

## Separation and Determination of Brilliant Green dye by Modified Iron oxide Nanoparticles

\*Hossein Tavallali

Department of Chemistry, Faculty of science, Islamic Azad University, Omidiyeh branch, Omidiyeh, Iran.

\*Corres.author: [tavallali@yahoo.com](mailto:tavallali@yahoo.com)

**Abstract:** The modified iron oxide nanoparticles for separation and determination of brilliant green dye (BG) were used. Optimal experimental conditions including pH, and composition of adsorbent have been considered. The method showed good linearity for the determination of BG in the range of 2.5-45.0 mg L<sup>-1</sup>. The limit of detection (LOD) was 0.5 mg L<sup>-1</sup> and relative standard deviation (RSD) for 10.0 mg L<sup>-1</sup> was 2.4%. The BG was determined successfully in fresh aquarium water and laboratory samples.

**Keywords:** Iron oxide nanoparticles, sodium dodecyl sulphate, separation.

### Introduction

Dyes are one of the most easily recognizable pollutant in the environment. These compounds are used in large quantity in many industries including textile, leather, cosmetics, paper, printing, plastic, pharmaceutical, food, etc. to color their product<sup>1</sup>. At present, more than 10,000 of different types of commercial dyes and pigments are available on the market<sup>2</sup>. The industrial manufacturing of azo dyes and textile finishing processes generate wastewater streams contaminated with azo dyes. Some of the azo dyes are difficult to treat by conventional wastewater treatment methods. In a study of USEPA, 11 out of 18 azo dyes passed through the activated sludge process substantially untreated, while the other 4 dyes were significantly adsorbed onto the waste activated sludge, and only 3 dyes were apparently biodegraded<sup>3</sup>. Some studies have shown that azo dyes are very difficult to be biodegraded under aerobic conditions<sup>4,5</sup>. Usually, dye wastewater can be decolorized through conventional treatment such as coagulation with hydrolyzing metals followed by flocculation and filtration (or sedimentation plus filtration). But this conventional process produces a large amount of sludge which needs further disposal. On the other hand, adsorption onto activated carbon is also an effective method for color removal. However, activated carbon may have a very short life, depending on the initial color level and the nature of dyestuff. Regeneration of activated carbon is inefficient and very expensive. The other treatment method such as membrane filtration is also effective but very expensive<sup>6</sup>. The operating cost of disinfection of secondary effluent (99.9% faecal coliform reduction) by membrane filtration was much higher than ozone, UV or chlorine.

Brilliant green is a triphenylmethane dye which is most widely used for coloring purpose, among other dyes of its category<sup>7</sup>. This cationic dye is generally used for the dyeing of cotton, wool, silk, paper and also in distilleries<sup>8</sup>. The determination of BG often is difficult because of the very low concentration in most cases a separation process is essential before the determination of BG. Several methods have been tried to remove

various dyes with different adsorbents<sup>9</sup>. In this paper the modified nanoparticles for separating and determination of brilliant green were discussed.

## Experimental

### Material and apparatus

All reagents were of analytical grade purity and all solutions were prepared with doubly distilled water. Brilliant Green, FeCl<sub>3</sub>(96% w/w), FeCl<sub>2</sub>.4H<sub>2</sub>O(99% w/w), hydrochloric acid (37% m/m), sodium hydroxide, Nitric acid, sodium dodecyl sulfate (SDS), were purchased from Merck (Darmstadt, Germany). The spectrophotometric measurements were carried out with a Perkin-Elmer UV-Vis Lambda 25 at  $\lambda=623$  nm. A pH-meter (632 Metrohm, Herisau, Switzerland) and super magnet (1.4 Tesla, 10cm× 5cm× 2cm) were used.

