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Research Article

Studies on Sorption of Indigo Caramine Dye Using *Parthenium* Plant Powder

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Abstract: The present work portrays the Process optimization for the removal of Indigo caramine dye with *Parthenium* powder using central composite design. This strategy has several points of interest. To be specific, they are, minimal effort, basic removal of IC dye (toxic) material, most important one being its eco-friendly nature. In the present work we have used *Parthenium* for the removal of IC dye. A versatile strategy was implemented for the removal of IC dye. Equilibrium studies and isotherms were connected to correspond the preparation parameters (time, pH, concentration and dosage) to the decolourisation of IC dye from aqueous dye solution. The outcomes demonstrated that the ideal conditions for the removal of IC dye utilizing *Parthenium* powder were contact time of 40 min and pH-6, concentration of 20 mg/L and dosage 35 g/L. The *Parthenium* appear to be a decent sorbent for the removal of Indigo caramine dye from synthetic waste water.

Keywords: Sorption, dyes removal, time, pH, size.

Introduction

Water is only the compound which has acquired a prior importance in the daily practice of all the living organisms on the earth. Though under 1% of the water on this planet is fresh water suitable for human use and a lot of that fresh water is frozen in polar ice caps, the water we do have is adequate to support everyone. Water covers about 70% of the World's surface however 0.002% of the water is open for human usage. Contaminated water is the main channel for powerful diseases (like Amoebiasis and Intestinal ailment, Cholera, Free insides, Paratyphoid Fever, Typhoid, Jaundice). Water pollution due to toxic heavy metals released by industrial activities is a serious environmental and public health issue because they tend to remain indefinitely circulating and eventually accumulating throughout the food chain. Water pollution occurs when undesirable effluents disperse in a water system and so water quality change. Water pollution divided into three main sources, natural Sources: include thermal and acid effluents from volcanic areas domestic sources that are primarily sewage and laundry wastes and generated in houses, apartments, and other dwellings. In rural and some suburban areas, domestic wastes are handled at the individual residence and enter the environment through the soil either in partially treated or untreated fashion. In urban areas, domestic wastes are collocated in sewage pipes and transmitted to control location either for treatment or discharge into a watercourse without treatment. A number of physicochemical methods, such as chemical precipitation, adsorption, solvent extraction, ion exchange, membrane separation, etc., have been commonly employed for stripping toxic metals from wastewaters.

Industrial wastes vary from industry to industry and from location to location. Such industries include dairy and food-processing plants, meat-packing houses, chemical plants, mining facilities, and textile mills, Fertilizer plants. Common contaminants in the water include arsenic, lead, phosphate, copper, iron, chlorine, and nitrate. Another group of pollutants that are increasingly causing pollution in fresh water bodies are dyes. Dyes are basically chemical compounds that can attach themselves to fabrics or surfaces to impart colour. Most dyes are complex organic molecules and are need to be resistant to many things such as the weather and the action of detergents. Synthetic dyes are extensively used in many fields of up-to-date technology, e.g., in various branches of the textile industry, in leather tanning industry, in paper production, in food technology, in agricultural research, in light-harvesting arrays, in photo electrochemical cells, and in hair colorings. Dyes can be classified according to their chemical structure or according to their use. However, classifications vary from country to country though there are some fundamental categories that are common to all. Dyes have generated much concern regarding its use, due to its toxic effects. It has been reported to cause carcinogenesis, mutagenesis, chromosomal fractures, teratogenicity and respiratory toxicity [1-5].

Materials and Methodology

The present experimentation is carried out in batch-wise, on biosorption of Indigo caramine (IC) dye from aqueous solution onto *Parthenium plant* powder.

Reagents and Chemicals

Indigo caramine (IC) is used as source of dye stock solution.

Preparation of the bisorbents

Parthenium plant was collected from AU Engineering college campus in Visakhapatnam city, Andhra Pradesh, India. The collected plants were washed with distilled water several times until the dirt particles are removed. After through washing with distilled water, sorbent was sun dried until it became crispy, cut into small pieces, powdered and sieved. In the present study, 53, 75, 105, 125 and 152 µm size powders was used as sorbent without any other pretreatments.

