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Original Research Paper

Removal of Dyes and Heavy Metals Using Garlic Husk

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ABSTRACT

Dyes and heavy metals can be removed from industrial effluents by a wide range of physical and chemical processes available. Among these, adsorption method is one of the most common. In this work, garlic husk has been used, *a* cheap adsorbent, to remove Patton and Reeder's indicator, Solochrome black-T, crystal violet, murexide, basic fuchsine and potassium permanganate by batch process. Effect of pH, adsorbent dose, contact time and the concentrations of dyes has been studied, which showed the cent percent removal of dyes and heavy metals.

INTRODUCTION

Synthetic dyes and heavy metals are widely used in the industries like textiles, leather, paper, plastics, electroplating, cement, metal processing, wood preservatives, paints, pigments and steel fabricating industries (Ponnusami et al. 2008). These industries discharge large quantities of toxic wastes, and the untreated effluents from these industries cause soil and water pollution, which results in the accumulation of heavy metals and colour to the water. Heavy metals are toxic even at very low concentrations and pose serious problems due to their possible entry into the food chain (Vasanthy et al. 2004). Colour is a visible pollutant and presence of very minute concentration of colouring substances in water makes it unsuitable for domestic purposes like drinking and recreational purposes due to its anaesthetic appearance (Vasanth Kumar et al. 2003).

A wide range of physical and chemical processes are available for the removal of these dyes and metals from wastewaters, such as precipitation, ultra filtration, adsorption, ion exchange, reverse osmosis, oxidation, ozonisation, coagulation, flocculation and membrane filtration processes (Somasekhara Rao et al. 2008). Among these, adsorption technique has been proved to be an excellent method to treat dye effluents, offering advantages over conventional processes (Kaushik et al. 2005). Recently, surface modified carbon has generated diversity with superior adsorption capacity. Adsorption of heavy metals and dyes onto activated carbon is an important and highly effective method (Sudha et al. 2008).

A number of adsorbents like activated carbon, coconut shells (Manju et al. 1990), sawdust (Verma et al. 2005), coconut coir pith (Namasivayam et al. 2002), wood (Poots et al. 1978), lignite and *Sphagnum* peat (Allen et al 1989), fly ash (Khare et al. 1987), boiler bottom ash (Mall et al. 1995), rice husk (Lodha et al. 1997), coal (Gupta et al. 1990), inorganic salts, etc. have been used for adsorption of dyes and heavy metals.

The present work deals with adsorption of dyes such as Patton and Reeder's indicator, crystal violet, murexide, basic fuchsin, Solochrome black-T and metal Mn (VII) on activated carbon. Effect of pH, adsorbent doses, contact time and the effect of concentration have been studied.

MATERIALS AND METHODS

Preparation of garlic husk: Freely available garlic husk was cleaned by removing unwanted materials, kept in a hot air oven for 30-45 min at 150°C temperature, powdered and directly used as an adsorbent for murexide.

For all other dyes and metals, the garlic husk powder was treated with 2N HCl for acid activation, washed thoroughly with distilled water, squeezed and then once again kept in oven to maintain dry condition at 150°C temperature, and then used for adsorption process.

Preparation of manganese solution: 2.870 g of $KMnO_4$ was dissolved in one litre of water which gives l00 ppm of Mn and diluted to required concentrations.

Preparation of dye solutions: Patton and Reeder, crystal violet, murexide, basic fuchsin and Solochrome black-T dyes were weighed 0.1 g each and dissolved separately in one litre flask, which gives 100 ppm of solutions and diluted to required concentrations. All chemicals used were of Analar grade.

Batch Experiment: Dyes and metal adsorption experiments were conducted in batch mode with 50 ml stock solution. The variables studied were adsorbent doses, contact time, dye concentration and pH. The mixtures were observed for adsorption process by keeping the solutions for adsorption to take place.

RESULTS AND DISCUSSION

The effect of parameters like pH (Fig. 1), dose of adsorbent (Fig. 2a, b & c), concentration (Fig. 3a, b & c) and contact time (Fig. 4) on the removal of dyes and metals in aqueous media were investigated.

Effect of pH: pH is an important factor for dyes and metals adsorption phenomena in aqueous solutions. The effect of pH on Mn (VII) and dyes adsorption was studied with pH range 2, 4, 6, 8 and 10. Concentration and dose were kept constant. The pH does not show any effect on adsorption (Fig. 1) but at pH 5-6, the adsorption is very fast in case of Patton and Reeder's dye, Mn (VII), Solochrome black-T and basic fuchsin dyes. In case of crystal violet and murexide, the pH was not altered because crystal violet turns yellow in basic medium and murexide turns colourless in acidic medium. Results are shown in Table 1.

