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Effluent Treatment of Textile Industrial Waste using Treated Sugarcane Bagasse

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Abstract: The study investigates the efficacy of effluent treatment methods on textile wastewater with bagasse. The textile industry is known to produce significant amounts of wastewater, which can contain various pollutants, including dyes, chemicals, and heavy metals. The study evaluates various treatment processes, such as coagulation-flocculation, adsorption, and membrane filtration, to determine their ability to remove pollutants from textile effluent. The research also considers the environmental and economic impacts of these treatment methods. The findings suggest that membrane filtration is the most effective method for removing pollutants from textile effluent, although it can be costly. The study concludes that implementing appropriate effluent treatment methods is essential for minimizing the environmental impact of the textile industry and maintaining the sustainability of water resources.
Keywords: Wastewater treatment, Effluent, Dye removal, Adsorption, Foundry sand, Textile.

I. INTRODUCTION

In the modern world, environmental pollution caused by rapid industrialization is one of the main and most important problems. Of all industries, the most polluting wastewater comes from the textile industry. The industry plays an important part by providing direct employment to about 35 million people in the Indian economy. It promotes 4% of GDP and 35% of gross export earnings. The textile sector contributes 14% to the value added in the manufacturing sector. Textile processing involves many different steps. Wastewater is produced in almost all of these steps. The amount and composition of this wastewater depend on various circumstances, including the fabric being treated and the type of process. Changes in machinery, chemicals used or other process characteristics also change the character of the resulting wastewater. Some processes produce almost no wastewater, such as yarn-making, weaving, and singing. The quantity of wastewater yield in a process such as sizing is small but highly concentrated, contrasting to how processes such as washing, bleaching, and dying produce big amounts of wastewater that vary widely in composition. The main one is produced wastewater with very high levels of chemical oxygen demand (COD), biochemical oxygen demand (BOD) and typical toxic pollutants generated from various dyes, auxiliary chemicals such as organic acids, fixing agents, defoamers, oxidizing/reducing agents and diluents. environmental concerns.

The textile sector is enabled and facilitated by the increasing use of materials, which has a manifold impact on the environment. Degradation through soil, air and water pollution occurs as a result of an increase in the wastewater load in the environment. For industrial wastewater to be successfully treated with biological means, it should contain the amount of organic matter that needs to be removed, and these (and any other constituents present in the wastewater) should not impede the biological process. The amount of organic substances in the waste water is indicated by the values of BOD5 and COD (dichromate). Since BOD is the oxygen consumption developed by microorganisms to degrade organic matter, while COD is the biodegradability (i.e., approximately equivalent to total organic matter), the difference between COD and BOD values would provide an indication of the amount of non-biodegradable organic matter. Similarly, the BOD5:COD ratio can provide an indication of how amenable the wastewater is to biological treatment. Since the COD value of dichromate is higher than the BOD_5 value, the BOD_5:COD ratio would be relatively small or close to zero.

One of the most important resources on the planet is clean water, which is also a valuable resource, especially at sites of regularly happening droughts and shortages of water in various areas of the world. Although, harmful substances are one of the constituents of wastewater which cannot be released back into the environment without being processed. The significance of treatment of wastewater is therefore twofold: to reinstate the water supply and to protect the planet from toxins. Conventional water treatment methods have certain limitations, such as high operating costs, low sustainability, chemical stability, high sludge formation, separation difficulties, and long processing time. With these limitations, the final results of conventional treatment are ineffective and unpromising.

Zero Liquid Discharge (ZLD) is a waste treatment system that is fabricated to ensure that no industrial wastewater is released into the environment. It is achieved by treating waste water by recycling, then recovering it and reusing it for industrial purposes 1 2 Research in Technology Advancement (ZLD) is needed to improve and optimize Systems can be achieved using new technologies such as physical adsorption, irradiation, ion exchange, Oxidation processes, electrocoagulation, bioremediation, biodegradation, enzymatic, treatment, sonication, and membrane separation techniques. These methods are required for the study of textile wastewater treatment. Thus, textile wastewater containing high pollutants and dyes is a major threat to the environment. Effective measures should be taken to clean the disposal of textile wastewater into the water tank. These advanced separation processes can thus help treat chemically complex pollutants and follow safe wastewater disposal procedures.

II. LITERATURE REVIEW

In[1], this paper, the extraction of cationic dyes, which are constituents of wastewater, using activated carbon created from sugarcane bagasse was studied. The potential of sugarcane to produce activated carbon was investigated. A spike in the Ph of dye resulted in a corresponding increase in its adsorption efficiency. The efficiency and effectiveness of this inexpensive adsorbent that is made from sugarcane bagasse is demonstrated in this study. It shows how effective it is in removing dyes from solutions and how highly possible it is to be used for simple and low-cost methods for the extraction of dyes from wastewater in stirred tanks or batch reactors. The use of stirred tank reactors or batch reactors is decided from the data obtained to design an optimal system. The effect of activated carbon made from sugarcane bagasse on the adsorption of cationic dyes is predicted in this study.