### Procedure

10 mg of Fe<sub>3</sub>O<sub>4</sub> was added to 20 mL the dye solutions (12 mg L<sup>-1</sup>) then pH of solutions were adjusted to 7 and SDS was added into the dye solutions (0.25 mL of 5 mg mL<sup>-1</sup> solution). The mixture solutions were stirred for 5 min after dye adsorption, magnetic nanoparticles were separated from the sample using a magnet. There residual concentrations were determined spectrophotometrically a calibration curve.

## Results and discussion

### Effect of pH

The pH value of solution is an important process controlling parameter in the adsorption study since it determines the surface charged of sorbent. The effect of pH was studied at a pH range of 4-8. The result was shown in Fig. 1. pH 6 was chosen for sorption of BG in the experiment.

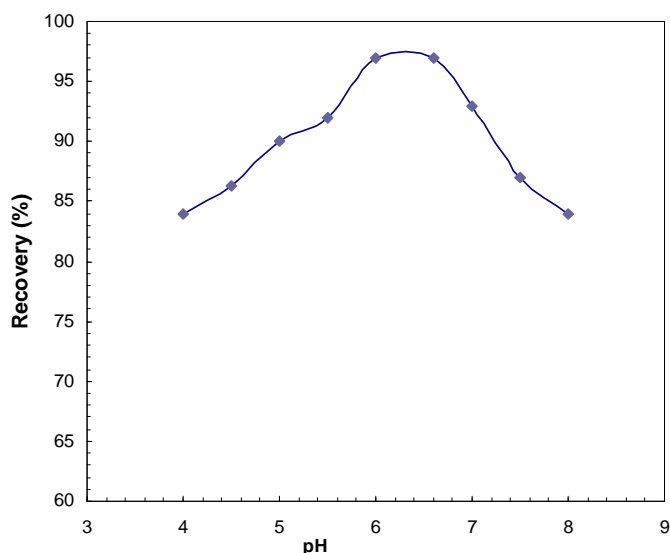
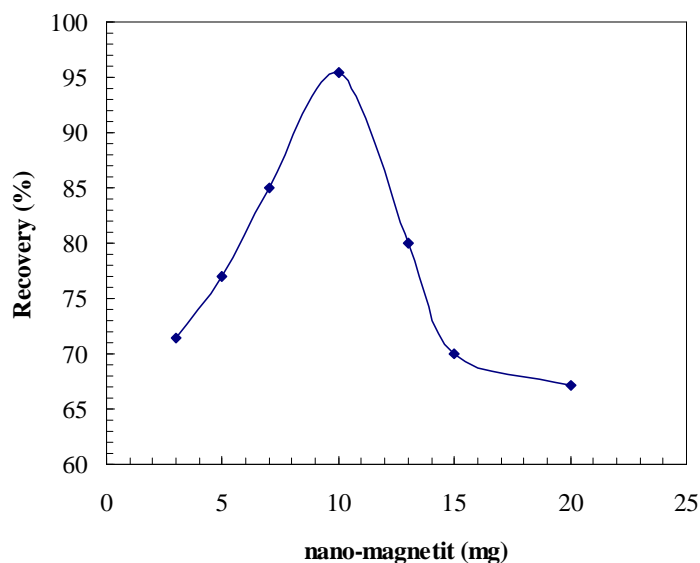


Fig. 1. Effect of pH on the adsorption efficiency of BG

### Effect of adsorbent

The amount of nano sorbent investigated to 3- 30 mg amount respectively added to solutions in the beaker (pH=6). Dye removal increased with increasing nanomagnetic. An adsorbent content of 10 mg was enough for more than 95 % dye removal. The result showed that 10 mg was optimum nano sorbent (Fig 2).



**Fig. 2.** Effect of amount of nano-magnetic

**Effect of SDS amount**

In order to attain the optimal of SDS for this process, 0.005- 0.022 mg mL<sup>-1</sup> of SDS 5 mg mL<sup>-1</sup> were added to BG solutions (pH 6), then these solutions were stirred mechanically. The results showed that amount of SDS exceeded of 0.0125 mg mL<sup>-1</sup> and low of this amount, the adsorption percentage of BG on nano-Fe<sub>3</sub>O<sub>4</sub>/SDS decreased. According to the results, with increase in the SDS amount, the adsorption amount of the dye increased remarkably.

