International Journal of Science, Environment
and Technology, Vol. 1, No 2, 56 - 62, 2012

REMOVAL OF REACTIVE YELLOW DYE FROM AQUEOUS SOLUTIONS BY USING NATURAL COAGULANT (MORINGA OLEIFERA)

Veeramalini J.B.[1*], Sravanakumar. K[2] and Joshua Amarnath. D[3]

[1]P.G Student, Department of Environmental Engineering, Sathyabama University, Chennai, INDIA.

[2,3]Department of Chemical & Environmental Engineering, Sathyabama University, Chennai, INDIA

E-mail: saroo_1978@yahoo.co.in (*Corresponding Author)

Abstract: Dyes are the main pollutants existing in wastewater of textile industries. Dyes are produced naturally or artificially and can cause fabrics to take different colors. In this paper the ability of natural products in removing dyes has been tested. After a preliminary screening for dye removal capacity, a vegetal protein extract derived from Moringa oleifera seed have been fully studied. The influences of several parameters such as pH, temperature or initial dye concentration have been tested and the behavior of coagulants has been compared. pH results to be an interesting variable and dye removal decreases as pH increases. Temperature seems not to be so affecting parameter, while initial dye concentration appears to be a very important variable in q_c capacity, which is higher as IDC increases. Langmuir isotherm model fits very well in M. oleifera seed extract dye removal.

Keywords: Colour removal; coagulant; Textile wastewater: Moringa oleifera: Dye

1. INTRODUCTION

Textile wastewater as one of the most polluted sources has been rather difficult to study due to its highly variable composition — various dyes, additives, detergents, etc.

Reactive dyes have been a great concern for protecting the water ecosystem because many azo dyes and their breakdown products have been found toxic to aquatic life, mutagenic/carcinogenic and gentoxic[1]. The activated sludge, coagulation and flocculation processes and their combination are widely used in textile wastewater treatment. However, aerobic biological treatment is not sufficient to break down azo double bonds of reactive dyes which cause the colour problem in the effluent, while coagulation process is only able to absorb them up to some extent but the sludge produced from both processes becomes more difficult to be disposed off.

In aqueous solution, anionic dyes carry a net negative charge due to the presence of sulphonate (SO3_) groups, while cationic dyes carry a net positive charge due to the presence of protonated amine or sulfur containing groups [2]. Due to their strong interaction with many surfaces of synthetic and natural fabrics, reactive dyes are used for dyeing wool, cotton, nylon, silk, and modified acrylics.

Many treatment methods have been adopted to remove dyes from wastewater, which can be divided into physical, chemical, and biological methods [3]. Although chemical and biological methods are effective for removing dyes, they require specialized equipment and are usually quite energy intensive; in addition, large amounts of by-products are often generated. Generally, physical methods which include adsorption, ion exchange, and membrane filtration are effective for removing reactive dyes without producing unwanted by-products [4].

Several methods are used to treat coloured effluents to achieve decolourization. These include physicochemical methods such as filtration, coagulation, use of activated carbon and chemical flocculation [5, 6]. These methods are effective but they are expensive and involve the formation of a concentrated sludge that creates a secondary disposal problem which requires safe disposal.

The objective of the present study was to examine the decolourization of the Reactive Yellow 145 by under static conditions and in the determination of the effect of the dye and the degraded metabolites on the growth of crop plants.

2. Materials and Methods

2.1 Preparation of coagulant

The husk covering the *M. oleifera* seeds were manually removed, good quality seeds were selected, and the kernel was ground to a fine powder using an ordinary electric blender. The active component from coagulant was extracted using sodium chloride (NaCl) or potassium chloride (KCl) salt solution. A concentration of 4% (4 g of powder in 100ml salt solution) was used throughout the study after several trials. The whole mixture was stirred for 30 min at room temperature using a magnetic stirrer. The suspension was filtered using whatman filter paper. The resultant filtrate solution was used as a coagulant. A fresh solution was prepared every day for reliable results.

