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Two - Stage Adsorption Process in Colour Removal of Crystal Violet Dye

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Abstract:- The textile industry is one of the major contributor towards environmental pollution. The amount of effluent directly being disposed off into the water resources, causes hazardous diseases and various other effects in human beings. Various methodologies are adopted for the treatment of textile effluent like precipitation, absorption, adsorption, nanofiltration, flocculation etc.

In this work titled " TWO STAGE ADSORPTION PROCESS IN COLOUR REMOVAL OF CRYSTAL VIOLET DYE" we are performing a two stage consecutive process in the treatment of basic dye "Crystal Violet". We have chosen adsorption process because of the simplicity and reliability of the process, it requires low energy and maintenance costs .The methodology consists of biosorption technique where we used rice husk as adsorbent and then followed by chemisorption technique for which we used zinc oxide nanoparticles, prepared by precipitation method. By varying the dosage, time, pH of the adsorbent the optimum optical density values were found using UV-VIS Spectrophotometer. The various characteristics of the treated sample were studied and reported. Significant changes in the colour removal of dye was observed and the maximum removal was found at 300ppm of concentration of dye, 0.8 gram of rice husk(biosorbent), 200 minutes of time , pH value of 6 and dosage of ZnO nanoparticles of 1 gram (chemisorbent). The experimental results show that these adsorbents have good potential to remove the colour from the effluent.

I. INTRODUCTION

Removal of toxic materials from waste water is necessary for health and environmental protection. For this purpose, conventional methods such as reduction, precipitation, adsorption, oxidation and ion exchange are commonly used. However, among them adsorption process is the most suitable method because of its high efficiency and economic consideration. Adsorbents such as activated carbon, zeolites, bio materials, polymers, nano materials have been extensively used for waste water treatment.

Rice husk, which is relatively abundant and inexpensive material containing huge amounts of silicon, cellulose and lignin which makes it one of the best adsorbent . In addition to the organic adsorbent, we have used synthesized zinc oxide nanoparticles which is a white to yellowish-white crystalline powder which has antibacterial properties, greater durability, selectivity and heat resistance. Various studies have been made in using these adsorbents in effective colour removal of dye.

The objective of this work is to examine the removal characteristics of pretreated rice husk and zinc oxide nanoparticles in the colour removal of crystal violet dye, by a consecutive process of biosorption and chemisorption.

II. MATERIALS AND METHOS

A. Pretreatment of Rice Husk.

In order to increase the specific surface area, the rice husk was washed using distilled water, soaked in a mixture containing 50 ml of concentrated sulphuric acid and 5000ml of distilled water for a duration of 24hours and then filtered. The acid treated rice husk was oven dried at a temperature of 80℃ to remove moisture content. The oven dried rice husk was ground into powder form and sieved through 75µm sieve.

B. Synthesis of Zincoxide Nanoparticles.

ZnO nano particles were synthesized by direct precipitation method using zinc acetate dihydrate and ammonium hydroxide as precursors. In this work, the aqueous solution of 3.29gram of zinc acetate dihydrate with deionized water was prepared. The solution was placed under uniform stirring and ammonium hydroxide solution was slowly added until a pH of 10 was reached, forming a white suspension. The solution was stirred vigorously for 4 hours and then allowed to precipitate. The white product was washed three times with distilled water and later incubated at 80° C to obtain zinc hydroxide particles. The obtained product was calcined at 400° C to obtain ZnO nanoparticles.

III. EXPERIMENTAL METHODS

In this study, the experiments were carried out by employing batch adsorption technique. Adsorption of crystal violet dye using rice husk as adsorbent were studied under four different experimental conditions, followed by the consecutive study of ZnO nanoparticles as adsorbents by variation of dosage only.

IV. RESULTS AND DISCUSSION

A. Biosorption Process(Stage -1).

Effect of Change of Initial Concentration.

