogingival Flap Technique With Fish Derived Collagen Matrix And Connective Tissue Graft In Treatment Of Mandibular", IJDSCR May- June - 2020, Vo2. – 2, Issue - 3, P. No. 01-04.

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Advance oxidation process (AOP) is a technology of wastewater treatment that utilizes the hydroxyl radical (OH•) for the removal of recalcitrant organic matters from industrial as well as municipal wastewater. This AOP technology was first introduced in 1980s for water treatment and later was widely used for treatment of different wastewater. This technology can degrade less reactive toxic pollutants like phenols, synthetic dyes, petroleum, organic compounds, pesticides and aromatics into biodegradable components which can be further treated by conventional biological treatment. The OH•

Keywords

Advance oxidation process; Hydroxyl radical; Organic matter; Wastewater treatment

Introduction

The increasing world population, improving living standards, changing consumption patterns, and expansion of irrigated agriculture are the main driving forces for the rising global demand for water and lack of fresh water resources to meet water demand.

Aop Technologies

AOPs can be divided into established and emerging technologies based on the existing literature and the water treatment industry's experience with the technology. Emerging technologies are defined here as technologies that have very limited, if any, full-scale applications in drinking water treatment. The following AOPs technologies are discussed in this report: Each of the above AOPs technologies is evaluated in Section on the basis of its performance reported in the engineering literature, results of manufacturer or vendor studies, and the industry's experience with the technology.

Sulfate Radical-Based Aops

$S_2O_8^{2-}$ itself is a strong oxidant with a standard oxidation potential (Eo) of 2.01V (Kolthoff IM, Stenger VA, Belcher R. Volumetric analysis. 2.Titration methods: acid–base, precipitation, and complex formation reactions. Interscience Publ; 1947, Huling SG, Pivetz BE. In-situ chemical oxidation; DTIC Document. 2006.). Once activated by heat, ultraviolet (UV) irradiation, transitional metals, or

Ozone-Based Aops

There has been an increasing interest in the last decades in using ozone to treat effluents containing hazardous pollutants with the development of large-scale ozone generators along with reduced installation and operating costs. Ozonated water is more efficient in pollutant degradation and it is not harmful for most of the organisms, because no strange compounds are added to treated waters. Ozone (O_3) is a strong oxidant itself with an oxidation potential of 2.07 V. However, direct O_3 oxidation is a selective reaction, in which O_3 preferentially reacts with the ionized and dissociated form of organic compounds, rather than the neutral form. Under certain conditions, OH· is produced from O_3 to initiate the indiscriminate oxidation (indirect mechanisms). Its oxidizing power and the absence of hazardous decomposition products, ozone is a potential pre-treatment agent to transform refractory compounds into substances that can be further removed by conventional methods. Ozonation has been widely used for drinking water disinfection—bacterial sterilization, odor, algae, and tri-halomethane removal and organic compound degradation but its application to wastewater treatment is limited due to its high energy demand.

Fenton-Related Aops

One of the most efficient AOPs is the use of Fenton and photo-Fenton. Fenton reactions have been extensively studied for the degradation of wide range of pollutants and emerging contaminants. Fenton reaction is an eco-friendly process and does not require any harmful reagents.

In this study, the COD removal and Dye removal efficiencies of homogeneous and heterogeneous

Photo-Fenton process are compared for the treatment of synthetic textile wastewater. The effect of parameters like pH, catalyst dosage, H_2O_2 dosage and UV power are evaluated using Taguchi's experimental design. In heterogeneous photo-Fenton process copper modified iron oxide is used as the catalyst. Heterogeneous photo-Fenton process is more efficient than homogeneous for COD removal and colour removal. The heterogeneous process showed the highest removal efficiencies under optimum condition with COD removal of 62% and Dye removal of 85%.For homogeneous photo-Fenton process COD removal and Dye removal are 47% and 82% respectively. Also it is found that the sludge formation is less in heterogeneous photo-Fenton process compared to homogeneous method.

Recently, the use of fine and ultra-fine bubbling technologies has been extensively used for improving ozone-based AOPs for water and wastewater treatment. Microbubble (MNBs) enhance the ozone mass transfer in water and therefore speed up oxidation of the organic compounds, and also decrease the loss of ozone. Ozone MNBs effectively generate hydroxyl radicals that are highly effective in decomposing the organic molecules in both acidic and alkaline water environment.

Solar photo-Fenton is another AOP widely used in combination with an aerobic biological system for the treatment of pharmaceutical wastewater. For example, a combined solar photo catalytic–biological pilot-plant system was employed to enhance the biodegradability and complete mineralization of a biorecalcitrant industrial compound (αmethylphenylglycine, a common pharmaceuticals precursor), dissolved in distilled water and simulated seawater at 500 mg/L (Oller et al., 2007a)

UV-Based Aops

In the UV peroxide process UV spectrum photons react with hydrogen peroxide to form hydroxyl radicals as shown by the simplified reaction below:

$H_2O_2 \rightarrow 2 \bullet OH$ (in the presence of UV light)

The major components of a H_2O_2/UV system include: UV lamps, lamp sleeves, and lamp cleaning system, hydrogen peroxide storage and injection system, reactor chamber, in-line mixer, supply and discharge pumps and piping, monitoring and control systems. For the H_2O_2/UV system, higher

Electrochemical Aops

Electrochemical methods are clean and effective techniques for the direct production (anodic oxidation) or indirect generation via Fenton's reagent (electro-Fenton) of hydroxyl radicals. In anodic oxidation these radicals are formed from water oxidation on a high O_2-overvoltage anode such as a Pt, PbO_2 and boron-doped diamond(BDD) electrode. The electro-Fenton method corresponds to a coupling between the Fenton's reagent and electrochemistry in which H_2O_2 electron generated at the cathode reacts with Fe^{2+} present in the medium leading to the formation of hydroxyl radicals from Fenton's reaction

Sonolysis Aops

The chemical effects of ultrasound on aqueous solutions have been studied for many years. The primary products are H_2 and H_2O_2; there is strong evidence for various high-energy intermediates, including H_2O, H·, OH

Conclusion

Advanced oxidation processes have emerged as an important approach to treat wastewater. Majority of the processes for wastewater treatment are physicochemical in nature, physical or chemical processes or combine both. As one of the advanced methods, AOPs are based on a basic principle that entails the generation and use of a hydroxyl free radical (HO*) as a strong oxidant for the destruction of compounds which cannot be oxidized using conventional oxidants. AOPs have shown premises in various water treatment sectors due to its superior efficiency in pollutant elimination. eliminated. Ultimate degradation: (Mineralization) conversion of organic carbon to CO_2. since we are reviewing AOPs we hardly recommend it to be used in pharmaceuticals industries due to it's capacity to remove taste and odor compounds, and reduce disinfection byproduct precursors in both drinking water and reclaimed water treatment. In most cases, organic pollutants are completely mineralized by AOPs but are partially oxidized into transformation products (TPs), being ubiquitously detected in the treated water and adding complexity to the cocktail of the treated water.

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