Effect of absorbent dose: Five 50 mL samples of 100 ppm /L dyes and metal solutions were taken and dose of adsorbent was studied .The results are shown in Table 2 and Figs. 2 a, b & c.

Effect of concentration: Constant doses of adsorbents (1.0 g) were separately added to 50 mL samples with different concentrations of dyes and metal solutions (20, 40, 60, 80 and 100 ppm) at room temperature and the solutions were kept for observation. The results are shown in Table 3 and Figs. 3a, b & c.

Table 1: Adsorption percentage of dyes and metals at different pH values.

pH	Acidic Condition (5-6)	Basic condition (8-9)	Without adjusting pH	Adsorption in %
Dyes and metal	Patton and Reeder's	-	Crystal violet	100
	Manganese	-	Murexide	100
	Solochrome black-T	-		100
	Basic fuchsin	-		100

Table 2: Effect of adsorbent dose on adsorption of dyes and metals.

Dyes and metal	Adsorbent Dose range (in g)	Adsorption dose in g
Crystal violet	0.5-2.5	As dose increases, adsorption increases.
Patton and Reeder's indicator	0.5-2.5	As dose increases, adsorption increases.
Basic fuchsin	0.75-2.0	As dose increases, adsorption increases.
Murexide	0.20-1.0	0.6 g
Solochrome black-T	0.20-1.0	0.2 g
$KMnO_4$	0.20-1.0	0.2 g

Table 3: Effect of concentration of dyes and metals on adsorption.

Dyes and metal	Concentration of dyes and metal in ppm	Percentage of removal (in ppm)
Crystal violet	20-100	Adsorption decreases, as concentration increases
Patton and Reeder's indicator	20-100	Adsorption decreases, as concentration increases
Basic fuchsin	20-100	Adsorption decreases, as concentration increases
Murexide	20-100	100
Solochrome black-T	20-100	100
Potassium permanganate	20-100	100

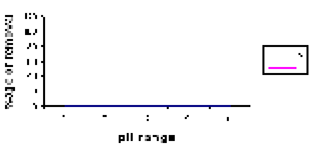

Fig. 1: Effect of pH.

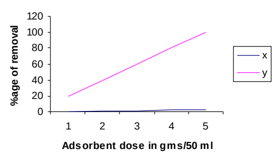

Fig. 2a: Effect of adsorption dose for crystal violet and Patton & Reeder's indicator and basic fuchsin.

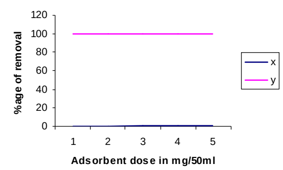

Fig. 2b: Effect of dose of adsorbent for manganese and EBT.

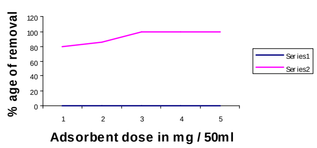

Fig. 2c: Effect of dose of adsorbent on murexide.

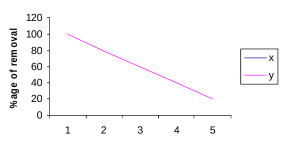

Fig. 3a: Effect of concentration for Patton & Reeder and crystal violet.

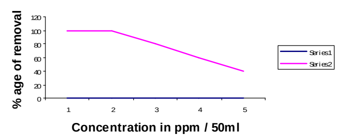

Fig. 3b: Effect of concentration for basic fuchsin dye.

Table 4: Adsorption period for dyes and metals.

Dyes and metal	Adsorption period in hrs
Patton and Reeder's indicator.	20 hrs
Crystal violet	24 hrs
Basic fuchsin dye	24 hrs
Murexide	48 hrs
Solochrome black-T	5 hrs
Manganese	3 hrs

Effect of dose verses concentration for dyes: Five 50 mL samples of dye solutions from 20 ppm-100 ppm and varying doses of adsorbents from 0.5-2.5 g were added in series and then the solutions were kept for adsorption process to take place. The results shown in Fig. 5 indicate that the dose and the concentration of crystal violet, Patton and Reeder's, and basic fuchsin dye solutions are correlated with each other.

