Removal of Acid Orange 7 Dye from Wastewater: Review

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Abstract

The most recent removal methods for the removal of Acid Orange 7 (AO7) dye from wastewater are complied. Microbial bio-degradation, chemical decomposition by oxidation, photo-degradation and adsorption by various adsorbents are various methods used in removal of AO7. The advantages and disadvantages of the various methods are discussed and there efficiencies are compared.

Synthetic dyes are extensively used in many industrial fields, such as dyestuffs, textile, paper and plastics. It is estimated that there are around 100,000 commercially available dyes with over 7×105 tons of dyestuff are produced annually . Synthetic dyes exhibit considerable structural diversity, and, on an industrial scale, they can be classified into azo, anthraquinone, sulfur, indigo, triphenylmethyl (trityl), and phthalocyanine derivatives . The majority of synthetic dyes currently used in the industry are azo dyes and their derivatives because they are highly stable during washing, lightfast and not susceptible to degradation under natural conditions . Azo dyes contain one or more azo bonds (-N=N-) as chromophore groups linked to aromatic structures with functional groups such as –OH, and -SO3H . Even small amounts of dyes (of the order of a few ppm) are undesirable as they colorize water, make it look unaesthetic, and disturb life processes in it. Most dyes are non-biodegradable, hinder sunlight penetration and inhibit the photosynthesis process and increase the chemical and the biological demand for oxygen. Therefore, water ecosystems are disturbed . Anionic azo dyes, in the presence of a sulfonate (SO3-) groups, will become strongly water solubilizing substituents. In aqueous solution, the negatively charged anionic azo dyes exist over a broad pH range. Anionic monoazo dyes and their metal salts are widely used on dyeing papers and leather, or as pigments . Among monoazo dyes acid orange 7 [p-(2-hydroxy-1-napththylazo) benzene sulfonic acid] is the most commonly used anionic dye because it is water soluble. Acid orange 7 (AO7) is also well known, inexpensive and dyes rather quickly in weak acidic solution. Because of these properties, it is extensively used for dying a variety of materials such as nylon, aluminum, detergents, cosmetics, wool and silk . Like most other azo dyes, acid orange 7 tends to be disposed in industrial waste water and possess health threats to humans . It is highly toxic, and its ingestion can cause eye, skin, mucous membrane, and upper respiratory tract irritations; severe headaches; dizziness; nausea; and loss of bone marrow leading to anemia . Its consumption can also prove fatal, as it is carcinogenic in nature and can lead to tumors. AO7 tends to withdraw electrons from the azo group, leading to a deficiency of electrons, thereby reducing it to carcinogenic amino compounds. The reduction of AO7 produces 1-amino-2-naphthol, which has been reported to induce bladder tumors . Inside the human body AO7 can also easily undergo enzymatic breakdown, along with reduction, and forms aromatic amines, which, upon exposure, can cause methemoglobinemia. The intermediate amines thus formed also tend to oxidize the heme iron of hemoglobin from Fe (II) to Fe (III) and block oxygen binding, resulting in some characteristic symptoms such as cyanosis of lip and nose, weakness, and dizziness . Purification of waste water containing AO7 dyes is becoming a more important goal to avoid the potential threats to the environment. The discharge of waste water contaminated by AO7 azo dyes is strictly regulated in many countries for aesthetic reasons and because of breakdown products which are toxic and mutagenic . Because of the toxicity and carcinogenic nature of the AO7, researchers have tried biological, chemical and/or physical decolorization techniques (oxidation, coagulation, flotation. and sorption, respectively) to remove this colored effluent . Considering the effects of AO7, removal of AO7 has been attempted using different biodegradation methods. Biological treatment is the most economical, valuable, and simple method of decolorization of azo dyes when compared with other physical and chemical procedures. Even though it is an economically attractive process, drawbacks exist. Besides being a slow process, the method also needs optimally favorable conditions, certain nutrition requirements, and large area for AO7 to decolorize. This leads to less flexibility in design and operation of biological decolorization methods. Anaerobic decolorization of AO7 uses a pure bacterial or mixed microbial consortium which leads to increase the toxicity of AO7 by nearly 100-fold, (AO7 EC50=15.7 mg/L and AO7 with E. faecalis EC50=0.2 mg/L) due to the production of 1-amino-2naphthol (EC50 0.1 mg/L) . Co–metabolism in a Microbial Fuel Cell (MFC) (S. oneidensis) utilized rapid AO7 decolorization kinetics at low to moderate AO7 concentrations. The decolourization kinetics constants (k) observed in the study above is comparable or better in comparison to that of other studies utilizing pure or mixed microbial cultures.

This review article presented current publications in the field of the removal of AO7 azo dye from wastewater with help of adsorption, oxidation and biodegradation. All the decolorization methods discussed on removal of AO7 have advantages and drawbacks. most economically valuable choices compared with

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other treatment techniques, due to the less running cost. However, biological treatment required long processing time to yield complete removal of AO7 colour and mineralization of the byproducts. Another drawback of biodegradation, with increasing AO7 initial concentration more toxic products are tend to make and finial toxicity level increase. Wide ranges of natural adsorbents were used on aqueous wastewater systems for the removal of AO7, due to there are inexpensive, locally available and effective material could be used in place activated carbon. Among non–conventional and conventional adsorbents, chitosan and anion exchange with quaternary ammonium ions, were able to show higher adsorption capacities on removal of AO7. Although much has been accomplished in the area of removal of AO7, much work is necessary on improving the adsorption capacity of AO7 and demonstrates the use of treatment methods on large scale. Among adsorption and biological methods, advance oxidation techniques are still a costly-comparative substitute for the treatment of AO7 wastewaters and wildly able to practice by the small and large scale industries. Main disadvantage of oxidation treatment is the formation of toxic products, during degradation process. However, until to date the applicability of adsorption, oxidation and biodegradation methods for the removal of AO7 is very limited on industrial level. More and more studies required to estimate their application for colour removal of AO7 particularly, their performance at higher concentration of AO7, pH, organic matter and heavy metal etc.

Keywords: Acid orange 7; Wastewater; Adsorption; Oxidation; Biodegradation