2.2 Coagulation Studies

The coagulation studies were performed using Jar test apparatus which allowed for six 1 litre beakers to be agitated simultaneously and rotational speed could be varied between 0 and 100 rotations per minute (RPM). The beakers were filled with 1000ml dye sample. During rapid mixing at 100RPM for 2 min coagulant dosage was added into each beaker and was followed by slow mixing at 40RPM for 30min. The duration of sedimentation was kept constant at 30 min. The supernatant after sedimentation was filtered using whatman filter paper. The filtrate was analyzed for absorbance using UV-spectrophotometer at a maximum wavelength 526.5 nm. Color removal efficiency was measured as a decrease in optical density measurement at 475 nm. The readings were taken in triplicate for each individual solution to check repeatability.

RESULTS AND DISCUSSION

Dye characterization

The acidity constants (Ka) for these particular dyes have not been previously reported. The values of pKa of the reactive dyes were determined using a standard potentiometric titration method. Due to their acidebase properties, dyes can be titrated using suitable acid or base solution. The pKa values of reactive dyes were calculated by plotting the equilibrium pH against buffer intensity of dyes.

Table 1 summarizes the number of polar and ionizable functional groups that were present in dye molecules and contain much the same density of polar functional groups (15-18 groups/molecule) and ionizable groups (3-4 groups/molecule) [7.8].

Table.1. Characteristics of Reactive Yellow Dye 2

C.I generic name	λmax (nm)	Solubility at 25^0C	pKa	C (Wt%)	Number of ionizable groups	Number of polar functional groups located on dyes				
						-S-O-	-C-O-	-Cl	-NH	-NH2
Reactive Yellow 2	404	70.0	5.3	34.5	3	9	1	3	2	-

Effect of coagulant dose on coagulation:

Different concentrations such 100, 200, 300, 400 or 500 mg Moringa oleifera was added to a 1000 ml textile waste water sample (figure.1). After rapid mixing for 5 min at 200 rpm and slow mixing for 55 min at 60 rpm, the sample was withdrawn by using a plastic syringe from a point about 2 cm below the top of liquid level at the beaker in order to determine the COD and colour, so that the effect of coagulant dose on coagulation could be studied. For the purpose of coagulation, pH was adjusted to 8.5 by addition of Ca(OH)2.

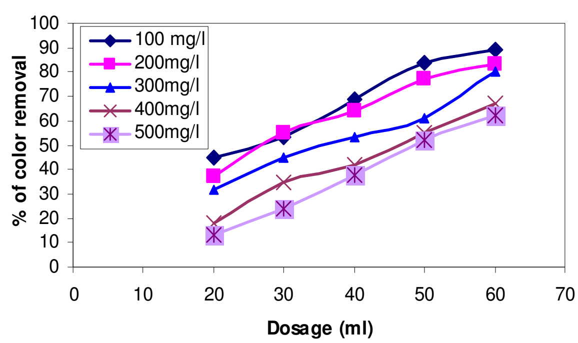

Fig. 1: Effect of coagulant dose on the removal of Color

EFFECT OF CONTACT TIME

The preceding section discussed the effect of contact time on the degradation of dye (figure.2). This section extends the discussion to include the effects of contact time vs % of removal. The typical graph represents constant dose 0.20g under room temperature was maintained at natural pH of variable concentration.

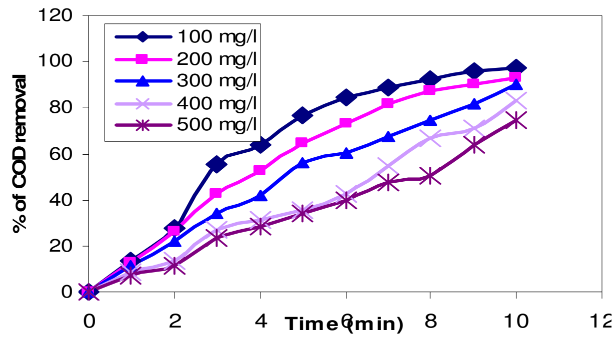

Figure 2. Effect of contact time on decolorization- Reactive yellow dye by Moringa oleifera.

