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Removing dyes from wastewater using biosorbent: A review Paper

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ABSTRACT

The removing dye from wastewaters is a main concern in textile industries letter, press and other commercial manufacturing systems in this decade. This process can make our environment polluted and endanger human being health as they are poisonous and have negative effects on human body. This review paper firstly recognizes synthetic pollution, its characterization and poisonous particles; then, it presents several improvements regarding optimum methods for treating and removing dye from wastewater and finally it suggests some adsorbents that are bio-based and money-saving. A comprehensive category of adsorbents including agricultural waste, bio and natural materials and industrial waste were reported. This paper suggests adsorption method using bio-waste adsorbent as an acceptable method in order to remove dye from waste water. However, further studies are needed to scrutinize the precise results of this approach in industry.

Introduction

Water pollution is any pollution of water with compounds or other foreign materials that are harmful to human beings' health, animals and plants. The textile manufacturing is one of the major contaminators in the world. Throughout the world, approximately 2 billion people drink polluted water that could be dangerous to their health (Allen, Mckay et al. 2004). Wastewater from textile dyeing industry results in water pollution which is a source of major concern. . Moreover, the existence of color in water causes reduction of aquatic diversity, this phenomenon happens as a result of light transmission blockage. The dyes removing techniques are costly and ineffective as the dyes sustain chemical changes in environment and their modified outputs probably add more cancer-causing and harmful particles than their original molecules to the environment. Therefore, it is recommended to study the toxic effect of the wasted materials on several living organisms instead of finding every chemical separately. (Robinson, McMullan et al. 2001)

Dye pollution

Dyes are threatening living organisms; therefore, it is vital to protect the natural surroundings from such like pollutants. In order to mitigate the drinking water pollution through dyes, at the first place, it is important to quantify and discover these substances in waste waters (Padhi 2012).

All types of dyes including acid dyes have the capability to cause cancer and allergic problems in human bodies as a result of their complex molecular formation and also the decomposition of these compounds which occurs in body. Moreover our skins have exposed to dye every day as we dress up the fabrics clothes and also a wide range of foods that we eat frequently have colored by acid dyes(O'Neill, Hawkes et al. 1999).

In human being, these effects are related to various carcinogenic and genetic Previous studies prove that human bodies are not able to process these chemical and toxic materials as they are not safe and damage the immune system and may cause the dysfunction of stomach and affect the kidneys negatively (Baskaralingam, Pulikesi et al. 2006) cause the dysfunction of stomach and affect the kidneys negatively (Baskaralingam, Pulikesi et al. 2006). Different of kinds of dyes have been shown in table 1.

There are several connections that connect molecules of acid dyes to fibers, such as hydrogen bonding ionic, and van der waals force. These dyes are organic sulfonic acids, the industrials accessible structures are generally sodium salts which expose great water solubility. Synthetic nylon and Animal protein fibers have plenty cationic sites. Thus, cationic site on the fiber attracts anionic dye molecule.(Judd 2010).The characteristics and chemical structure to connecting dye molecules to fiber surface is showed in figure 1.

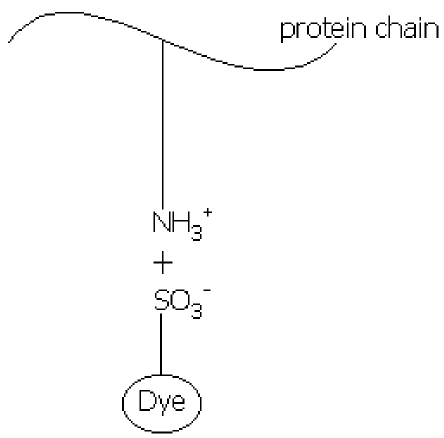

Figure 1. Connection of dye to fiber

Acid dyes are commonly used with certain fiber types for instance, wool, silk, polyamide, modified acrylic, and polypropylene fibers as well as mixtures of the aforementioned fibers with other fibers such as cotton, rayon, polyester, regular acrylic.(Attia, Rashwan et al. 2006). One of the most important dyes is Acid Green 25 ($C_{28}H_{22}N_2O_8S_2$.2Na) which actually fit in the commercial dyes that has several functions in textile industry. This dye was categorized as toxic dye and its removing from waste water is the major concern. Acid green 25 also apply in cosmetic products and hair dye formulation that ingredient used in non-oxidative hair dye productions. Acid Green 25 is

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constant in water at 20 °C until 7 days. As a consequence, some marine creature and flora existence may be compromised. Beside, this compound can also lead to bring a spotty or slight discolor in the orbital cell of several animals at 10 percent aqueous solution, lots of soft irritation at 15% aqueous solution and cutaneous irritation at 50 percent aqueous solution in 1persent CMC (carboxymethyl fiber) (Koswojo, Utomo et al. 2010). The structure of acid green 25 molecule is shown in figure 2.

