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Dye Removal from Low Cost Adsorbent: - A Review

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ABSTRACT - Environmental problem is very serious problem at present day in the world due to industrialization and urbanization such as air pollution, water pollution and soil pollution. Water is consuming a lot of quantity in industrialization, dye industry and urbanization sector so lot of quantity effluent discharge in fresh water sources so water quality is degradable. Their impacts are directly and indirectly affect our living organism and plantation. This review paper represents the use of various low cost adsorbent on the dye removal.

***Keywords*: -** Modelling and Simulation, Adsorption, Biodegradable solid waste, dye, waste water treatment.

1. Introduction

Water is very essential to our life, animal life, processing industry, plantation and aquatic system. If the dye effluent waste water discharges in hydrosphere, because of that water quality degrade and their adverse effect to environment. The greatest environmental concern problem deals with dyes absorption and reflection of sunlight that entered to water which interferes on the growth of bacteria level cannot biologically degradable in the water body. Because color is very high wavelength (200 to 800 nm) in the water so directly effect on absorption of sun light in water body and there also side effect on photosynthesis reaction, when lake of photosynthesis reaction its adverse effect of plankton growth and their adverse effect to fisheries production [M.A.M Salleh et al., 2011]. If fish production is low so naturally water purification system effect and there directly impact to environmentally and economically loss due to discharge of effluent dye waste water in fresh water. This problem can be solved by different engineering method such as physical method, chemical method and biological method.

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

The main factor which on the adsorption process are surface area, pore size, chemical composition and dyes properties such as molecular size, molecular polarity. Activated carbon is the most widely used adsorbent for dye removal because of its micro –pore structures, high adsorption capacity, extended surface area and high degree of surface reactivity. However, commercially available activated carbon is very expensive and has high regeneration cost.

2. Method of dye removal.

2.1 Physical method

Physical method includes as membrane filtration process, reverse osmosis, electrolysis, sedimentation, and adsorption. Adsorption treatment method is an effective alternative method used to remove dye from waste water. The adsorption treatment has many advantages such as low cost; easily change, less susceptibility to toxic chemicals, greater flexibility in design and operation. Generally two type adsorbent uses **a).** Natural adsorbents **b)** Prepared activated carbon. Natural adsorbents used for dye removal such as clay, siliceous materials, zeolites etc.

Prepared agricultural waste materials used as low cost adsorbent such as orange peel, banana peel, rice husk, almond shell, soybeans husk and coconut shell. There adsorption capacity various factors affecting are adsorbent dosage, contact time, PH value, agitation speed, ionic strength, temperature and initial dye concentration etc.

2.2 Chemical method

Chemical method includes such as coagulation/flocculants, oxidation, ion-exchange, and neutralization. It involves the addition of substances such as aluminium, calcium and ferric ions in to the effluent, as such flocculation.[M. M,A Shitu et al., 2014]. Generally, a chemical treatment has feasibility, economic and efficiency, but major drawback is that, the costs of chemical are expensive.

2.3 Biological method

Biological method includes such as activated sludge, anaerobic digestion and aerobic digestion adsorption by (living or dad) microbial biomass, fungal decolonization, and microbial degradation. Microorganism such as fungi, yeast, bacteria and algae are able to accumulate dye and degrade different pollution [Mustafa T.Yagub et al., 2014]. Biological treatment may be aerobic and anaerobic. But the major drawback is that required large land area and high construction cost.Table1 gives advantage and disadvantage of dye removal methods

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 (chemical treatments)	Ozone can be applied in its gaseous state and does not increase the sludge and volume of waste water.	Very costly and short half-life(20) min
4.	Electrochemical destruction	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

2.1 Sources of Dye

Dyeing is a process of coloring the fabric using dyes which are organic compounds. They are widely used for imparting colour to textiles industry and other many industry. They are produced either synthetic or naturally. Dyeing properties depended on two reasons. First, the sizes of the dye molecules are smaller than the size of the pores in the fibre. The second reason is the affinity of the dye to the fiber due to forces of attraction. The dye which has diffused or penetrated into the fiber is held there by the forces of attraction between the dye and the fibre. Dyes could be either obtained from natural and synthetic sources. Dye is naturally occurring in the nature such as wood, leaf of tree, soil, bark of tree, seed, root, minerals, fungi, and insect, clay and microorganism. Sources of dye are two type, naturally and synthetic. Naturally dye source is from clay, bark of tree. Leaf, root .seed, fungi, Minerals and microorganism [V.K Gupta et al., 2009]. Synthetic dyes are obtained from many different industry such as cosmetics industry, printing industry, rubber industry, plastic industry, textiles industry and dye and pigment industry. All the above industry effluent discharge in fresh water source so water quality degradable

2. Classification of Dye

Basically dyes are two types 1. Natural Dye 2. Synthetic Dye.

