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Removal of Dyes by Using Wheat Husk Waste as low Cost Adsorbent: A Review

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ABSTRACT: This review examines the techniques for the expulsion of colors from the wastewater effluents. Wastewater effluents contain engineered colors which make potential adverse effects on the earth consequently these colors need to expel from the water bodies. The different color expulsion strategies are arranged into Chemical, Physical, and Biological techniques. Physical strategies incorporates adsorption, particle trade, and filtration/coagulation techniques and so on while synthetic techniques incorporates ozonisation, Fenton reagent, photograph synergist responses and organic techniques incorporate oxygen consuming debasement, anaerobic digestion, biosorption and so forth. Adsorption observed to be exceptionally compelling and modest technique among the all accessible color evacuation strategies. Colors from the mechanical waste water effluents are adequately isolated by utilizing adsorbent, for example, enacted carbon, however, its cost confines the utilization in extensive scale applications. Experiments demonstrated that the compelling expulsion of colors is obtained using several cheaply available non-conventional adsorbents also. Subsequently, studies identified with looking for proficient and minimal effort adsorbents got from existing assets are picking up significance for the removal of colors.

Keywords: Wheat husk waste; bio-adsorbent; dye

INTRODUCTION

Colors are shaded mixes which are generally utilized as a part of materials, printing, elastic, beautifying agents, plastics, cowhide businesses to shading their items brings about creating a lot of hued wastewater. Fundamentally colors are characterized into anionic, cationic, and non-ionic colors. Among every one of the colors utilizing as a part of ventures, material businesses put in the main position in utilizing of colors for tinge of fiber [1]. Colors are concoction mixes which append themselves to textures or surface shells to confer shading. Depolarization of waste water from material and assembling enterprises is a noteworthy test for ecological chiefs as colors are water solvent and create brilliant hues in water with acidic properties. It has been anticipated that material and assembling businesses are utilizing in excess of 10,000 industrially accessible (around the world) colors and the utilization of colors in material industry is in excess of 1000 tones/year and around 10-15% of these colors are released into squander streams as effluents amid the coloring forms. Colors are mostly gotten from regular sources with no concoction treatment, for example, plants, creepy crawlies, creatures and minerals. Colors got from plant sources are indigo and saffron, creepy crawlies are cochineal bugs and lac scale bugs, creature sources are gotten from a few types of mollusks or shellfish, and minerals are ferrous sulfate, ochre. Enterprises, for example, material, printing, paper, cover, plastic, and cowhide utilize colors to give shading to their items. These colors are constantly left in modern waste and thus released into the water body [1]. The paper reviews the different studies carried out for the removal of dyes from waste water by using various bioabsorbents.

DYE REMOVAL/SEPARATION TECHNIQUES

Wastewater effluents contain synthetic dyes which may cause a potential hazard to the environment. Due to the environmental and health concerns associated with the wastewater effluents, different separation techniques have been used in the removal of dyes from aqueous solutions. The dye removal techniques are Physical, Chemical and Biological methods.

Feng et al. 2013 [2] modified *Brassica napus* L. by oxalic acid under mild conditions producing an efficient dye adsorbent. Equilibrium study showed that the Langmuir model demonstrated the best fit to the equilibrium data and the methylene blue (MB) adsorption capacity calculated by this model was 432 mg g^{-1}. This method both solved the disposal problem of contaminant-loaded bioadsorbents and produced an useful adsorbent thereafter. The study indicates that SRSOA is a promising substitute for ACs in purifying dye-contaminated wastewater and that producing biochars from contaminant-loaded bioadsorbents maybe a feasible disposal method.

Daneshvar, et al. 2014 [3] focused on kinetics, balance and thermodynamics of Acid Blue 25 (AB25) dye biosorption from aqueous solution using the shell of *Penaeus indicus shrimp* as a biosorbent. Optimum sorption conditions were recognized by varying solution pH, biomass dosage, initial dye concentration, contact time, salinity and ionic strength. Equilibrium data were well fitted by the Temkin, Freundlich and Langmuir isotherm models, while the pseudo-second order model best described kinetics. Thermodynamic data showed that AB25 dye biosorption onto shrimp shell was a feasible, spontaneous and exothermic one. The biosorption capability enhanced with reducing the sorbent particle size and with the addition of salts (NaCl, MgSO4, KNO_3 and KH_2PO_4). The high sorption capacity of *P. indicus* shell obtained in this study suggests its use as an effective, low-cost biosorbent for the removal of acid dyes from wastewaters.