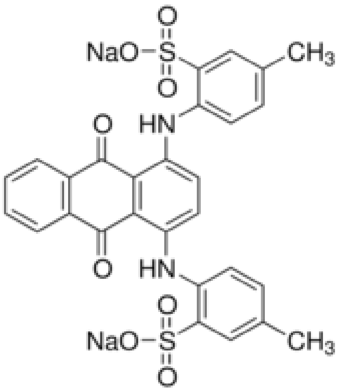

Figure 2. Acid Green Dye 25

Adsorption

Various techniques like precipitation, filtering by membrane , coagulation (Amini, Arami et al. 2011), including chemical degradation (Minero, Lucchiari et al. 2005) electrochemical, ion exchange, chemical oxidation(Wu and Chern 2006)adsorption (Gupta 2009), and so on were examined for removing dye from wastewater.

The adsorption of synthetic dyes by low cost, effective and bio solid was considered as a regular and money saving technique for removing dye from wastewater plus water. The adsorption specification of a variety range of organic and inorganic synthesis were evaluated and the capacity of this adsorbent for removing dyes compound was measured (Wang, Silva et al. 2007)

In recent years, a wide range of agronomy lignocellulose by-products were employed to extend low cost, useful and available adsorbents for separating colorant of wastewater such as, clay(Ramakrishna and Viraraghavan 1997) orange peel (Namasivayam, Muniasamy et al. 1996), banana pith(Namasivayam, Prabha et al. 1998) , rice husk(Ho, Chiu et al. 2005) , powdered activated sludge(Doğan, Alkan et al. 2004), and activated carbon/ charcoal(Sharma, Upadhyay et al. 2009). Now a nowadays, using low cost fibers as adsorbent are very common in the adsorption of dye discharge (Koswojo, Utomo et al. 2010). A summary of advantages and disadvantage of various methods in removing dyes was shown in Table 2.

Among all these methods, adsorption is preferred because of its low cost and high treatment efficiency. The main benefits of adsorption processing are related to easy design and simple process, no effect by toxicity materials, greater removing and less energy investment for organic waste components as compared to the conventional treat techniques (Hameed, Krishni et al. 2009). For selecting an effective adsorbent, there are some aspects that should be considered as main factors such as environment and economy. Different kinds of researches have studied on adsorption processes for wastewater treatment, especially to remove the dyes. The aim of these researches are to compare the sorption capacity of bio sorbent core fibers on the removing of dye. The selectivity of bio adsorbents are mostly more than common ion-exchange resins specially commercial activate carbon, in addition they could decrees dye concentration micro quantity.

Bio Sorption

Removing and clearing the contaminants from water and waste water by using of organic resources has known as bio sorption .Over the decades, bio-adsorption method was functional because of some beneficial aspects such as easy to access , being competitive , impressive, available and cheap. These substances are accessible in large quantities so they would be implemented as sorbents because of their physical and chemical specifications. (Aksu and Dönmez 2003) They have numerous biological syntheses such as hemicellulose, fiber and lignin with polyphenol groups that can be beneficial for removing molecule of dye through diverse methods. The most important benefit of adsorption by bio materials methods is their potential in removing the wide range of compounds that cause pollution in water such as dye molecule and heavy metal ion (Aksu and Tezer 2005).

Thus, bio mass alternative adsorbents such as agricultural waste were used because of economic issues. One of the impressive biomass that can be used as an adsorbent in adsorption process is kenaf. . The expression of kenaf (hibiscus cannabinus L) started from Persian language in late nineteenth century. Kenaf is the third-world yield after wood and bamboo, and it is ready to be the following industrials harvest in Malaysia. The local government has apportioned RM12 million for identification and further improvement of the kenaf-based industry under the ninth Malaysia Plan (2006–2010) in distinguishment of kenaf as an economically suitable harvest (Akil et al., 2011)It was reported from previous studies that kenaf is an excellent adsorbent for removing pollution from waste water. In previous researches, kenaf core fiber used to separate copper ions into aqueous solution. Moreover, in different studies the kenaf was treated to examine the capability for removing methylene blue dye (MB) from aqueous solutions (Mahmoud, Salleh et al. 2012) Additionally from the results of previous studies it can realized that kenaf core fiber is a qualified adsorbent to separate heavy metal ions from aqueous solution (Sajab, Chia et al. 2011).

Conclusion

Pollutants mostly go into surface waters through discharging from a diversity of industrial processes such as food, dye, chemical industries and the petrochemical materials. The presence of toxic pollutants in water sources has stimulated much attention in recent decades. Furthermore, they cause unwanted effects in the color, taste and odor of source waters. Dyes might be dangerous for mankind and harmful to lentic organisms. Adsorption using activated carbon is the most common method for removing dye because of the efficiency process. However there are some limitations for using activated carbon in these areas due to the high expenses of its activation and regeneration. Furthermore, it is important to consider cheap substance to remove color in order to keep industries into textile dying. This review represented adsorption method by bio-waste as an alternative adsorbent for removing dye from waste water. Additionally, this study recommended using different kinds of treatment on adsorbent surface in order to enhance the capability of adsorption. However, it is necessary to compare the adsorption results with modified and un- modified adsorbent to detect the optimum efficiency of adsorption.

