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Elimination of Dyes from Waste Water via Adsorption Materials - A Mini Review

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Abstract

The problem with waste waters containing dyes is that these impurities impart acute and/or chronic consequences once exposed to living organism. The results of this exposure depend upon dye concentration, exposure time, besides their ability to absorb/reflect sunlight entering in to the aqueous media. Thus the concentration of these organic dyes leads to severe effects on the growth of aquatic life as well as other living organism that found entrance. Unlike the existing reports which present chemical decomposition by oxidation, photodegradation, microbial decoloration, use of activated sludge, etc., here in this work we have purely highlighted the cost-effective and easy to handle approach (adsorption) for the removal of dyes from the waster waters. Conclusions have been drawn from the compiled literature and few crucial points regarding futuristic research for the removal of dyes have been presented.

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Introduction

Organic and Inorganic dyes discharged from various industries result in a variety of hazards and environmental issues across the globe. These chemical entities are not only aesthetically displeasing but also hamper the sunlight dissemination into the streams, thus affecting the aquatic ecosystem. The organic chemistry of dye revealsa complex aromatic molecular framework which imparts them extreme stability and non biodegradability. Wastewater containing these dyes is very difficult to deal with, since these materials are defiant to aerobic digestion, and are stable to light, heat besides oxidizing agents[1]. Furthermore, dyes are usually toxic to microorganisms, and may perhaps cause destruction or reticence of their catalytic properties. Consequently, environmental contamination which comes into existence due to these dyes is a serious problem attributed to their negative eco-toxicological effects, bioaccumulations

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besides laying thebasis of eutrophication[2]. It is estimated that to an approximation almost 20 % of these dyes enter into the industrial waste waters during manufacturing and processing[3]. The effect is further aggravated due to the fact that waste water restrained with these dye materials is difficult to get rid of because of their inert properties and low concentration. They are resistant to aerobic digestion, stable to light, heat and oxidizing agents. Industries such as textile, leather, paper, plastics, cosmetics, paint and pharmaceuticals use dyes in order to color their manufactured goods and also devour substantial amount of water.This sometimes results in the generation of considerable amount of colored waste water. It has been reported that over 7×10^5 tonnes is the outcome of dye stuff annually from more than thousands of marketed dyes[4]. Hence substantial release of dyes in the ecosystem is of great concern in the scientific community all over the world. In addition to these, many dyes entering in to the water are difficult to decompose and are a source of carcinogenicity in water[5-7]. Due to increasingly stringent constraint on the organic contents of industrial effluents it is essential to get rid of dyes form waste waters before it is expulsed.

The problem with waste waters containing dye material is that they can impart acute and/or chronic effects on the living organisms which get exposed to them. The aliments which are outcome of this exposure depend on the dye concentration as well as the exposure time.The chronic effects also depend on their ability to absorb/reflect sunlight entering the water. This leaves drastic effects on the growth of bacteria and upsets their biological activity. Sometimes in wastewater colorants undergo chemical and biological modifications, devour dissolved oxygen (DO) from the stream and destroy the life which prevails in water ecosystems. Above and beyond, they have the tendency to impound metal ions, hencecreate micro toxicity to fish and other organisms.

Some of the dyes like Mthylene blue (MB) is of utter importance from medical and dying purpose but can cause serious optical injuries in human as well as animals. It can cause breathlessness or difficult breathing; oral ingestion causes nausea, vomiting, diarrhea, gastritis, mental confusion (methemoglobinemia) along with burning sensation[7-8]. Similarly other dyes like Crystal violet, is extensively used, and besides suspected to possess cancer causing consequences. In addition to all this, it has been marked to be a recalcitrant molecule as it is a poorly metabolized by microbes and non-biodegradable. It is proposed to be thebasis for permanent injury to eyes, including cornea and conjunctiva. Brilliant Green, a dye used for the production of the cover paper in paper industry is responsible for the irritation of the gastrointestinal track followed by symptoms like vomiting, nausea and diarrhea. It is also accountable for the irritation to respiratory track, leading cough and shortness to breath.Thus there exists a range of dyes which need to be removed from industrial effluent; this at the moment is considered to be one of the major environmental concerns.

Methods Adopted

Researchers have adopted a number of conventional treatments for the removal these dyes; these involve conduction of range of investigations on their physico-chemical properties. The developed approaches utilize the use of coagulants[10], oxidizing agents[11], ultra-filtration[12], electro-chemical[13-14] and adsorption[15] based approaches. However, owing to the economic inconvenience, above means are not widely used. Besides all these, electrochemical and coagulation based methods are barely practicable when it comes to their large scale applications.

Amongst all, strategies which adopt adsorption have been recognized to display a enormous due owing to the ease with which it operates, simplicity in design, towering efficiency and insensitivity towards toxic substances. Adsorption also provides an attractive alternative for removal of dye stuff from waste water, especially when the material utilized for adsorption is inexpensive and readily available in the day to day life. Thus, the removal of dyes and related organic materials by an economical means remains an important concern irrespective of presence of a large number of systems intended for adsorption. However the good adsorbent for good adsorption should have some specified properties such as cost effective, availability in bulk, high adsorption capacity.

Activated carbon adsorption presents one such extremely effectual means of removing dyes and pigments[16], however its extensive usage is often

restricted due to the fact that it proves uneconomical. the use of low-cost adsorbents, such as clay minerals[17], bottom and fly ash[18-20], fungi[21], waste materials from agriculture representing an essential target for these countries[22-24]. Various groups of researchers sincea decade have mainly focused on the adsorption of various classes of dyes (acid, basic, reactive, and metal complex based) utilizing saw dust of different woods: beech, walnut, rubber wood and cherry tree. Other materials available in the surroundings include pine, cedar, clay-wood sawdust mixture, Indian rosewood, treated sawdust spruce sawdust magnetically modified, charred and oak. In spite of all these, still some difficulties are still prevailing in its removal from the waste water like low removal capacity. In addition to these, zeolite materials present another attractive alternative to more costly adsorbents for removal of dyes from industrial waste water[25].

Conclusions and Future Aspects

The elimination of organic dye material from the waste water is an active area of research and there has been marvelous focus on the use of suitable low cost adsorbents. We believe utilization of by-products from the agriculture and industrial waste may prove advantageous in terms of adsorption performance, vast abundance, and little processing requirement and are inexpensively. Bedsides, fly ash synthesized Zeolitic adsorbent materials presents another potential alternative to activated carbon for treatment of waste water contaminated with organic dyes. In conclusion, we believe use of thrown away materials like fly ash, agro industrial waster (Willow Sawdust) which is usually available in bulk in the surroundingsmayproven deal in order to overcome the shortcomings associated with existing methods. We hope this mini review inspires researchers with unique analytical, synthetic and physical chemistry tools, to delve into this crucial problem of interest.

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Conflict of interest

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