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Removal of reactive orange 12 by eggshell

Mohammad Reza Fat'hi*, Abusaleh Shariati, Said Hafezi, Gholam Reza Salehi

Department of Chemistry, College of Basic Science, Islamic Azad University, Gachsaran Branch, Gachsaran, (IRAN)

E-mail : fathiemadabadi@yahoo.com

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ABSTRACT

The use of eggshell as adsorbent for the removal of Reactive Orange 12 (RO12) from aqueous solutions was investigated. The initial pH of dye solutions in the range 2-10 did not influence significantly removal of RO 12 by eggshell. The highest value of removal of dye was observed at 55±1^{0}C. The extent of removal of the dye was related directly to the surface area of the adsorbent. © 2011 Trade Science Inc. - INDIA

KEYWORDS

Eggshell;
Reactive orange 12;
Removal of dye.

INTRODUCTION

Large quantities of reactive dyes are utilized by the textile industries. Mainly due to their extensive application in the dyeing of cotton, about 20-30% of all of the used worldwide dyestuffs are reactive dyes. The persistent nature of reactive dyes complicates wastewater treatment within the textile industries.

Removal of dyestuffs from wastewater is applied by either biological methods or physicochemical methods (e.g., adsorption, oxidation-reduction, chemical coagulation, and membrane filtration). Various adsorbent materials (e.g. activated carbon, chitosan and natural waste) have been studied[1,2].

Eggs are used by food manufacturers and restaurants and the eggshells are discarded as waste. Many investigations have been conducted to explore useful applications for eggshells[3].

The porous nature of eggshell makes it an attractive material as an adsorbent. Each eggshell has been estimated to contain between 7000-17000 pores[4].

The principal component of the shell is calcium carbonate which comprises more than 90% of the material[5]. However, the investigations about application of discarded eggshells in the removal of RO 12 by adsorption are insufficient. This work has been designed to examine the possibility of using eggshell as adsorbent for reactive orange 12. The effects of temperature, pH, and particle size of the adsorbent on removal of a RO12 were investigated.

EXPERIMENTAL

Material

The dye used in this study is reactive orange 12 which is an anionic dye (color, yellow; λ_{max}, 417nm) was obtained from Merck. The rest of the chemicals were used as received.

Preparation of adsorbent

Discarded eggshells were collected from local restaurants. To prevent decomposition, eggshells were first washed in tap water, then boiled in distilled water, and finally dried at 105±1^{0}C in a hot air oven for 2 h.The powdered materials were sieved to obtain particles of various size ranges.

Full Paper

The sieved materials were tested for their adsorbent qualities without further chemical or physical treatment.

General procedure

An aliquot of the RO 12 solution, at pH=2 and 25±1°C was passed through a mini column containing 0.8g powder eggshell (100 mesh). The absorbance of RO 12 was measured spectrophotometrically at λ_{max} = 417 nm before and after passing of RO 12 through the column.

Finally, the percent of removal of RO 12 was calculated by using a its calibration curve.

Effect of particle size on removal of RO 12

Removal is directly related with surface area of adsorbent; therefore, the effect of particle size (Figure 1) was studied. It was found that percent removal of reactive dye was decreased with increasing particle size of adsorbent.

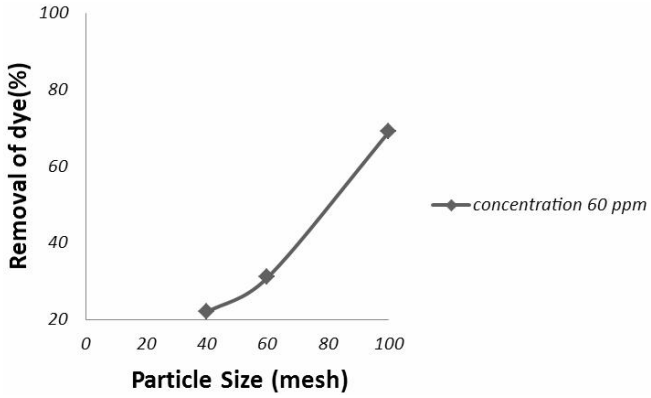

Figure 1 : Effect of particle size on removal of RO.

Effect of pH on removal of RO 12

Since pH is the most important parameter affecting the removal of the dye, 25 mL volumes of solutions containing various concentrations of RO12 (40, 60 and 80 ppm) were passed from a packed column containing 0.8 g eggshell (mesh 100). The effect of pH on removal of RO 12 60 ppm (Figure 2) was studied in range of 2-10 at temperature 25±1°C. It was found that percent Removal of reactive dye increased with decreasing pH.

Effect of temperature on removal of RO 12

As various textile dye effluents are discarded at relatively high temperature (50-60°C), so temperature will be an important design parameter affecting the adsorption in the real application adsorption by RO 12 in future. 25 mL volumes of solutions containing various concentrations of the dye (40, 60 and 80ppm) were passed from a packed column containing 0.8g eggshell (mesh 40).The effect of temperature (Figure 3) was studied in the temperature rang 12-55±1°C at pH=2 and 60 ppm of RO 12. It was found that percent removal of reactive dye increased with increased of temperature.