Effect of contact time: The effect of contact time with 1.0 g adsorbent dose in 50 mL (20 ppm) dyes and metal solutions

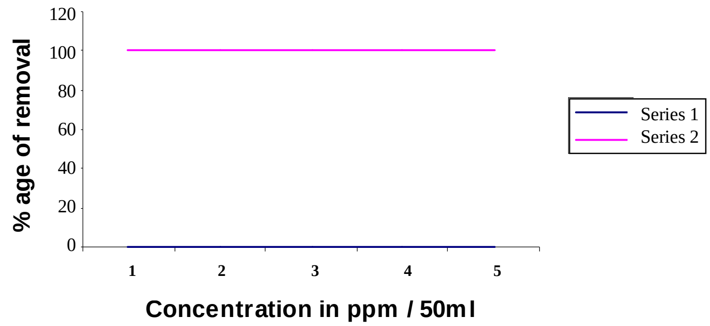

Fig. 3c: Effect of concentration for manganese, murexide and EBT.

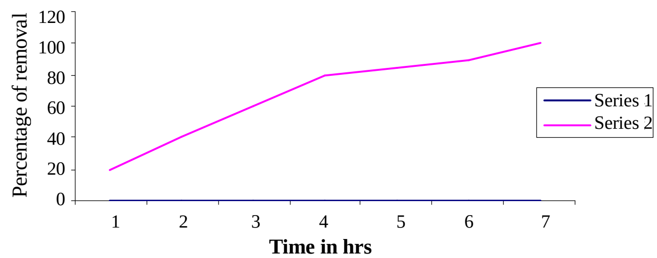

Fig. 4: Effect of contact time.

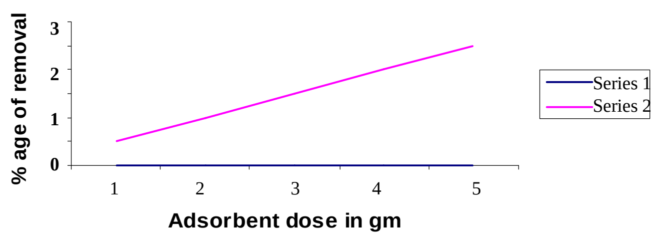

Fig. 5: Correlation of dose of adsorbent and concentration of Patton & Reeder, crystal violet and basic fuchsin dye.

were investigated, and the colour removal increased with increase in time. Contact times for dyes and metals are shown in Table 4 and Fig. 4.

Effect of temperature: The 30 ppm of dye solutions, 1 g of adsorbent and required pH were maintained. The temperature was adjusted to 50°C and 75°C. There was no effect of temperature on adsorption of any of the dyes. Adsorption of dyes at room temperature was also studied.

CONCLUSION

Activated carbon from the garlic husk was developed. The low cost effective adsorbent was found highly effective in removing dyes and metals. It can be used as a cheap and free of cost substitute for commercial adsorbent for the removal of dyes and metals from industrial effluents for a cleaner environment.

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INNOVATIONS, NEW ENVIRONMENTAL TECHNOLOGIES

Coal-to-Liquid Technology

The Centre for High Technology (CHT), an arm of the Petroleum Ministry, has signed a memorandum of understanding (MoU) with Engineers India Ltd. (EIL) and Bharat Petroleum Corporation Ltd. (BPCL) to develop an indigenous coal-to-liquid (CTL) fuels technology. The major activities that will be undertaken under the MoU are:

(i) Mathematical model for Fischer Tropsch (FT) reactor and basic flow sheet development;
(ii) Hydrodynamics simulation using computational fluid dynamics (CFD);
(iii) Syn gas clean up and conditioning and preparation of process design package; and
(iv) Costing of demonstration plant.

There are only a few companies in the world who have requisite technology to convert coal to liquid fuels, such as Sasol and Lurgi.

The CHT is also planning an ambitious energy performance audit of public sector refineries to identify technology gaps and performance, which can be subsequently improved. The proposal is for formation of joint audit teams with experts from industry and EIL to develop the requisite methodology for data formats, data collection and validation, program finalization and audit. The CHT has conducted energy audit and hydrogen management studies jointly with EIL. The idea of performance audit came about from this exercise and also from various benchmarking exercises conducted through Shell Global Solution's Integrated Refinery Business Improvement Program and suggestions form various activity committee meetings.

Chemical Weekly, October 27, 2009

Harnessing Tree Power

Scientists at University of Washington (UW) have developed electrical circuits that run entirely from power in trees. A study last year from the Massachusetts Institute of Technology (MIT) found that plants generate a voltage of up 200 millivolts when one electrode is placed in a plant and the other in the surrounding soil. Those researches have since started a company developing forest sensors that exploit this new power source. The UW team sought to further academic research in the field of tree power by building circuits to run off that energy. They successfully ran a circuit solely off power for the first time.

The system could provide a low-cost option for powering tree sensors that might be used to detect environmental conditions or forest fires. The electronic output could also be used to gauge a tree's health.

University of Washington, November 5, 2009