In[2],The employment of inexpensive and bionomic adsorbents has been investigated as a substitute of activated carbon for elimination of dyes from wastewater. The removal of methyl red dye from an aqueous solution was successfully carried out in a batch reactor. The inherent use of sugarcane bagasse pre-treated with formaldehyde (PCSB) and sulfuric acid (PCSBC) for the elimination of the dye from simulated wastewater. This pre-treated sugarcane bagasse was employed to adsorb the mentioned dye at different concentrations, Ph, contact time and adsorbent dose. A similar experiment was conducted with commercially abundant powdered activated carbon (PAC) to assess the potency of PCSB and PCSBC. PAC>PCSBC>PCSB is the order of the adsorption efficiency of different adsorbents. It is suggested that PCSB and PCSBC in batch or stirred tank reactors can be used as a low-cost alternative in wastewater treatment for dye removal.

In[3],Sugarcane bagasse ash is a potent adsorbent for extraction of dyes from aqueous solutions. The investigation of elimination of Acid Orange-II dye from an aqueous solution was carried out in the form of a batch adsorption study. Adsorbents are very effective in decolorized diluted solution. The study of the influence of bed depth and of flow rate on the breakthrough curve was carried out. The investigation of dye removal at varying flow rates, initial dye concentration, bed height, pH, column diameter and temperature using sugarcane bagasse ash as adsorbent was carried out. Changing these parameters resulted in a change in the dye adsorption percentage. For example, it increased by decreasing the flow rate from 2 l/h to 1 l/h, increasing bed height from 15 cm to 45 cm, decreasing the initial concentration from 150 mg/l to 100 mg/l, increasing the column diameter from 2 .54 cm to 3.5 cm, by maintaining neutral pH and at 45ºC than 25ºC & 35ºC. The result shows that bagasse ash is a good adsorbent for the treatment of waste dyes.

In[4]The investigation of the effect of different fly ash treatment methods was carried out using standard sonochemical, chemical, and microwave methods on dye adsorption in an aqueous solution. The basic dyes being used are Methylene blue, rhodamine B and crystal violet. It was discovered that the adsorption capacity of fly ash varies according to the type of dye used. An increase in adsorption capacity will occur with treatment with HCl, and it will vary according to the preparation parameters. Microwave treatment is a quick and orderly method in the production of a sample with the highest adsorption capacity. pH of the solution and organic salts that the dye solution consists of majorly affect adsorption. Langmuir, Freundlich, and Redlich-Peterson isotherm models were employed to assess the adsorption data. The outcome shows that the models that provide better correspondence to the experimental data were Freundlich and Redlich-Peterson isotherm models.

In[5]A substitute for usual costly methods for dye removal from wastewater, investigation of a cheap adsorbent being used is carried out. For a low-cost adsorbent, fly ash that was generated at the National Thermal Power Plant was gathered and made into it. It was hence used for elimination of dyes from wastewater. Adsorption studies were performed for varying adsorbent dosage, pH, particle sizes and temperatures. An increase in temperature resulted in increase in adsorption of each dye, showing that the process is endothermic by nature. The removal of each dye was inversely proportional to the particle size of fly ash. The Langmuir and Freundlich models were able to accurately show the adsorption data in linear and nonlinear forms. The outcomes stipulate that the Freundlich adsorption isotherm provided a superior fit to the data.

Moreover, the interdependence of the data was preferable with nonlinear than the linear form of this equation. Thermodynamic conditions like enthalpy, entropy and free energy of adsorption of dye-ash systems were calculated. Feasibility is indicated by negative free energy values and the endothermic nature of the process is shown by the spontaneous nature of the process and positive enthalpy. A first-order kinetic rate governs the absorption of crystal violet and basic fuchsin. The adsorption capacity of the studied substance was found to be corresponding to other commercially available adsorbents employed for the elimination of cationic dyes from wastewater when compared to other affordable adsorbents.

In[6]Elimination of a basic dye is carried out with the use of red mud and fly ash. In this paper, methylene blue is used. It is extracted from an aqueous solution. The adsorbent samples have been put under heat treatment and chemical treatment. It is confirmed that the adsorption capacity of fly ash is higher than that of red mud. The untreated fly ash and red mud have an adsorption capacity of 1.4 x 10(-5) and 7.8 x 10(-6) mol/g, respectively. Heat treatment results in a decrease in the adsorption capacity of both the adsorbents, while acid treatment with HNO3 causes an increase of the same in fly ash and reduces it in red mud. To analyze the adsorption data, Langmuir, Freundlich, and Redlich-Peterson isotherms have been used. The results demonstrate that the Redlich-Peterson model provides a more precise connection of the experimental data. Isotherms have been used to get thermodynamic characteristics such as adsorption entropy, enthalpy and free energy.