Yu et al. 2016 [4] developed a novel high-performance porous carbon material, nickel-doped magnolia-leaf-derived porous carbon (Ni/MPC) by a KOH activation process and nickel-doping approach. Removal of anionic dye congo red (CR) from contaminated water was performed in a batch reactor system to obtain adsorption kinetics and isotherms. The results showed that pseudo-second-order kinetic model and Langmuir adsorption isotherm matched well for the adsorption of CR onto Ni-doped MPCs. Compared with earlier studies on adsorbents, Ni/MPCs demonstrated a superior CR dye adsorption capability.

Babalola et al. 2016 [5] advocated that alteration of the structural and functional integrity of the aquatic ecosystems due to contamination from toxic industrial dyes warrants cost effective remedial strategies. *Cedrela odorata* Seed Chaff (COSC) was locally sourced, indigenous and ubiquitous. The efficacy of the COSC was assessed for the adsorption of some toxic industrial dyes, namely Methylene Blue, Congo Red, Methyl Violet and Methyl Orange from aqueous solutions. The microstructures of COSC were carried out using pH of Point of Zero Charge, Specific Surface Area, Bulk Density, FTIR, XRD, TGA and SEM which indicated that various organic moieties were present in COSC, which the toxic industrial dyes studied were adsorbed onto. The results support the use of COSC as a cost effective material for removal of toxic industrial dye from an aquatic system.

Song et al. 2017 [6] argued that high-efficiency and recyclable three-dimensional bioadsorbents can be prepared by incorporating cellulose nanocrystal (CNC) as reinforcements in keratin sponge matrix to remove dyes from aqueous solution. Adsorption performance of dyes by CNC-reinforced keratin bioadsorbent improved significantly due to adding CNC as filler. Batch adsorption results showed that the adsorption capacities for Reactive Black 5 and Direct Red 80 by the bioadsorbent were 1201 and 1070 mg g^{-1}, respectively. The isotherms and kinetics for adsorption of both dyes on bioadsorbent followed the Langmuir isotherm model and pseudo-second order model, respectively. The experiments revealed that the removal efficiencies of the bioadsorbent for both dyes could remain above 80% at the fifth recycling cycles. Moreover, the bioadsorbent influenced brilliant packed-bed column operation performance. Those results suggested that the adsorbent could be considered as a high-performance and promising candidate for dye wastewater treatment.

Feng et al. 2017 [7] prepared a carboxylic functionalized bioadsorbent that met the "4-E" criteria: Efficient, Economical, Environmentally friendly, and Easily-produced. Sesame straw (*Sesamum indicum* L.) was functionalized through treatment with citric acid (SSCA) and tartaric acid (SSTA). The excellent dye adsorption capacity of SSCA can be attributed to the introduction of ester groups during citric-acid modification and the tube-like structures. At last, the cost of carboxylic acid functionalized bioadsorbents was evaluated, which showed that SSCA would be the most cost-effective bioadsorbent. Additionally, this study presents a thermo-decomposition methodology for contaminant-loaded bioadsorbent. Results confirmed that SSCA is probably one of the few bioadsorbents can be produced and applied in industrial scale.

Fideles et al 2018 [8] used as an environmentally friendly adsorbent for removal of the basic dyes auramine-O (AO) and safranin-T (ST) from aqueous solutions at pH 4.5 and 7.0. Maximum adsorption capacities for removal of AO and ST were 1.005 and $0.638\ \text{mmol g}^{-1}$ at pH 4.5, and 1.734 and $1.230\ \text{mmol g}^{-1}$ at pH 7.0, respectively. Adsorption enthalpy changes obtained by isothermal titration calorimetry (ITC) ranged from -21.07 ± 0.25 to $-7.19 \pm 0.05\ \text{kJ mol}^{-1}$, representing that both dyes interacted with STA by physisorption. Dye desorption efficiencies ranged from 41 to 51%, and re-adsorption efficiencies ranged from 66 to 87%, showing that STA can be reused in new adsorption cycles.

