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Photocatalytic Degradation of Methylene Blue Dye Using Chitosan Silica Composite

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The ability of chitosan silica composite for the degradation of methylene blue dye from aqueous solution is studied by direct sunlight irradiation. Batch mode adsorption experiments are carried out to know the degradation capacity of the composite. Maximum removal efficiency 89.05 % of methylene blue is achieved at pH 10 with composite dosage of 0.1 g. Langmuir and Freundlich adsorption isotherm models are used to fit the obtained adsorption data. The maximum adsorption capacity is found to be 11.467 mg/g for the adsorption of methylene blue. The kinetic data is well fitted with pseudo first order kinetics. Degradation ability of methylene blue is confirmed by UV spectra studies.

Keywords: Degradation, Chitosan silica composite, Adsorption isotherms, Methylene blue.

INTRODUCTION

Among all the industrial wastewater the textile water is one of the most polluted water and it cause many unfavourable effects to the living environment [1]. Methylene blue is a thiazine (monovalent cationic) dye most commonly employed in dyeing cotton, silk, leather and cellulosic fibers. Methylene blue is not a toxic dye but it causes adverse effects on living beings. It causes eye burns, which could be a reason for permanent injury in the eyes of human beings and animals. Along with the eye infections vomiting and diarrhea, problem in gastrointestinal tract with symptoms of nausea and also creates dyspnoea, tachycardia, cyanosis, methemoglobinmia and convulsions are caused [2]. Methylene blue is dark green crystalline solid, water soluble and gives chloride ion and methylene blue cations in solution. In the oxidizing environment it is blue in colour and becomes colourless when it is reduced using reducing agents [3,4]. It is essential to degrade methylene blue from the industrial effluent. Commonly used conventional processes are ineffective because of the non-biodegradable nature of the textile wastewater [5]. Several methods have been employed for the decolourization of wastewater including electro chemical destruction, membrane filtration, ion exchange, adsorption, ozonation, flocculation, electro kinetic coagulation, irradiation *etc*. From the above methods irradiation by direct sunlight is considered to be a most effective method particularly for the non-degradable dyes [6,7]. It is necessary to develop eco- friendly method for the wastewater treatment. Solar energy has much potential which provides future energy for all the necessary needs and exploitation of this alternate energy resource.

Chitosan is high molecular polysaccharide and it has many useful aspects like antibacterial, biocompatibility and biodegradable properties [8]. Due to the intra and intermolecular hydrogen bonding between H^+ and $–NH_2$, chitosan dissolves only in the acidic medium. Raw chitosan enhances the degradation ability and it decreases the flocculent efficiency. Chitosan is suitable for anionic dyes degradation which can be compared to cationic dye. In order to increase the cationic dye degradation capacity of chitosan, various functional groups have been used to modify the chitosan [9]. Many attempts have already been reported for the degradation of methylene blue dye using chitosan based materials like chitosan zinc oxide hybrid composite [10], chitosan/ZnO nanocomposites [11], chitosan grafted polyaniline/Co_3O_4 nanocube nanocomposites [12], chitosan-copper oxide hybrid material [13], TiO_2-chitosan porous materials [14] using UV light irradiation.

In the present work the chitosan is modified with silica. Generally, silica is inert for most of the reactions but it is active towards dye degradation in aqueous solution [15,16]. Chitosan and silica is abundantly available and low cost, so they have great interest on wastewater treatment process. The novelty of the prepared chitosan silica composite is highly rigid, porous and surface functionality due to the presence of chitosan and silica. It has good physio-chemical properties, specific surface area and thermal stability than raw chitosan, which enhances