The adsorption of methylene blue on fly ash and red mud is an endothermic reaction with DeltaH(0) at 76.1 and 10.8 kJ/mol, respectively.

III. METHODOLOGY

Experimental Materials Textile wastewater will be made in the lab The physicochemical analysis of generated samples will be done by using sophisticated analytical methods and its biodegradability index will be calculated. Material for adsorbent preparation will be collected from local sugar factories and foundry plants. Different azo dyes and reactive dyes will be collected from local textile processing plants from the textile industry preparation of Adsorbent Sugarcane bagasse (SB): Sugarcane bagasse 500 grams of SB collected will be dried for 24 hours at 105ºC. Pulverized & sieved from 125 to 250 ŀm sieves. Soaked in HCL (2% V/V) for 24 Hours then filtered & dried for 2 hours at 105ºC. Then pH was balanced by 13 successive washings using demineralized water & dried for 5 hours at 105ºC, then stored in a desiccator until used for experiments.. Soaked in HCL (2% V/V) for 24 Hours then filtered & dried for 2 hours at 105ºC. Then pH balanced by successive washings using demineralized water & dried for 5 hours at 105ºC, then stored in a desiccator until used for experiments. Characterization of Adsorbent. Adsorbent will be characterized as follows:

Scanning electron microscopy (SEM): SEM carries out a scan of focused electron beam on a surface to create an image.

This conveys about surface topography and composition.

Fourier transform infrared (FTIR): FTIR involves the use of infrared light for sample scanning and assessing chemical properties. It is used for the identification of unknown materials and their chemical composition.

Characterization of dye preparation of dye solution Reactive dyes such as follows Reactive Red M5B and Remazol Brilliant Orange 3RID are selected for preparation of the experimental solution, Accurately weighed 1000 mg on METTLER TOLEDO high precision weight balance and diluted to 1000 ml using DM water in 1000 ml volumetric flask. 2. Characterization of Maximum absorbance (λ max) Solutions of concentration such as 50 ppm are prepared from dye stock solutions of Reactive Red M5B and Remazol Brilliant Orange 3RID respectively by successive dilutions of stock solution for determining λ max value of the above reactive dyes by plotting graph of wavelength v/s absorbance & transmission using SYSTRONICS Spectrophotometer 166. This λ max value of above reactive dyes was used to for further data generation, Solutions of concentration such as 0,5,10,15,25,50,100 ppm are prepared by successive dilutions of stock solution for determining graph of absorbance and transmission at λ max value by using SYSTRONICS Spectrophotometer 166.

Textile wastewater collected The Characterization of this wastewater was carried out as per standard procedures.

1) pH measurement was done using pH paper and was found in the range of 9.5-10.
2) pH is also determined using a Universal indicator. 0.2 ml of Universal indicator was added to 10 ml of effluent sample.
3) pH of the sample was determined using a color chart. pH was found to be in the range of 9.5-10.
4) Chemical Oxygen Demand (COD): COD measurement was done according to the following procedure: For COD analysis, prepare two COD bottles, one for a blank sample and one for an effluent sample.
5) Add 10 ml Potassium Dichromate (K2Cr2O7) solution in both.

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6) Add a pinch of Mercuric Sulphate (HgSO4) powder.
7) Add 30 ml mixture of [Conc. H2SO4 + AgSO4]. (for 98% strength, add 5.5 gm of AgSO4 in 1 liter of H2SO4).
8) Add 20 ml of distilled water in a Blank sample bottle.
9) According to COD range, add sample concentration but total mixture composition of dist. Water and sample must be 20 ml.
10) Because of the high concentration of effluent samples, we take 0.5 ml of sample and add 19.5 ml of distilled water.
    Keep the flasks with cap in COD digester for 2 hrs at 150°C.
11) Cool the sample for a few minutes and add 80 ml dist. Water in both flasks. Add a few drops of Ferroin indicator. Titrate samples against Ferrous Ammonium

Fig. 1Raw and crushed bagass

TABLE I
UV ANALYSIS READINGS

Ppm solutions	100	150	200	250
Intial Dye content	1.130	1.289	1.618	2.019
Time(min)	Adsorption done by adsorbent			
15	0.908	1.142	1.378	1.945
30	0.713	1.030	1.288	1.890
45	0.700	0.987	1.207	1.813
60	0.644	0.959	1.118	1.749
75	0.584	0.919	1.056	1.701
90	0.573	0.883	0.991	1.638

IV. RESULT AND DISCUSSION

The adsorbent made with the help of sugar cane molasses is successfully adsorbing the dye present in various ppm solutions. Adsorption of dye using molasses as an adsorbent has been studied. Molasses, which is a byproduct of sugar refining, contains a high concentration of natural organic compounds and has been found to be an effective adsorbent for the removal of dyes from wastewater.Study found that the adsorption capacity of molasses increased with increasing initial dye concentration and contact time.

