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# Removal of Methylene blue in Aqueous Solution Using Modified $Fe_3O_4$ Magnetic Nanoparticles by Guanidine

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## Abstract

In this study, magnetic nanoparticle supported by guanidine was synthesized and its property investigated in adsorption of methylene blue from wastewater samples. Physical and structural characteristics of the adsorbent were investigated by SEM, TEM and FTIR techniques. The effect of pH, initial concentration of methylene blue and adsorbent, contact time, and temperature were investigated to determine equilibrium isotherms, and kinetics of adsorption process. The optimum conditions of adsorbent were: pH=6, contact time=30min, adsorbent dose of 2.5 g/L and room temperature. The equilibrium isotherm study show that the adsorption process was fitted by Langmuir model and the adsorption kinetic a good compliance with pseudo second-order model. The present study showed that the magnetic nanoparticle supported by guanidine has high potential for adsorption of methylene blue, in addition to features like simple and rapid separation. Therefore, it can be used for adsorption and separation of such pollutants from aqueous solutions.

**Keywords:** Removal, Methylene Blue, Modified $Fe_3O_4$, Guanidine.

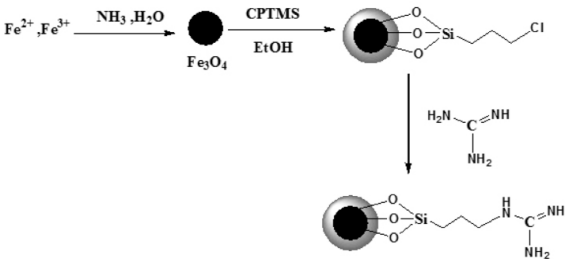
## Introduction

Dyes are one of the most hazardous industrial pollutants, which include acidic, basic, reactive and disperse dyes [1]. Because of their highly toxic structures and their degradation, dye products can cause severe health problems in humans such as potential mutagenic and carcinogenic risks [2, 3]. Moreover, in recent decades, many research works have paid increasing attention to the degradation of acid dyes in the water stream in recent years. The chemical oxidation, biological treatment, membrane separation coagulation/flocculation, adsorption and ion exchange are several techniques developed to remove dyes [4]. Among these techniques, ad-

sorption methods for removing various concentrations of dyes contaminated are much deliberated because of their simplicity to use and high efficiency. Many researches have used adsorbents such as zeolite, Graphene oxide and $SiO_2$ to adsorb dyes from water solutions [5-19]. $Fe_2O_3$ magnetic nanoparticles can be functionalized with special groups such as hydroxyl, acid and amine groups. Therefore, these materials would be proper for various applications for the attachment of biomolecules in water and wastewater industry [20]. The aim of the present work was to assess the ability of $Fe_3O_4$/Guanidine nanocomposites in removal of Methylene Blue dye solution. Thus, magnetic nanoparticles were prepared by the co-precipitation method proposed by Kang et al. (1996) [21]. Then, $Fe_3O_4$/Guanidine was synthesized.

## Methodology

In the first stage, silica-magnetite must be synthesized as follows: 1.2g of the synthetized magnetic iron was solved in 100 ml distillated water and 100 ml of ethanol and then placed in ultrasonic bath. After 30 minutes, 2.5 ml of chlorpropyltrimethoxysilane (CPTMS) was added under supersonic vibrations and the solution was mixed under nitrogen atmosphere and temperature of 38-33 °C for 8 hours. The gained suspension was centrifuged and then was re-dispersed in ethanol solution and Centrifuged for 10 minutes. Finally, the suspension was extracted by a magnet, 4/2 tesla, and washed five times with 5 ml of ethanol. To synthesis $Fe_3O_4$/Guanidine, 1 g of silica-magnetite nanocomposite in 8 ml of toluene was solved by ultrasonic and then, 382.0 grams of guanidine hydrochloride and 0.672 grams of sodium bicarbonate were added to it and placed under reflux for 28 hours. The final black sediment was separated by an external magnet and to remove the un-reaction guanidine from the surface of the nanoparticles, it washed twice, once with mixed of the same volume of dichloromethane and ethanol and then chloromethane. And finally, the precipitate was stored in a refrigerator after drying at 38 °C. The information are presented in the scheme 1. The results of TEM image show that the $Fe_3O_4$/Guanidine was synthesized very well (Fig. 1).




**Scheme 1: the reaction between $Fe_3O_4$ and guanidine**

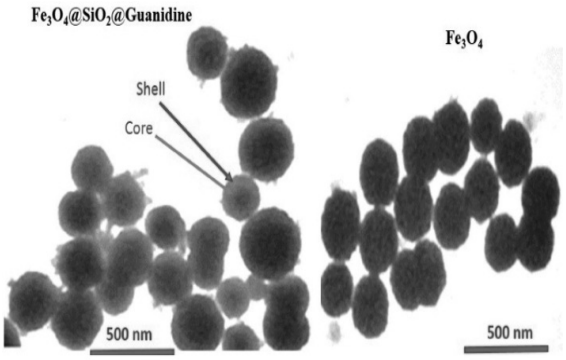



**Figure 1: TEM image of the $Fe_3O_4$/Guanidine**

The key parameters such as pH, contact time, amount of adsorbent and temperature on adsorption treatment were studied.

## Conclusion

Results indicated that based on 10 mg/L dye as initial concentration, the optimal parameters were as follows: adsorbent dosage of 2.5 g/l, temperature of 25 °C, reaction time of 30 minutes, pH of 6.

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