Figure 1. *Parthenium* plant

Preparation of Dyes stock solutions

Indigo caramine (IC), is used as the source for preparing stock solution (synthetic). All the required solution is prepared with double distilled water. 1.0 g of dye was dissolved in 1.0 L of distilled water to prepare 1000 mg/L stock solution. Samples of different concentrations of dye is prepared from this stock solution by appropriate dilutions. 10 mg/L of IC solution is prepared by proper dilutions. 10 ml of 1000 mg/L IC stock solution is taken in a 1000 ml volumetric flask and is made up to the mark with distilled water. Similarly solution with different concentrations such as 20 mg/L, 50 mg/L, 100 mg/L, 150 mg/L and 200 mg/L were prepared. The pH of the solution is varied by adding required amounts of 0.1 N HCl and 0.1N NaOH.

Results and Discussion

Effect of Contact Time

The % biosorption of Indigo caramine is plotted against contact time in figure 1. It is found from the chart that the % biosorption is constantly expanded in the underlying 40 min of disturbance. Past the contact season of 40 min, the % biosorption is essentially consistent. So, the Equilibrium contact time is 40 min. The increment in the pace of evacuation may be a direct result of the accessibility of empty useful gatherings on the biosorbent surface. Further expansion in contact time prompts the control of dynamic locales which brings about the immersion of the algal cell surface causing a harmony state and no extra adsorption. For a conventional assessment with 50 mL of watery arrangement adding 0.5 g/L of 53 µm size biosorbent, the % biosorption is extended from 15% to 53% in the contact time period of 5 to 40 min [6-10].

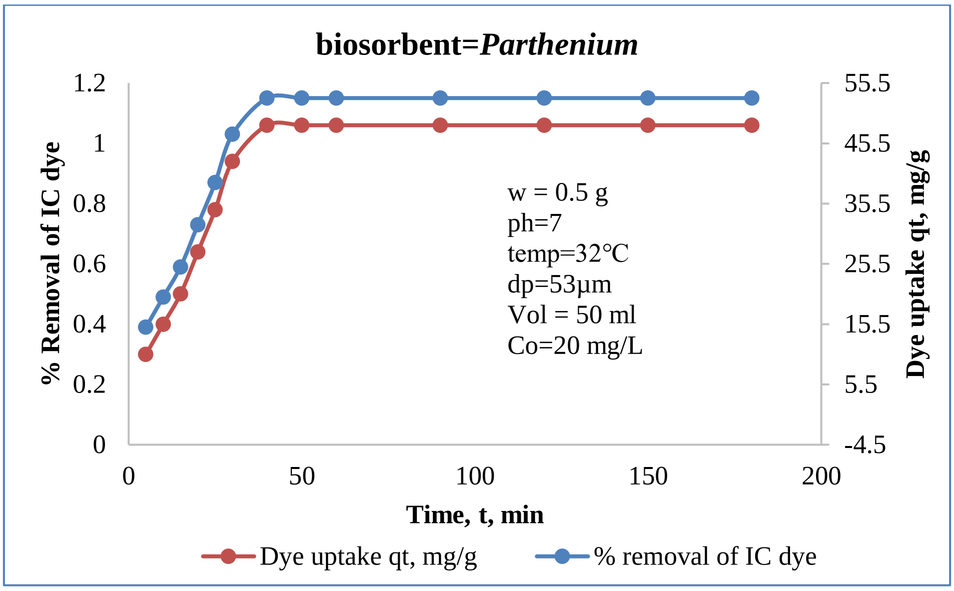

Figure 1. Effect of Contact Time on % removal of IC dye

Effect of Biosorbent Size

The assortments in % biosorption of Indigo caramine with biosorbent size are plotted in figure 2. The rate biosorption is extended from 34 % to 53 % as the biosorbent size reduces from 152 to 53µm. The surface space of the biosorbent increases as the size of the atom decreases and the number of dynamic objections on the biosorbent are better introduced to the biosorbate. The more modest the sorbent molecule size, more surface territory is made accessible and along these lines the quantity of locales increments [11-15].