2.1 Natural Dye

Dyes are obtined from natural sources such as insects, mineral, vegetable matter are called natural day. Amongst natural dyes, indigo is well known for its brilliant blue colour and was obtained by fermenting the leaves of a plant. The red color is extracted from Lac and brown color is extracted from iron oxide powder.

2.2 Synthetic Dye

Synthetic dyes are obtained from petrochemical feedstock and different organic chemical component mixture is called synthetic dye. First synthetic dye was manufactured by Perkin from coal tar. Synthetic dyes are direct dyes, azoic, acid dyes; disperse dyes, vat dyes, reactive dyes, basic dyes, moderate dyes, sulfur dyes and direct dye. Figure -1 shows the classification of dyes.

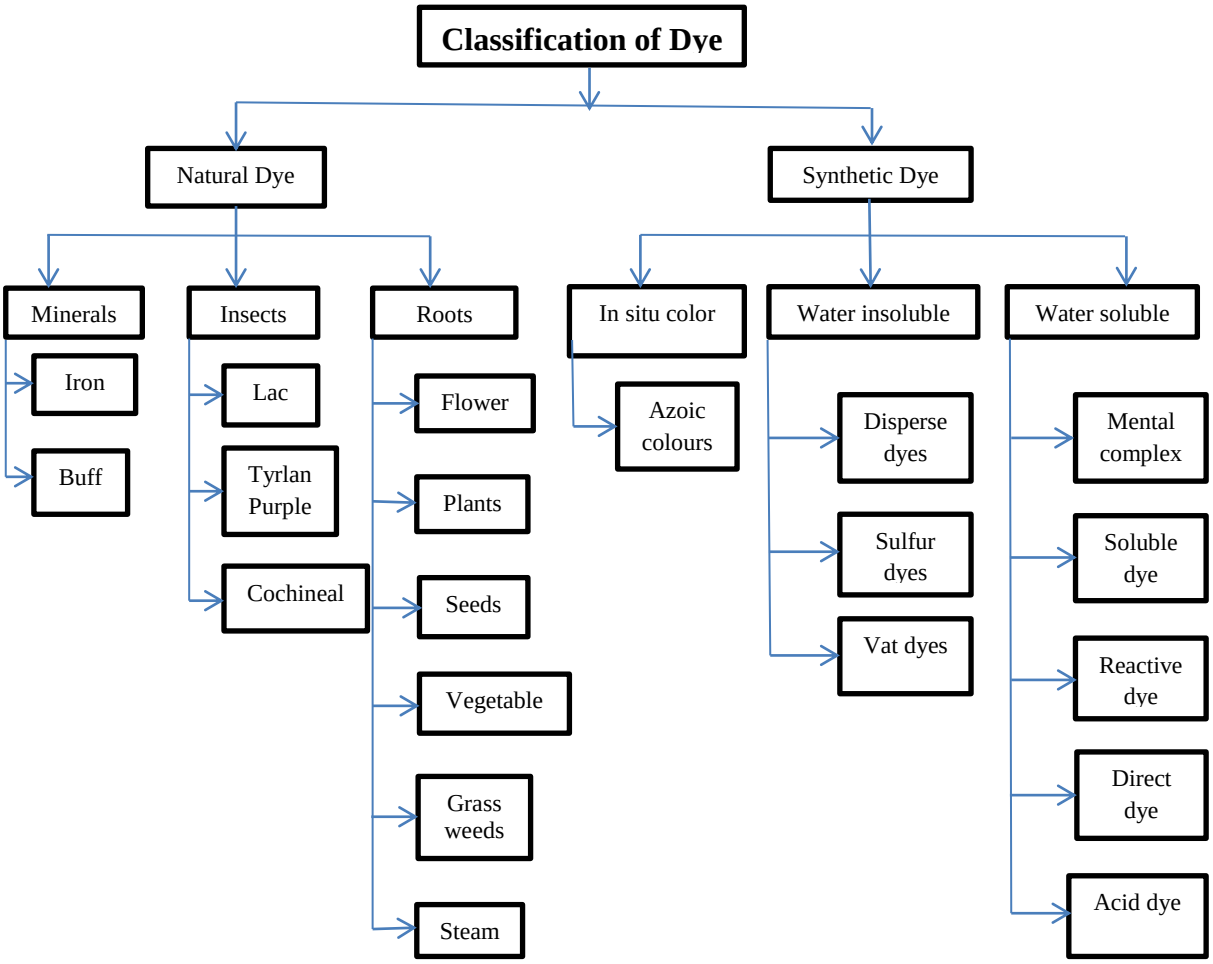

Figure-1: Classification of dyes

3. Literature Review on Dye Removal

The main effect factor on the adsorption process are contact time, initial dye concentration, pH value, temperature of solution, 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)[khaattri et al., 2011]. Table 2 show literature review on removal of dye using low cost adsorbent.

Table-2 : Literature review on dye removal.

Sources	Adsorbents	Adsorbate	pH	Adsorbent dose	Concentration (mg/l)	wavelength of adsorbate	Efficiency/adsorption capacity
Bhumica Agawal et. al. 2013	Granular activated carbon	Phenol and cyanide	8	30g/l g/l	200mg/ 20lmg/l	--------	79.9% 93.6%
Khaattri et al., 2011	Sagvan saw dust	Crystal violet dye		0.5g/ 200 ml	6 8 12	ƛ=592	86.68, 79.84, 72.19
Malik et al., 2007	Ground nut shell	Malachite green		0.1-1g/l	100-200	ƛ=617 nm	94.5%
Bentahar et al., 2017	Natural clay	Methylene blue crystal violet and Congo rate	2-12		100-600	ƛ=616 nm ƛ=589 nm ƛ=498 nm	202.13mg/g 289.59mg/g 289 mg/g