The increase in adsorption can be explained by adsorbed of cationic dye to the surface of Fe<sub>3</sub>O<sub>4</sub> NPs via electrostatic interactions. Maximum adsorption was obtained when SDS amounts were 0.0125 mg mL<sup>-1</sup>. At higher amounts of SDS, the adsorption of BG decreased gradually due to formation of SDS aggregates in the solution which can compete with formation of SDS aggregates on the surface of Fe<sub>3</sub>O<sub>4</sub>. Therefore, 0.0125 mg mL<sup>-1</sup> of the SDS was the optimum amount.

**Figures of merit**

In order to show the validation of the proposed method, the analytical features of the method such as linear range of the calibration curve , limit of detection (LOD), accuracy and precision were examined. The calibration graph was linear in the ranges of 2.5-45.0 mg L<sup>-1</sup> of BG dye. The equations for this calibration graph was  $Y=0.0125 C_{BG} + 0.1124$  ( $r^2=0.9978$ ).

The limit of detection (LOD), under optimum experimental conditions was 0.5 mg L<sup>-1</sup>. The relative standard deviations (R.S.D) for 10.0 mg L<sup>-1</sup> was 2.4%.

**Determination of BG in fresh aquarium water and laboratory samples**

In order to test the reliability of the proposed methodology the assaying were done for determination of BG in fresh aquarium water and laboratory samples by perposed method. The results are shown in Table 1 which gave satisfactory results.

**Table 1.** Determination of BG in fresh aquarium water and laboratory samples.

Sample	BG(mg L <sup>-1</sup> )		% Recovery
	Added	Found	
Fresh aquarium water	-	ND <sup>a</sup>	-
	20	22.32±0.3	108.6
	30	33.50±0.4	107.8
Laboratory samples	-	ND	-
	20	22.23±0.3	111.1
	40	44.51±0.4	109.0

a)ND: Not Detection

### Conclusion

In this paper, the adsorption behavior of B.G on nano-magnetit modify was investigated. The main advantages of the procedure are simplicity, good linearity of calibration graph in range of 2.5- 45.0 mg L<sup>-1</sup>, viable and high efficient, economical. The Fe<sub>3</sub>O<sub>4</sub> NPs are synthesized easily and can be regenerated. SDS-coated Fe<sub>3</sub>O<sub>4</sub> NPs as an efficient adsorbent was successfully carried out to remove the BG dye from wastewater samples.

### Acknowledgements

The authors wish to acknowledge the support of this work by Islamic Azad University, Omidyeh branch, Omidyeh Research council.

### References

1. V.K. Garg, R. Kumar, R. Gupta, Dyes Pigm. 62 (2004) 1–10.
2. Tan, I. A. w; Hameed, B. H. Ahmad, A. L. J. Eng. 127(1-3), (2007) 111-119.
3. Ince NH, Goñ nenc DT. Environ Technol 1997;18:179e85.
4. Pagga U, Brown D. Chemosphere 1986;15:479e91.
5. Owen G, Bandi M, Howell JA, Churchouse SJ. J Membr Sci 1995; 102:77e91.
6. M. A. Behnajady, N. Modirshahla, H. Fathi, J. Hazard. Mater., B 136 (2006) 816.
7. S. Y Mak, D. H. Dyes and pigments 61 (2004) 93.
8. Gregorio Crini, Harmel Ndongo Peindy, Frederic Gimbert. J. Separation and Purification Technology. 53 (2007) 97-110
9. S.Y. Mak, D. H. Chen, Dyes Pigments 61 (2004) 93.

\*\*\*\*\*