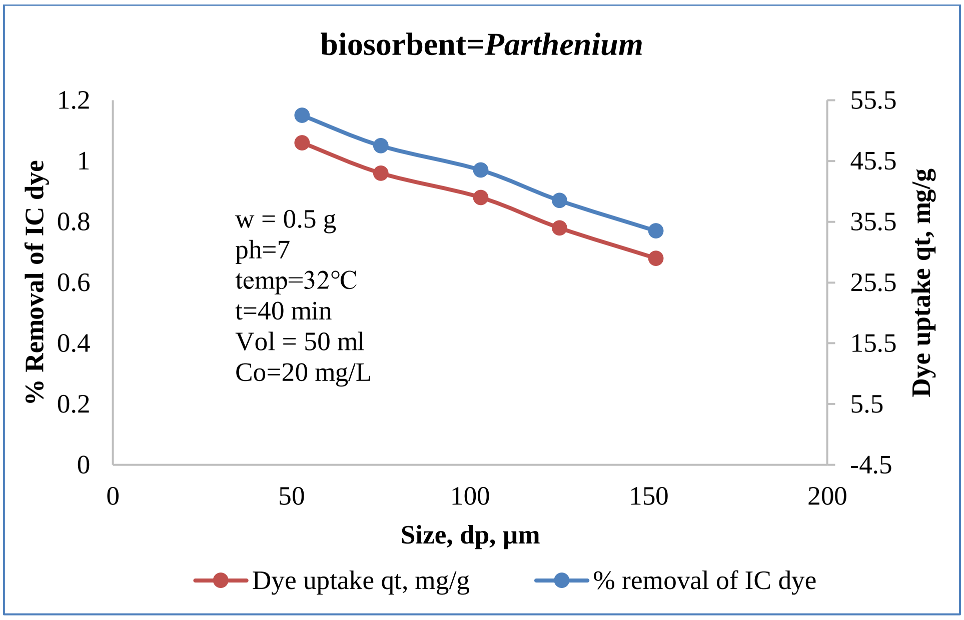

Figure 2. Effect of Bisorbent size on % removal of IC dye

Effect of pH in aqueous solution

A plot is pulled in figure 3 between % biosorption of Indigo caramine and pH of watery arrangement. An immense expansion in rate biosorption of IC is viewed as pH is expanded from 2 to 4 and diminished as pH is expanded more than 4. For a normal examination with 50 mL of watery arrangement, adding a biosorbent estimations of 0.5 g/L of 53 µm size, the level of biosorption is extended from 55 % to 67 % in the pH range from 2 to 4. At lower pH more protons will be accessible hence expanding electrostatic attractions between contrarily charged color anions and decidedly charged adsorption locales, and causing an increment in color adsorption [16-20].

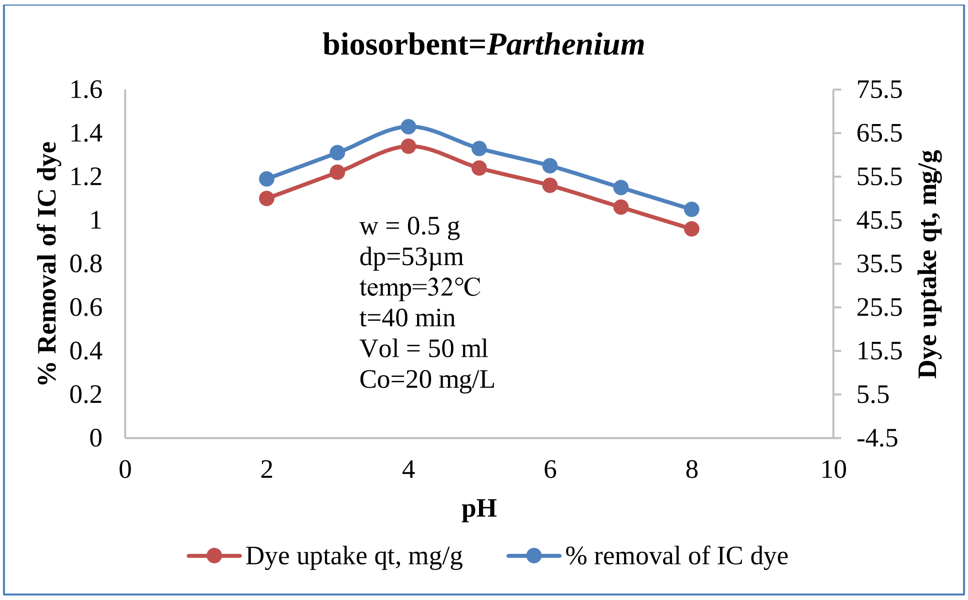

Figure 3. Effect of pH on % removal of IC dye

Effect of Initial Concentration of IC dye

The Effect of beginning grouping of Indigo caramine in the watery arrangement on the rate biosorption at harmony contact time is showed up in figure 4. The % biosorption is logically lessened from 67 % to 50 % (1.34 to 10 mg/g) by expanding IC color focus from 20 to 200 mg/L. Expanding the underlying centralizations of the color as a rule prompts an increment in the level of expulsion as it offers a main impetus that makes color go to the outside of the biosorbent particles [21-25].

