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LOW-COST ADSORBENT DYE REMOVAL: A REVIEW

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ABSTRACT

Due to industrialization and urbanisation, there are major environmental issues in the world today, including air, water and soil pollution. Due to the large amounts of water used in the industrial, textile, and urban sectors as well as the large amounts of effluent discharged into freshwater sources, the quality of the water is deteriorating. Both directly and indirectly, their effects have an impact on our plants and living things. This review paper illustrates the removal of dye using various low-cost adsorbents.

KEYWORDS: Modelling and Simulation, Adsorption, Biodegradable Solid Waste, Dye, Waste Water Treatment

Water is vital to human life, animal life, the processing sector, agriculture, and aquatic ecosystems. The water quality will deteriorate and have a negative impact on the ecosystem if dye effluent waste water is released into the hydrosphere. The biggest environmental issue is caused by dyes that absorb and reflect sunlight into water, interfering with bacterial growth and making it impossible for the water body's microbes to degrade organically. Because colour has a relatively high wavelength (200 to 800 nm) in water, it directly affects how much sunlight is absorbed by water bodies. Additionally, colour has a negative impact on photosynthesis, which has a negative impact on fisheries output when it occurs (Salleh *et al.*, 2011). If fish output is low, the effluent dye waste water discharge into fresh water will naturally affect the water purification system and have a negative economic and environmental impact. This issue can be resolved using a variety of engineering techniques, including physical, chemical, and biological techniques. The American dye manufacturing institute showed that the basic dyes are generally more toxic than acid or direct dyes. And some commercial dye are harmful to some microorganisms. Many dyes may cause allergic derma tics, dysfunction of kidney, skin irritation, central nervous system, liver, and brain. Organic dyes are harmful to human beings. The need to remove dye from waste water effluents become environmentally significance Surface area, pore size, chemical composition, and dye qualities like molecular size and molecular polarity all have a significant impact on the adsorption process. Due to its extensive surface area, high adsorption capacity, and high degree of surface reactivity, activated carbon is the most commonly employed adsorbent for dye removal. However, activated carbon that is sold commercially is quite expensive and has a high cost of regeneration (Table 1 and 2).

METHOD OF DYE REMOVAL

Physical Method

Membrane filtration, reverse osmosis, electrolysis, sedimentation, and adsorption are examples of physical methods. Adsorption treatment is a reliable substitute technique for removing dye from waste water. The adsorption treatment has various benefits, including low cost, ease of adjustment, reduced susceptibility to harmful substances, and increased design and operational flexibility. Two types of adsorbent are typically used (a). Organic adsorbents b) Ready-to-use activated carbon Natural adsorbents like clay, siliceous minerals, zeolites, etc. are used to remove dye.

Agriculture waste products that have been prepared and utilised as low-cost adsorbents include coconut shell, rice husk, almond shell, rice bran, and peels from oranges and bananas. Adsorbent dose, contact time, PH value, agitation speed, ionic strength, temperature, and initial dye concentration are a few of the variables that might affect adsorption ability.

Chemical Methods

Coagulation/flocculants, oxidation, ion-exchange, and neutralisation are examples of chemical methods. In general, chemical treatments are feasible, economical, and effective, but their main disadvantage is their high cost.

Biological Method

The biological technique comprises processes including fungal decolonization, aerobic and anaerobic digestion, adsorption by (living or dead) microbial biomass, and microbial degradation. According to

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Muhammad T. Yagub *et al.* (2014), microorganisms like fungi, yeast, bacteria, and algae can accumulate colour and break down many types of pollution. Anaerobic and aerobic biological treatments are both possible. However, the main disadvantage is the expensive cost of building and the needed huge land area.

Table 1: Advantages and Disadvantage of Dye Removal Methods (Salleh *et al.*, 2011).

No.	Methods	Advantages	Disadvantages
1.	Adsorption by activated carbon (physical treatments)	Good removal capacity of different Varity of dyes	Very costly
2.	Membrane filtration	Removal all types dye	Concentrated sludge production, blocking problems, maintenances cost very high.
3.	Ozonation (chemicaltreatments)	Ozone can be applied in its gaseous state and does not increase the sludge and volumeof waste water.	Very costly and short half-life (20) min
4.	Electrochemicaldestruction	No sludge formation and does not use chemical component	Relatively high flow rates cause a direct decrease in dye removal
5.	Microbial cultures (mixed bacterial) biological treatments	Decolorized in 24-30 hr	Under the aerobic condition azo dyes are not readily metabolized
6.	Adsorption by living/ dead microbial biomass	Certain dyes have a particular affinity for binding with microbial species	Not effective for all dyes
7.	Prepared activated carbon sample (bark of vachellia nilotica)	Good removal capacity of different dyes	Low cost

