Degradation of Methylene Blue by Chitosan Alumina Composite using Sunlight Irradiation

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Abstract

In this present work the photo degradation ability of the Chitosan Alumina Composite is analysed with Methylene Blue dye using sunlight irradiation by varying the contact time, pH, adsorbent dosage and initial dye concentration. The maximum percentage of dye degradation of Methylene Blue onto CAC is obtained at pH 9 in 270 minutes. The optimum condition for the Methylene Blue dye degradation is 0.15g dosage of CAC and the concentration of the dye is 20 ppm.

The degradation of Methylene Blue on CAC is explained by Langmuir and Freundlich isotherm. Adsorption of Methylene Blue onto CAC is favourable for Langmuir and Freundlich isotherms. The q_e value of CAC is 17.78 mg/g. From the results, it follows the pseudo first order kinetics. Chitosan Alumina Composite could be effectively used for the cationic dye degradation.

Keywords: Chitosan Alumina Composite (CAC), Methylene Blue, Photo degradation, Kinetics, Isotherms.

Introduction

Nowadays the use of synthetic dyes increased due to industrialization and urbanization. Discharge of these dyes from various industries like paper, leather, textile, cosmetics and food into the water resources cause many adverse effects to human beings, animals and plants. It also destroys the aesthetic nature of the environment [1-4]. Annually, more than 7,00,000 tonnes of dye stuffs are generated from various industries[5]. Methylene blue (Basic blue 9) is the most commonly used classical cationic dye with λ_{max} value of 663nm and it is used for dyeing in cotton, silk, leather and cellulosic fibers[6,7].

It has three mesomeric structures in which the positive charge is replaced either on the sulphur atom or amine nitrogen atom. It is water soluble, dark green crystalline solid and it gives Methylene Blue cations and chloride ion in solution. Methylene Blue is blue colour in oxidizing environment, it is readily reduced by reducing agents and it becomes colourless (Leuco form). It causes eye burns, cancer, skin irritation, breathing problems, increased heart rates on inhalation, headache, fever, vomiting, bladder irritation etc.[8,9] It is necessary to remove methylene blue from the industrial effluent. Numbers of attempts have been made by the previous researchers as methylene blue health effect as a pollutant in wastewater through the application and development of different adsorbents for its degradation ability[10].

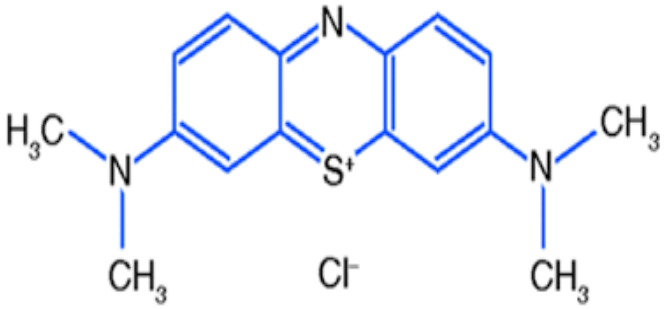

Fig. 1: Chemical structure of Methylene blue

Different techniques are available to treat the Methylene Blue dye wastewater such as coagulation, filtration, adsorption, electro coagulation, reverse osmosis, biological degradation, photo chemical degradation, flocculation and degradation using sunlight irradiation[11-15]. Among these methods, sunlight irradiation is effective and new technique particularly for the non-degradable dyes.[16-18] Solar energy has much potential to provide for the future energy needs and exploitation of this alternate energy resources is necessary. A number of adsorbents have been reported to degrade the dye. Activated carbon is the commonly used material for the wastewater treatment because it has a large surface area, variable characteristics of surface chemistry and porosity. The main drawback of the activated carbon is more expensive than other adsorbents[19].

The cost is decreased by number of attempts, so it has been made to find more alternative, low cost adsorbents like activated carbon prepared from Neem Leaves[20], Activated Carbon[21], Brazil nut shells[22], Garlic Peels[23], Rice Husk[24], Water Hyacinth Root Powder[25], Wheat Shells[26], Guava Seed[27], Wheat bran[28] etc. Recently, bio sorbent materials like fungal biopolymers are used[29,30].

So chitosan, a cationic polymer from natural resources has received much interest of the researchers due to its less cost, biodegradability, nontoxic and environment friendly qualities[31]. Chitosan is a straight chain copolymer made of (1-4)-linked D-Glucosamine and N-Acetyl - D-Glucosamine. Deacetylation of chitin yields chitosan. Chitosan is the second abundant polymer in nature after the cellulose[32].