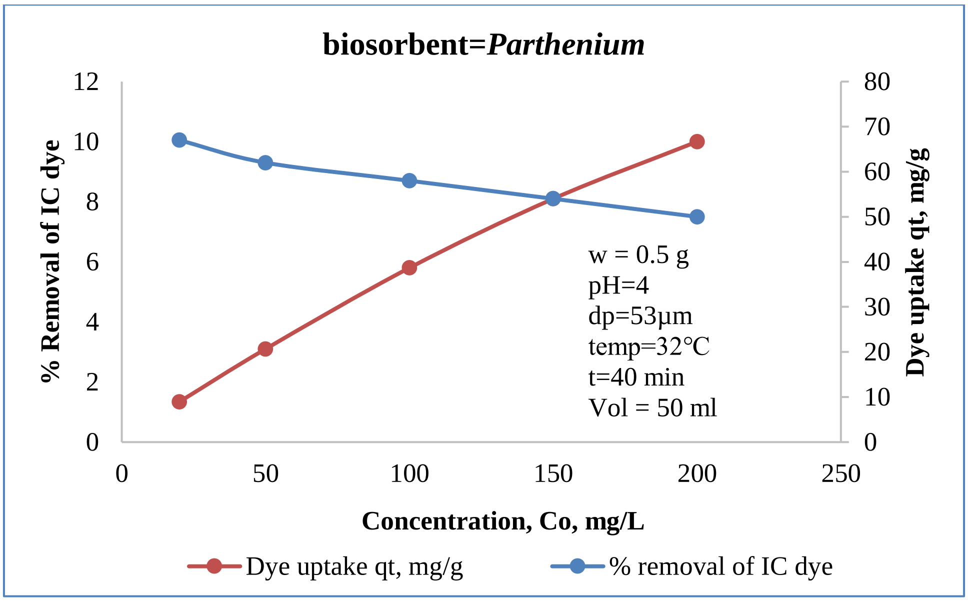

Figure 4. Effect of Initial Concentration on % removal of IC dye

Effect of Bisorbent Dosage

Figure 5 addresses the adjustment of rate biosorption of Indigo caramine from the watery arrangement with biosorbent portion. The % biosorption is expanded from 67 % to 88% as measurements is raised from 10 to 70 g/L. The % biosorption from the watery arrangement expanded with an augmentation in the biosorbent daosage. This is so in light of the fact that the number of dynamic locales open for color take-up would be more as the dose of the biosorbent is expanded [26-30].