V. CONCLUSION

The study suggests that molasses can be a low-cost and eco-friendly alternative to traditional adsorbents for the removal of dyes from wastewater. This could contribute to a more sustainable approach to industrial and municipal wastewater treatment, which is an important step towards protecting the environment and public health.

Overall, this study suggests that molasses can be an effective and low-cost adsorbent for the removal of dyes from wastewater. However, further research is needed to optimize the process and determine the practical feasibility of using molasses for large-scale wastewater treatment. How the adsorption capacity of molasses is influenced by changing pH, temperature, and adsorbent dosage can be calculated.

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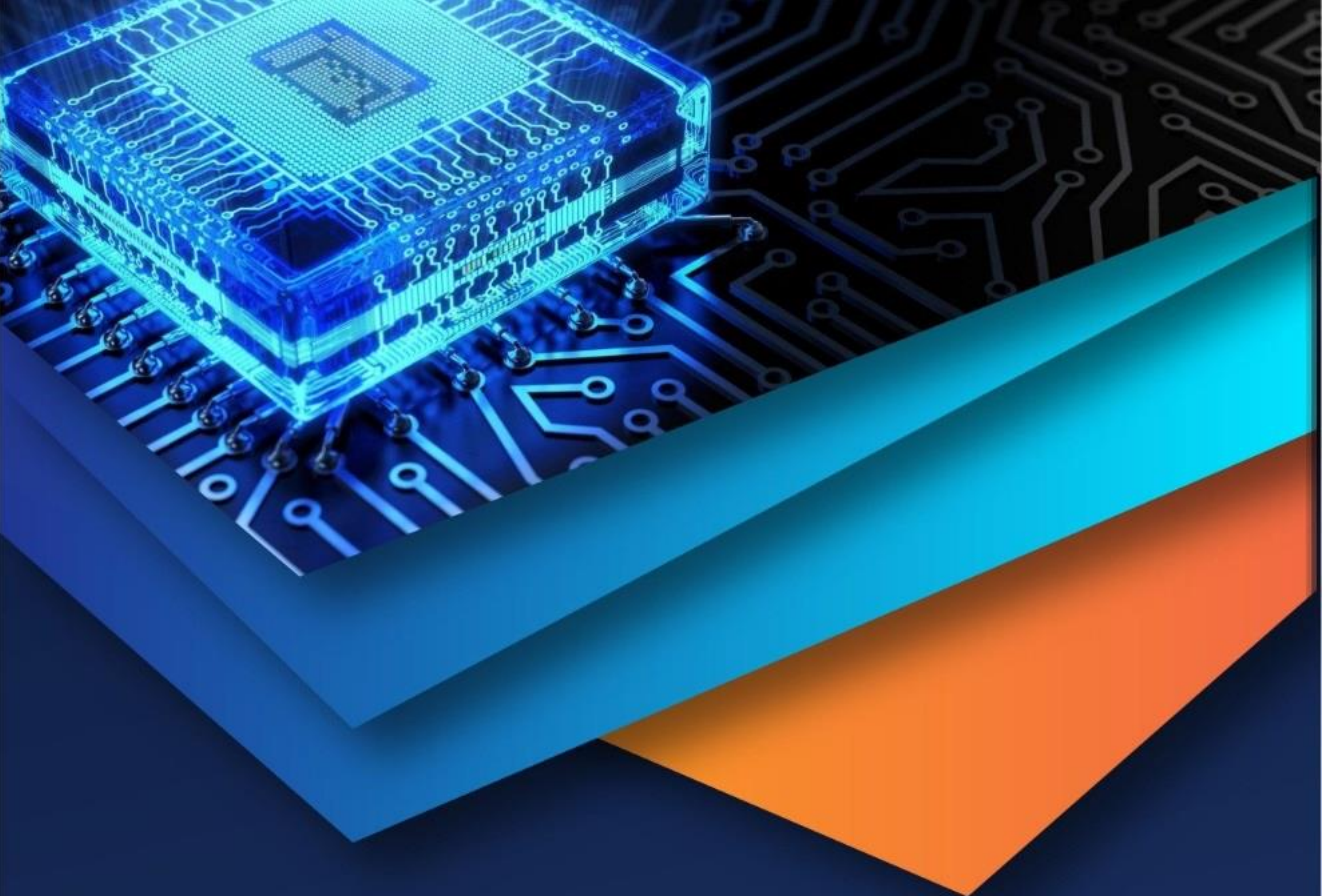

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