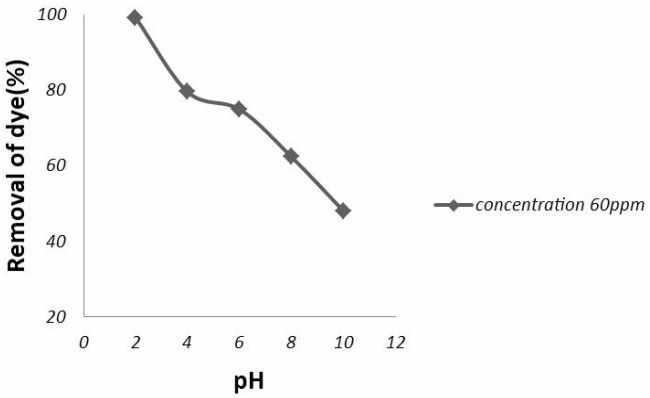

Figure 2 : Effect of pH on removal of RO 12.

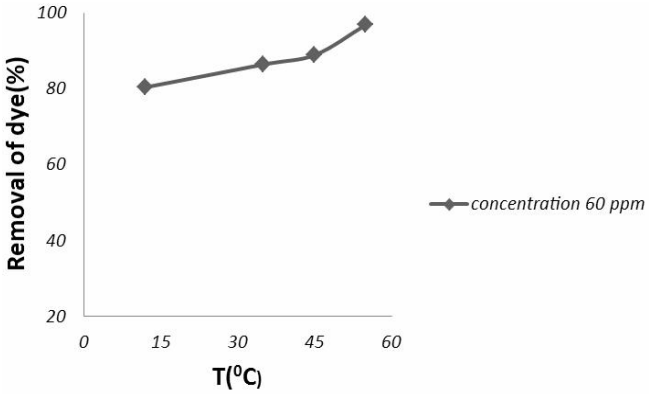

Figure 3 : Effect of temperature on removal of RO 12.

Effect of initial dye concentration on removal of RO 12

Dye concentration also affects the efficiency of color removal. Hence a higher initial concentration of dye may enhance the removal of dye. 25 mL volumes of solutions containing various concentrations of the dye (40, 60 and 80ppm) were passed from a packed column containing 0.8g eggshell (mesh 100). The effect of initial concentration of dye (Figure 4) was studied in pH 2. It was found that percent removal of reactive dye increased with decreased of initial concentration of dye.

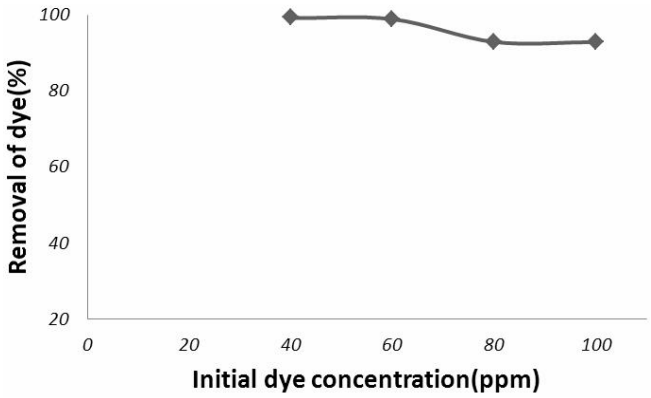

Figure 4 : Effect of initial dye concentration on removal of dye.

Regeneration of eggshell

One of the important characteristics of sorbent is whether it can be regenerated. Research has shown that eggshell can be eluted and regenerated by organic solvent such as methanol and NaOH solution. Eggshell can be regenerated by 5mL NaOH 0.2M and eluted by 5mL methanol solution. The regeneration (Figure 5) was studied in the temperature 25±1^{0}C at pH 2 and 80 ppm. The average desorption efficiency was above 96%. The result showed that eggshell could be used for several sorption- desorption cycles with similar efficiency.

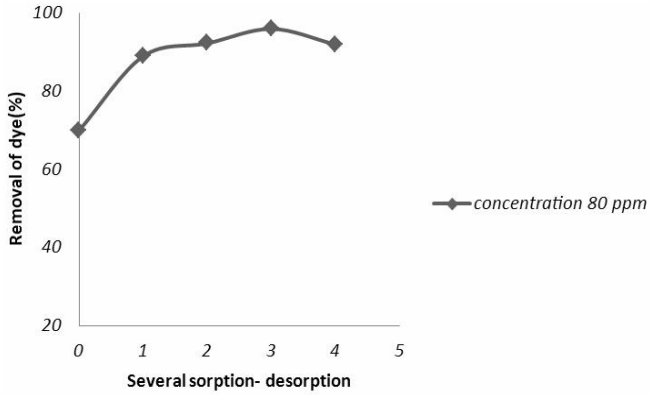

Figure 5 : Regeneration of eggshell

CONCLUSION

These results show that eggshell with membrane is a potentially useful material for the removal of RO 12 from industrial wastewater. It is suggested that work designed to increase the scale of its application to cope with the removal of these compounds under industrial conditions should be initiated.

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