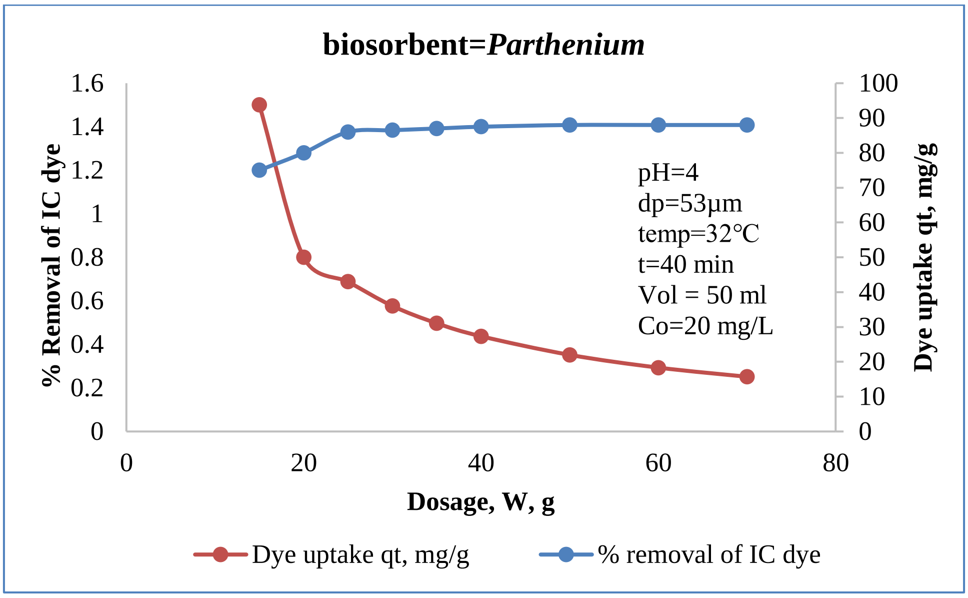

Figure 5. Effect of Bisorbent Dosage on % removal of IC dye

Effect of Temperature

The Effect of changes in the temperature on the IC color take-up is found in Figure 6. Results show that the adsorption furthest reaches of Parthenium growth for the IC color expanded with temperature. The upgrade in adsorption could be additionally because of the reduction in the thickness of the limit layer encompassing the sorbent with temperature, so the mass exchange opposition of adsorbate in the limit layer diminishes. This may likewise be an aftereffect of an increment in the portability of the color atom, and thus improved the pace of intraparticle dissemination of sorbate with the ascent of temperature [31-35].

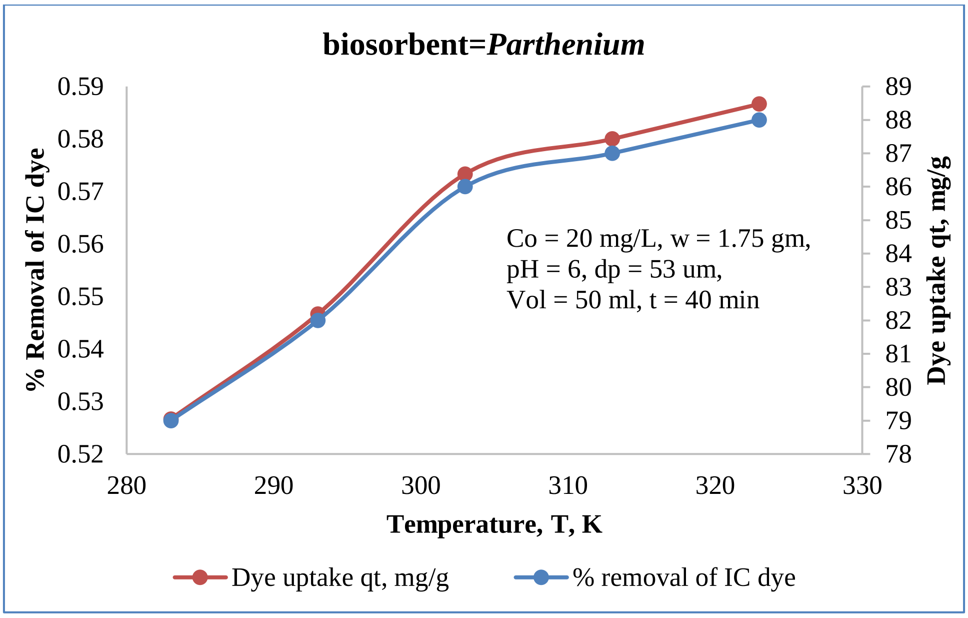

Figure 6. Effect of Temperature on %removal of IC dye

Conclusion

The aim of this investigation is to determine the suitability of *Parthenium* powder as sorbent for the removal of IC dyes from aqueous solutions. The equilibrium, kinetic and thermodynamic studies are carried out for sorption of IC experimentally and theoretically. The analysis of the experimental and theoretical data result in the following conclusions: The equilibrium agitation time for IC dye sorption is 40 minutes. Percentage sorption of IC dye from the aqueous solution increases significantly with increase in pH from 2 (50%) to 6 (70%). The optimum dosage for sorption is 35 g/L (1.75 mg/g). The maximum uptake capacity of 17.6367 mg/g is obtained at 303 K. It can be concluded from the above results that *Parthenium* powder is capable of removing Indigo caramine dye.

Conflicts of interest

The authors declare no conflicts of interest.

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