Bouaziz, et al. 2017 [9] investigated the potential of almond gum as low cost adsorbent for the removal of the cationic dye; malachite green from aqueous solutions. Almond gum was first analyzed by SEM and FTIR, and then the adsorption behavior was studied in batch system. The effects of the adsorption parameters like adsorbent dose, pH, contact time, particle size, initial dye concentration, temperature and agitation on the dye removal have been studied. Adsorption equilibrium and isotherms were evaluated depending on temperature using the isotherms of Freundlich, Langmuir, and Tempkin. The obtained result showed that both Langmuir and Freundlich models were adapted to study the dye sorption. The maximum adsorption capacities were equal to 172.41 mg/g, 181.81 mg/g, and 196.07 mg/g at 303.16 K, 313.16 K, and 323.16 K, respectively. The kinetics of sorption were following the pseudo-second order model. The thermodynamic changes in enthalpy (ΔH), entropy (ΔS), and free energy (ΔG) indicated that the adsorption of malachite green at the surface of almond gum is endothermic and occurs spontaneously. Desorption experiments were conducted to regenerate almond gum, showing great desorption capacity when using HCl at pH 2.

Naseeruteen et al 2018 [10] prepared Chitosan ionic liquid beads from chitosan and 1-butyl-3-methylimidazolium based ionic liquids to remove Malachite Green (MG) from aqueous solutions. Batch adsorption experiments were carried out as a function of initial pH, adsorbent dosage, agitation time and initial MG concentration. The optimum conditions were obtained at pH 4.0, 0.008 g of adsorbent dosage and 20 min of agitation time were utilized in the kinetic and isotherm studies. The maximum adsorption capacity (qmax) obtained from Langmuir isotherm for two chitosan beads 1-butyl-3-methylimidazolium acetate A and 1-butyl-3-methylimidazolium B are 8.07 mg g−1 and 0.24 mg g−1 respectively.

Alinejad-Mir et al 2018 [11] synthesized Fe_3O_4gelatin via a controlled co–precipitation method to obtain uniform and high efficient nanocomposite for direct yellow 12 (DY12) removal. The adsorbent morphology and chemical composition were evaluated using FE–SEM, VSM, FT–IR, XRD and BET. The analyses for characterization indicated that Fe_3O_4–gelatin was successfully obtained with crystallite size and average particle diameter about 82 nm and 81 nm, respectively.

CONCLUSIONS

Distinctive procedures accessible for expulsion of harmful natural mixes from squander water, for example, filtration, coagulation/flocculation, particle trade, adsorption, fenton reagent strategy, ozonisation, photocatalytic techniques, oxygen consuming debasement and anaerobic corruption strategies have been utilized. Synthetic and natural techniques observed to be restricted as they are frequently include high speculation and practical expenses. Then again physical techniques like particle trade and switch osmosis are fascinating strategies on account of their successful expulsion procedure of toxins from mechanical waste water yet these particle trade and turn around osmosis techniques confines the utilization in vast scale ventures because of their high capital and operational expenses. Among every one of the strategies accessible for detachment of contaminations from squander waters, the adsorption demonstrates conceivable technique for treatment and expulsion of natural toxins in squander water treatment. Adsorption takes after surface wonder and more beneficial over the other accessible techniques due to its low capital, task expenses and straightforward plan. According to the specialists the adsorption is most regularly utilized strategy for the expulsion of both natural and inorganic poisons from modern waste water. Adsorption material accessible from different sources, for example, regular sources, farming, and mechanical squanders. Color removal from wastewater utilizing enacted carbon is viable strategy yet in modern procedures it was limited because of its high operational and venture costs. In the adsorption strategy different other normal sources are accessible for expulsion of colors from mechanical wastewater

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