DYE REMOVAL FROM AQUEOUS SOLUTION USING EGG SHELL POWDER

Azlinda Abdul Ghani, Ragunathan Santiagoo, Anbu Clemensis Johnson, Naimah Ibrahim , Salsuwanda Selamat
School of Environmental Engineering, Universiti Malaysia Perlis, 02600 Arau, Perlis, Malaysia.

Abstract
Dyes and pigments have been used in many industries for colouration purpose. Textile industry is one of the prominent polluters releasing high concentrated effluent into the surrounding environment. Dyes contain carcinogenic materials which can pose serious hazards to aquatic life and end users of the water. Therefore, it is important to remove these pollutants from wastewater before their final disposal. This study investigates the potential of egg shell powder as a low cost adsorbent for methylene blue removal. The adsorption was carried out to study different initial methylene blue concentration using batch technique. Data were analyzed using Langmuir and Freudlich isotherm models.

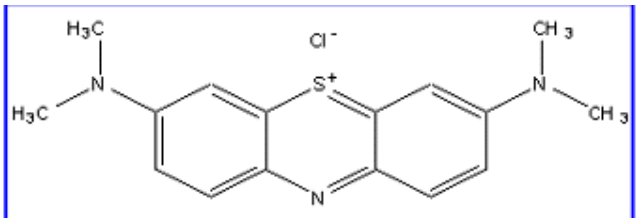
Keywords: Methylene blue (MB) ; Adsorption; Egg Shell; Isotherm Model

Introduction

Dyes and pigments have been used in many industries for colouration purpose. Textile industry is one of the prominent polluters releasing high concentred effluent into the surrounding environment. Over 7 x 10^5 tonnes and approximately 10,000 different types of dye and pigment are produced world wide annually and the volume is steadily increasing [1]. Dyes contain carcinogenic materials which can pose serious hazards to aquatic life and end users of the water. Therefore, it is important to remove these pollutants from wastewater before their final disposal.

Many physical and chemical methods including adsorption, coagulation, precipitation, filtration and oxidation have been used for the treatment of dye-containing effluent. Adsorption has become one of the most effective and comparatively low cost methods for the decolourization of textile wastewater [2-3]. Activated carbon is the most widely used adsorbent for this purpose because it has a high capacity for adsorption of organic matter, but its use is limited because of its high cost. In order to decrease the cost of treatment, attempts have been made to find low cost alternative adsorbents. Numerous approach have been made by various researchers to develop cheaper and effective adsorbents to remove dyes from a variety of starting materials from waste [2,4,5]. The purpose of this work is to study the potential of egg shell powder as a low cost adsorbent for dye removal.

Methylene blue (MB) was chosen for this study because of its known strong adsorption onto solids. MB is the most commonly used material for dying cotton, wood, and silk with molecular weight 373.9 corresponds to methylene blue hydrochlorine with three groups of water. The structure of the methylene blue is given as below.



MB, a cationic dye, is not regarded as acutely toxic, but it has various harmful effects. On inhalation, it can give rise to short periods of rapid or difficult breathing, while ingestion produces a burning sensation and may cause nausea, vomiting and gastritis problems [4-6].

Experimental

Egg shells were collected, washed with distilled water and dried in the oven. Then, it was grounded and sieved to 150-200 µm particle size. It was then dried at 105 °C for 24 hours to remove moisture and stored in a closed bottle for later use in adsorption studies.

Adsorption studies

A stock solution of MB (1g/l) was prepared and diluted accordingly to the required initial concentrations (10 ppm, 25 ppm, 50 ppm and 75 ppm). The adsorption studies were carried out at room temperature (25 ± 2ºC). Egg shell (0.5 g, 1.0 g, 1.5 g and 2.0 g) were added in 100 ml of dye solution with desired

concentration and stirred at 125 rpm for 10 – 40 minutes. The samples were immediately filtered using Whatman 90mm filter papers and analysed using UV-VIS Spectrophotometer (Hitachi U-2810). The experiments were repeated thrice to obtain consistent results.

Results and Discussion

The most widely used isotherm equation for design of adsorption systems are Langmuir and Freundlich equations. Adsorbent concentration was kept constant 0.5 g at 10 ppm, 25 ppm, 50 ppm and 75 ppm of methylene blue. The linear form of isotherms plots are presented in Figure 1. The isotherm constants and correlation coefficient are tabulated in Table 1. As observed from the table, the values of Freundlich constants, K_f decreases with increasing of dye concentration and showed easy uptake of MB at low concentration. However the monolayer adsorption by the absorbent with the same energy of active site was higher for high MB concentration (Q_{max}). The surface of this adsorbent was expected to have inhomogeneous sites for adsorption, so a poor fit was obtained with lower Q_{max} values.