To study the effect of initial concentration of CV dye by rice husk,the dose of adsorbent(2gram), time(60 minutes), speed (350rpm) were kept as constant and different initial concentration were maintained ranging from 100-500 ppm. The test solutions were stirred in the magnetic stirrer and later filtered using filter paper. The optical density of the filtrate was measured using the UV-VIS spectrophotometer. The effect of initial concentration of crystal violet dye by rice husk as adsorbent is presented in Fig.1.

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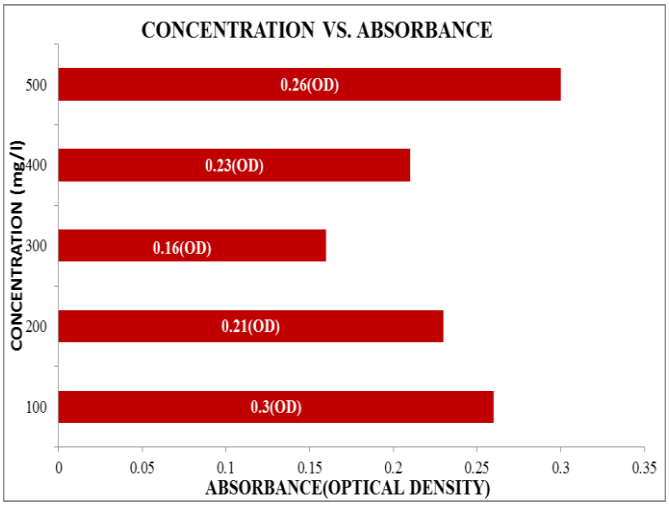

Fig 1:- Concentration Vs. Absorbance

The optimum concentration of dye was found to be 300 ppm.
Effect of Dosage of Adsorbent:

The experiments were carried out for various doses of adsorbent ranging from 0.2-1gram and concentration of dye as 300ppm with time(60minutes), speed(350 rpm) as constant. The effect dosage of adsorbent is presented in Fig.2.

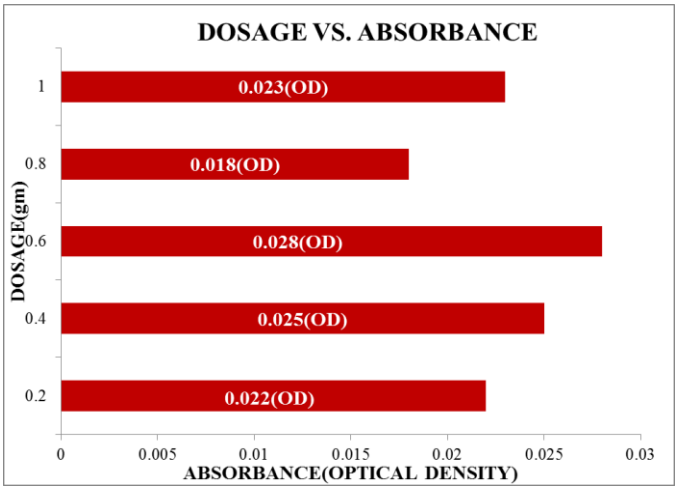

Fig 2:- Dosage Vs. Absorbance

The Optimum Dosage of Rice Husk Was Found To Be 0.8 Gram.
Effect of Contact Time:

The experiments were carried out for various time intervals ranging from 30 -120 minutes and the concentration of dye(300ppm), dosage of rice husk(0.8gram) were kept constant. The effect of contact time is presented in Fig.3.

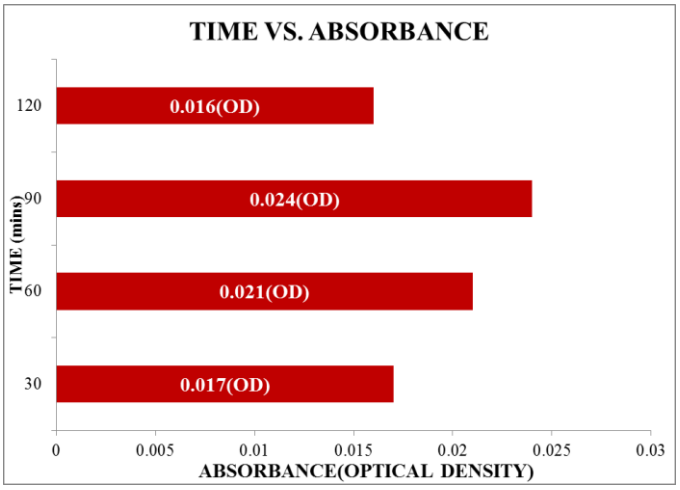

Fig 3:- Time Vs. Absorbance

The optimum time contact time was found to be 120 minutes.
Effect of Ph:

The experiments were carried out for various pH of solution ranging from 2- 8 by adding required volume of 0.1N solutions of HCL or NaOH, with optimum initial concentration (300 ppm), time(120mins), dosage of rice husk(0.8gram). The effect of pH is presented in Fig.4.

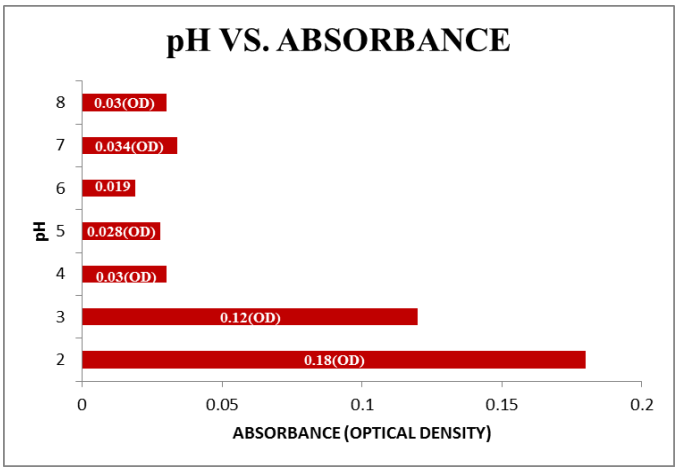

Fig 4:- pH VS. Absorbance

The Optimum Ph Was Found To Be 6.
B. Chemisorption Process(Stage-2).

The optimum results from the biosorption process were recorded and the second stage of the treatment process was carried out consecutively in observation of the recorded parameters.

Effect of Dosage Variation.

This experiment involves the variation of synthesized nanoparticles from 0.5 -1.5 gram with the optimum results from previous stage of treatment. The effect of dosage of ZnO nanoparticles is presented in Fig.5.

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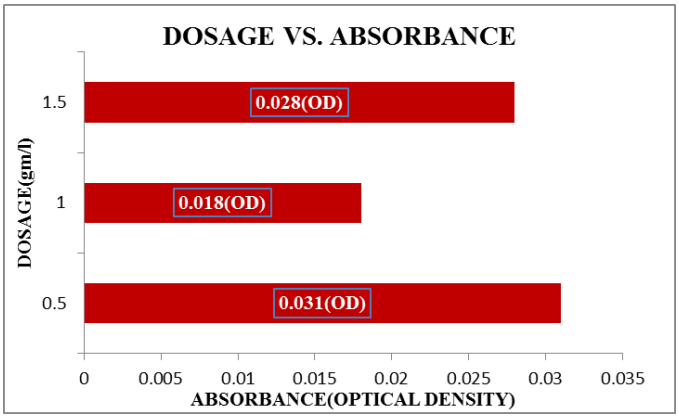

Fig 5:- Dosage Vs. Absorbance

The optimum dosage was found to be 1 gram.

V. CONCLUSION

In this work the colour removal of crystal violet dye by two stage adsorption process was investigated. This study monitored the ability of rice husk followed by synthesized ZnO nanoparticles in removal of CV dye.In the first stage of treatment the maximum colour reduction in dye was obtained at an optimum dosage of rice husk of 0.8g, an optimum contact time of 120 minutes and an optimum pH of 6.Consecutively the second stage of treatment was performed and the optimum dosage of synthesized ZnO nanoparticles was found to be 1 gram. A Comparison of the recent color removal technologies helped us to choose an innovative color removal technology. The two stage adsorption process can be used for effective colour removal of crystal violet dye proving to have the perks of both the adsorbents.

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