Effect of pH

The Effect of pH was one of the parameters was crucial to determine the optimum level in order to minimize the dosing cost and obtain the optimum performance in treatment. The aqueous solution of dyes having concentration of 100 mg l-1 were treated by varying constant concentration of 0.20 g dose of adsorbent for half an hour with varying pH 2 to 10. The pH was maintained with the help of 0.1 N-HCl and 0.1 N-NaOH solutions. pH variation in comparison had a significant effect on the decolorization of Reactive yellow by Moringa oleifera. Figure 2 shows that the highest color removal was detected in pH 10 (93%). The removal of dyes are more at higher pH, because the surface of activated coagulants are negatively charged, the decrease in adsorption capacity in the low pH region would be expected as the acidic medium would lead to an increase in hydrogen ion concentration which would then neutralize the negatively charged coagulant surface thereby decreasing the adsorption of the positively charged caution because of reduction in the force of attraction between adsorbate and adsorbent

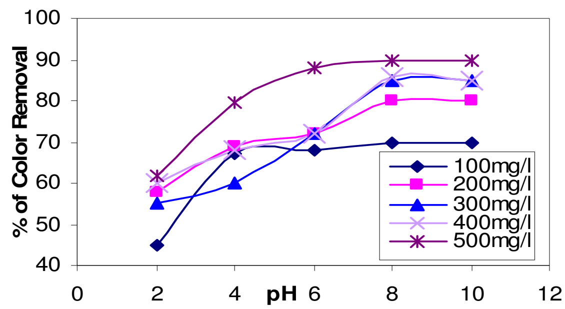

Figure 3. Effect of various pH on decolorization- Reactive yellow dye by Moringa oleifera.

Conclusion

Coagulation process was used to treat textile dye effluent. Results of the experiments revealed the following: 500mg Moringa oleifera reduces COD and color by 37 and 62% respectively. The pH range of 8-10 was found to be effective for the coagulation process. Increasing dosage increases the enhancement of removal of contaminants. Temperature effect on the removal of COD from the textile dye effluent during cogulation process was negligible. 1000mg coagulant enhances efficient removal of COD and color in the coagulation process.

REFERENCES

[1] A. Olsen, Low technology water purification by bentonite clay and *Moringa oleifera* seed flocculation as performed in Sudanese village: effects on *Schistosoma Mansoni cercariae*, Water Res. 21 (1987) 517-522.

[2] Chaudhari, S., Baes, A.U., Nishijima, W., Okada, M., 2001b. Isolation and characterization of coagulant extracted from Moringa oleifera seed by salt solution. Water Res. 35, 405-410

[3] Muyibi, S.A. and Alfugara, A.M.S. (December 2003). Treatment of surface water with *Moringa oleifera* seed extract and Alum - A comparative study using A Pilot scale water treatment plant. *International Journal of Environ. Studies*, Vol. 60, No. 6, pp. 617-626

[4] Okuda, T., Baes, A.U., Nishijima, W., and Okada, M. (1999). Improvement of Extraction method of coagulation active components from *Moringa oleifera* Seed. *Water Res*., Vol. 33, No. 15, pp. 3373-3378.

[5] Folkard, G.K., Sutherland, J.P., and Grant, W.D. (1992). *Natural coagulants as pilot scale*. 18th WEDC Conf. Proceedings, pp. 55-58.

[6] A. Ndabigengesere, S. Narasiah, Quality of water treated by coagulation using *Moringa olifera* seeds, Water Res. 32 (3) (1998) 781-791.

[7] Madsen, M., Schlundt, J. and E.F. Omer (1987). Effect of water coagulation by seeds of *Moringa oleifera* on bacterial concentrations. Journal of Tropical Medicine and Hygiene; 90(3): 101-109

[8] Nkurunziza, T., Nduwayezu, J. B., Banadda E. N. and I. Nhapi (2009). The effect of turbidity levels and *Moringa oleifera* concentration on the effectiveness of coagulation in water treatment. Water Science & Technology, Vol 59, No 8, pp 1551-1558.

Received April 20, 2012