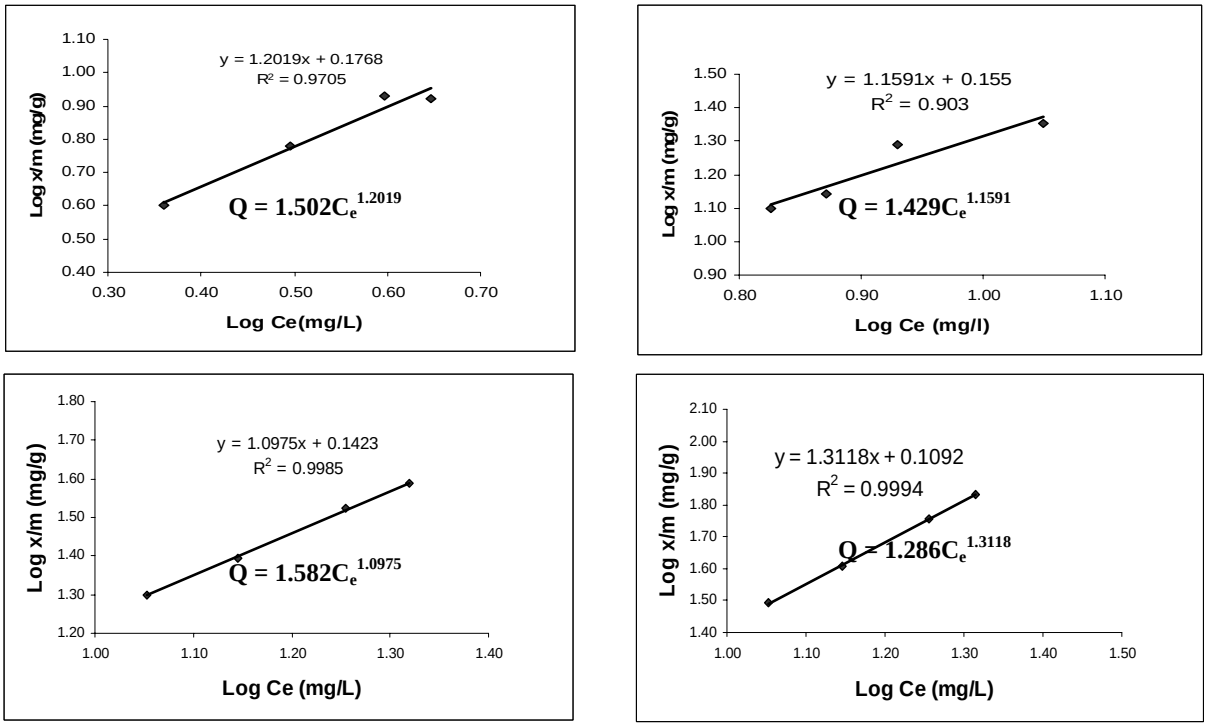


Figure 1. Freundlich Isotherm for Methylene Blue at (a) 10 ppm, (b) 25 ppm, (c) 50 ppm, (d) 75 ppm

Table 1. Isotherm constants and coefficient correlations (Freundlich and Langmuir)

Dye Concentration(ppm)	K_f	n	Q_{max} (Langmuir)	R^2
10	1.502	0.8320	42.02	0.9705
25	1.429	0.8627	31.85	0.9030
50	1.582	0.9111	40.00	0.9985
75	1.286	0.7623	48.08	0.9994

The percentage of removal at various concentrations (10ppm, 25ppm,50ppm and 75ppm) using same amount of adsorbent was studied (Figure 2). The kinetics of adsorption indicates higher removal capacity of dye at low concentration of MB.

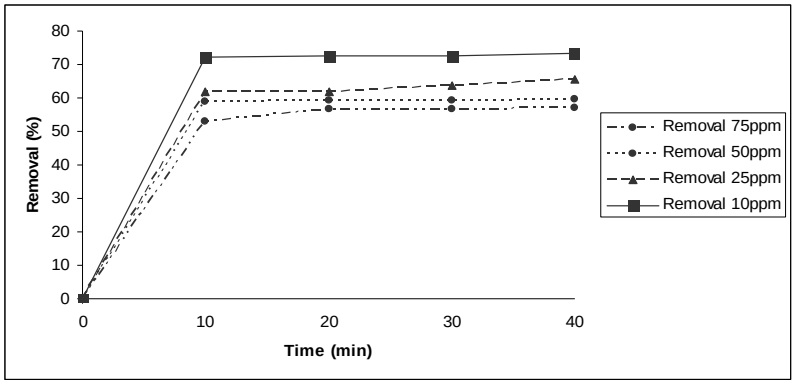


Figure 2. MB removal at various concentrations

The removal percentage showed a decreasing trend as the initial MB concentration was increased. At lower concentrations, all MB present in the adsorption medium could interact with the binding sites so higher adsorption removal were obtained. At the higher concentrations, lower adsorptions removed were observed because of the saturation of the adsorption site. The removal percentages were 72%, 61%, 58% and 53%.

Conclusion

The equilibrium adsorption is practically achieved in 10 minutes, the results suggest that pore diffusion and adsorption behaviour by monolayer Langmuir type isotherm. The presents study, conclude that the egg shell powder could be employed as low cost adsorbent for removal of colour and dyes from water and wastewater at low concentration.

References

[1] Iqbal, M.J.and Ashiq, M.N., Adsorption of dyes from aqueous solutions on activated charcoal *Journal of Hazardous Materials* **B139** (2005) 57-66.

[2] Annadurai, G., Juang,R.S., and Lee D.J., Use of cellulose-based waste for adsorption of dyes from aqueous solutions *Journal of Hazardous Materials* **B92** (2002) 263-274

[3] Arami, M., Limaee N.Y., Mahmodi, N.M., Investigation on the adsorption capability of egg shell membrane towards model textile dyes *Chemosphere* **65 (**2006**)** 1999-2008.

[4] Ozer D., Dursun G.and Ozer A., Methylene blue adsorption from aqueous solution by dehydrated peanut hull *Journal of Hazardous Materials* **144** (2007) 171-179.

[5] Hameed B.H., Din A.T.M., and Ahmad A.L., Adsorption of methylene blue onto bamboo- based activated carbon : Kinetics and equilibrium studies *Journal of Hazardous Materials* **141 (**2007) 819-825.

[6] Avom J., Mbadcam J.K., Noubactep C., and Germain P., Adsorpton of methylene blue from an aqueous solution on to activated carbons from palm-tree cobs. *Carbon* **35** (1997) 365-369.