Kayode et al., 2015	Rice husk, Lignin corcob, Saw dust wool, oil ash, coco, durian peat, sludge.	Cationic dyes-5gl, Acid blue- 25, basic rate-22, methylene blue, balsamic red-22, and acid green 25, crystal violet.	8-10		50-250	--------	312mg/g
Malik, 2003	Saw dust and rice husk	Acid yellow	3	-----	------	ƛ=414 nm	183mg/g, 86.9 mg/g
Jordan et al., 2016	Penut shell	Direct black-38 reactive red-144	------			ƛ=520 nm ƛ=543 nm	110 mg/g 284.5 mg/g
K. Y Foo . al., 2012	Husk	Methylene blue	------	0.2g/ 200ml	50-500	ƛ=668 nm	418.15 mg/l
Jia-Shun Cao et al.,2014	Walnut shell.	Reactive brilliant red K-2BP	0.5-11	0.1-6g/l	200	----------	568.18mg/g
Kihe et al., 2017	Cordial myxa	C.I. Disperse blue	7	0.1/25ml	100	ƛ=556 nm	80%
Olya et al., 2013		Reactive rate-12	7	15g/l	150	ƛ=530 nm	Economic analysis
Khatri et al., 2011	Sagwan sawdust	Crystal violet dye	7.5	0.5g/ 200ml	6,8.12mg/l	ƛ=592 nm	, 86.68%
Murugan et al.,2010	Mango leaves(mangifera india)	Grey BI	7	0.1-1.5g/l	50-500mg/l	ƛ=575 nm	33.7mg/g

4. Conclusion:-

The paper reviewed a various range of utilisation of low cost adsorbent for dye removal. The adsorption capacity depend on the adsorbent surface area, adsorbent particle size, contact time, initial dye concentration, aqueous solution of pH, ionic strength of adsorbent , speed of agitator and temperature. The adsorption capacity dependents on their carbonization temperature and chemical activation with various agents and activation time. Various literatures on the focus of the adsorption capacity dependent on nature of dye (cationic and anionic dye). This review article also reveals that the maximum absorptivity of dye in aqueous solution of water at various wavelength. Freundlich and Langmuir isotherm

model are used to evaluate the adsorption capacity of different adsorbent. This review paper encourages the research work on the using low cost adsorbent in local area for real waste water treatment.

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