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Table 1. Typical dyes used in textile dyeing operations

Vat	Water-insoluble; oldest dyes; more chemically complex
Basic	Water-soluble, applied in weakly acidic dye aths; very bright dyes
Direct	Water-soluble, anionic compounds; can be applied directly to cellulosic without mordents (or metals like chromium and copper)
Disperse	Not water-soluble
Reactive	Water-soluble, anionic compounds; largest dye class
Sulfur	Organic compounds containing sulfur or sodium sulfide
Acid	Water-soluble anionic compounds

Table 2: Advantages and disadvantages of dyes removal techniques(Salleh, Mahmoud et al. 2011).

Methods	***pros***	***cons***
Chemical treatments oxidative process	Simplicity of application	(H2O2) agent needs to activate by some means
H2O2+Fe(II) salts (Fenton reagent)	Fenton reagent is a suitable chemical means	Sludge generation
Ozonation	Ozone can be applied in its gaseous state and does not increase the volume of wastewater and sludge	Short half-life (20 min)
Photochemical	No sludge is produced and foul odors are	Formation of by-products
Sodium hypochloride (NaOCl)	Initiates and accelerates azo-bond cleavage	Release of aromatic Amines
Electrochemical Destruction	No consumption of chemicals and no sludge build up	Relatively high flow rates cause a direct decrease in dye emoval
Biological treatments Decolorization by white-rot fungi	to degrade dyes using enzymes	Enzyme production has also been shown to be unreliable
Other microbial cultures (Mixed bacterial)	*Decolorized in 24–30 h*	*Under aerobic conditions azo dyes are not readily etabolized*
Adsorption by living/dead microbial biomass	Certain dyes have a particular affinity for binding with microbial species	Not effective for all dyes
Anaerobic textile- dye bioremediation systems	Allows azo and other water- soluble dyes to be decolorized	Anaerobic breakdown yields methane and hydrogen sulfide
Physical treatments Adsorption by activated carbon	Good removal of wide variety of dyes	Very expensive
Membrane filtration	Removes all dye types	Concentrated sludge production
Ion exchange	Regeneration: no adsorbent loss	Not effective for all dyes
Irradiation	Effective oxidation at lab scale	Requires a lot of dissolved O2
Electrokinetic coagulation	Economically feasible	High sludge production

Table 3: Previous studies of the adsorption of dyes using adsorbents based on agricultural solid wastes (Yagub, Sen et al. 2014)

NNO	Adsorbent	Dye	NNO	Adsorbent	Dye
1	Sugar beet pulp	Gemazol turquoise blue-G	21	Peanut hull	Reactive Black 5
2	Powdered peanut hull	Sunset yellow, Amaranth and Fast green	22	Loofa activated carbon	Reactive orange
3	Rice husk ash	Indigo Carmine	23	Apricot stone activated carbon	Astrazon yellow (7GL)
4	Chemically modified	Methylene blue, Brilliant cresyl blue,	24	Lemon peel	Direct red 80
5	peanut hull	Neutral red, Sunset yellow and Fast green	25	Bagasse fly ash	Methyl violet
6	Peanut hull	Methylene blue, Brilliant cresyl blue, Neutral red	26	Polygonum orientale Linn activated carbon	Malachite green
7	Coir pith activated carbon	Reactive orange 12, Reactive red 2 and Reactive blue 4	27	Banana pith	Acid brilliant blue
8	Carbon pith activated carbon	Congo red	28	Mango Bark	Malchite Green
9	Coir pith carbon	Methylene blue	29	Tamarind shell	Congo red
10	ZnCl2 activated coir pith carbon	Acid brilliant blue, Acid violet, Methylene blue and Rhodamine B	30	Grape fruit peel	Reactive blue 19
11	Coir pith	Acid violet	31	Cherry saw dust	Methylene Blue
12	Rice husks activated carbon	Malachite green	32	Barley husk	Dye mixture
13	Rice husk-based porous	Malachite green	33	Cotton waste	Safranine
14	Rice husk	Congo red	34	Yellow passion fruit	Methylene Blue
15	Tea waste	Methylene blue	35	Jack fruit peel	Basic blue 9
16	Coniferous pinus bark powder	Crystal violet	36	Banana pith	Rhodamine-B
17	Orange peel activated carbon	Direct N Blue-106	37	Corncob	Dye mixture
18	Neem sawdust	Malachite green	38	Rice husk	Methylene Blue
19	Guava seed carbon	Acid blue 80	39	Eucalyptus bark	Remazol BB
20	Palm kernel shell	Reactive Black 5	40	Peanut hull	Methylene Blue

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