Sources of Dye

The technique of dying involves dyeing the fabric with organic dyes. They are frequently utilised to add colour to the textile sector and other numerous industries. They are created artificially or spontaneously. The qualities of dyeing varied for two reasons. First of all, the dye molecules' diameters are smaller than the holes in the fibre. The second cause is the dye's affinity for the fabric due to attractive forces. The forces of attraction between the dye and the fibre hold the dye that has diffused or penetrated into the fibre in place. Dyes can be obtained from both natural and artificial sources. Natural sources of dye include things like wood, tree leaves, soil, tree bark, seeds, roots, minerals, fungi, insects, clay, and microorganisms. There are two types of dye sources: natural and artificial. Clay and tree bark are naturally occurring sources of dye. (V.K. Gupta *et al.*, 2009) Leaf, root, seed, fungus, minerals, and microorganisms. Synthetic dyes are sourced from a variety of industries, including the textile, printing, rubber, plastic, rubber, cosmetics, and dye and pigment industries. All of the aforementioned industries drain wastewater into freshwater sources, causing a decline in water quality.

Classification of Dye

There are essentially two kinds of dyes. 1. Natural dye. and 2. Synthetic dye

Natural Dye

Natural dyes are those that are obtained from natural sources including insects, minerals, and plant debris. In terms of natural dyes, indigo is well recognised for its intense blue hue and was produced by fermenting plant leaves. Lac is used to extract the red colour, whereas iron oxide powder is used to remove the brown hue.

Synthetic Dye

Synthetic dyes are created using petrochemical feedstock and a variety of various organic chemical component mixtures. Perkin created the first synthetic dye from coal tar. Direct dyes, azoic dyes, acid dyes, disperse dyes, vat dyes, reactive dyes, basic dyes, moderate dyes, sulphur dyes, and direct dye are all examples of synthetic dyes. Figure -1 illustrates how dyes are categorised.

Literature Review on Dye Removal

Contact time, initial dye concentration, pH value, solution temperature, total suspended solid, adsorbent doze, adsorbent particle size, shaking speed, activated carbon characteristic (pore size, surface area, chemical composition), and dye characteristic (chemical composition, molecular weight) are the primary factors that affect the adsorption processb. Table 2 displays a literature evaluation on the use of inexpensive adsorbents to remove dye.

Table 2: Literature Review on Dye Removal

Sources	Adsorbents	Adsorbate	pH	Adsorbent dose	Concentration (mg/l)	wavelengthof adsorbate	Efficiency/ adsorption capacity
Bentahar *et al.*, 2017	Natural clay	Methylene blue crystal violet and Congo rate	2-12		100-600	λ=616 nm λ=589 nm λ=498 nm	202.13mg/g 289.59mg/g 289 mg/g
Malik *et al.*, 2007	Ground nut shell	Malachite green		0.1-1g/l	100-200	λ=617 nm	94.5%
Malik,2003	Saw dust and rice husk	Acid yellow	3	-----	------	λ=414 nm	183mg/g, 86.9 mg/g
Jia-ShunCao *et al.*, 2014	Walnut shell.	Reactive brilliantred K-2BP	0.5-11	0.1-6g/l	200	----------	568.18mg/g
Khatri *et al.*, 2011	Sagwan sawdust	Crystal violet dye	7.5	0.5g/200 ml	6,8.12mg/l	λ=592 nm	86.68%
Murugan*et al.*, 2010	Mango leaves (mangifera india)	Grey BI	7	0.1-1.5g/l	50-500mg/l	λ=575 nm	33.7mg/g

CONCLUSION

The paper examined several applications of inexpensive adsorbent for dye removal. Adsorbent surface area, particle size, contact time, initial dye concentration, pH of the aqueous solution, ionic strength of the adsorbent, agitator speed, and temperature all affect how much material may be absorbed. The carbonization temperature, chemical activation with different agents, and activation period all affect the adsorption capacity. Various academic works have emphasised how the type of the dye affects the adsorption capability (cationic and anionic dye). The maximum absorptivity of the dye in an aqueous solution of water at different wavelengths is also disclosed in this review paper. Isotherm of Freundlich and Langmuir models are employed to assess the adsorption potential of various adsorbents. This review paper promotes more investigation into the use of inexpensive adsorbent in the community for effective waste water treatment.

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