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An Eco-Friendly Process for Removal of Environmental Pollutants in water and wastewater: A Review

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Abstract

Water an Pollution resulted from environmental pollutants such as heavy metal ions, Dyes and phenol compounds is a serious problem due to the severe toxicity and carcinogenic nature of these compounds. On the other hand, petroleum substances has become a major problem all over the world as a result of industrial growth. Therefore the study on water and waste water treatment and find methods for protecting plants and living organisms is inevitable.So far, numerous methods have been taken to remove pollutants from aqueous environments, which often cost a lot of money.Among the various methods, the sorption mechanism with the low cost, eco-friendly, abundance, and availability of Natural and Biosorbents is considered as one of the best practices.In this research , the efficiency of some natural sorbents as well as their modified form for the removal of petroleum products,heavy metals and some organic pollutants from water and waste water will be mentioned.

Keywords: Dye Removal, Phenol, Petroleum Substance, Biosorbent, Adsorbent Materials, Adsorbtion, Biosorption, Waste Water Treatment

Introduction

Wastes are arbitrarily disposed into the water bodies by industrial and household activities in some parts of the countries. The increase in water quality parameters such as heavy metals, nutrients and organic matter is as a result of the contamination of coastal and inland water bodies by generated wastes (Mustapha et al., 2016). Pollution of water resources with heavy metals,organic compounds and petroleum products is one of the major concerns in today's world. The main sources of water contamination are industrialization, civilization, agricultural activities and other environmental and global changes. Few hundred organic pollutants have been found contaminating water resources. The contamination due to organic pollutants is very dangerous due to their various side effects and carcinogenic nature (Ali, Imran, Mohd Asim, and Tabrez A. Khan, 2012). Heavy metals released by a number of industrial processes are major pollutants in marine, ground, industrial and even treated wastewaters (Parvathi et al., 2007). Several conventional methods are available with a varying degree of success to remove heavy metals ions and organic pollutants from wastewater. Some of them are chemical precipitation ion exchange,filtration,solvent extraction ,reverse osmosis and adsorption (Moosa et al., 2016). On the other hand the annual production of oil products is estimated to be around 100 million tons. Also, according to estimates, from 2000 to 2011, 224,000 tons of oil spills have entered the marine environment (Wahi et al., 2013). In general, leaked oil on the sea can be removed, dispersed or burned. Among these methods, the process of retrieving and collecting oil from the seawater is usually preferred in other ways, due to the low

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environmental risk posed by it. However, in poor atmospheric conditions and when there is limited access to mechanical equipment for collecting oil spills, burning techniques and dispersed materials are used to clean contaminated areas (Cojocaru et al., 2011). As previously mentioned,a mong different methods which are used for the removal of pollutants ,Adsorption is considered as the best method due to its universal nature, inexpensiveness and ease of operation. Adsorption can also remove soluble and insoluble organic pollutants. The removal capacity by this method may be up to 99.9%. Due to these facts, adsorption has been used for the removal of a variety of organic pollutants from various contaminated water sources. Basically, adsorption is the accumulation of a substance at a surface or interface. In case of water treatment, the process occurs at an interface between solid adsorbent and contaminated water. The pollutant being adsorbed is called as adsorbate and the adsorbing phase as adsorbent (Ali, Imran, Mohd Asim, and Tabrez A. Khan, 2012).

In this study, a number of studies on the removal of environmental pollutants in water and wastewater are briefly mentioned.

Application for water and wastewater treatment

Surface water, ground water, and industrial or household wastewater contains many different types of pollutants. These pollutants include inorganic and organic compounds and are more or less hazardous to human being, animals and plants (Wang, Shaobin, and Yuelian Peng, 2010). In the following sections, more recent applications of some natural adsorbents for removal of various pollutants from aqueous environments are discussed in detail.

petroleum Substances

As previously mentioned ,Oil spill has a great negative influence on the ecosystem by putting the marine lives at high risk. However, the extent of risk is dependent on the type and volume of the oil in addition to other abiotic factors such as the sensitivity limit of the marine habitat. The need for eco- friendly and cost effective natural sorbents cannot be overemphasized in recent times. Diverse agricultural products such as peat, leaves and wood products have been employed. Cotton, straws, kenaf, corn cob, wood fibre, milkweed floss, peat moss, kapok fibre was reported (Idris et al., 2013). Adsorbents used in the removal of oil spills can be divided into three main groups, depending on the source of origin:(i) inorganic mineral sorbents;(ii) natural organic sorbents;(iii) synthetic organic sorbents (synthetic polymers). Mineral adsorbents represent a very large group; these are commonly used as they have a number of advantages such as non-flammability, chemical inertness, relatively low cost and easy availability. Natural organic adsorbents used in chemical rescue include peat, needle-cover, moss, dry leaves, straw, sawdust, bark and wood waste, cellulose from paper and cotton products, linen materials,cotton and hemp (Bandura et al., 2017). Synthetic sorbents include man-made materials that are similar to plastics, such as polyurethane, polyethylene, polypropylene, and nylon fibers. Most synthetic sorbents can absorb as much as 70 times their weight in oil. Synthetic sorbents that cannot be cleaned after used can present difficulties because they must be stored temporarily until they can be disposed of properly. They are best suited to absorb lighter viscosity oils that can perpetrate or wick into its fiber[1]. It should be noted that there are two other types of synthetic sorbents the adsorbent only or "OilSnare" which can recover 20 to 60 times its weight depending on the viscosity of the oil. This is best utilized on heavier more viscous oils such as the # six to # four oils. They are very effective for shoreline cleanup since tidal and wind fluctuations help the adsorbent abrade oil from shoreline environments. The last type of synthetic sorbent is the polymer. These products generally absorb lighter viscosity oils and polymerize them into a rubber type material. These products have proven themselves for removing light sheens on the water surface[2]. Some studies investigated by researchers are described below.

In 2016, Muir and Bajda studied the efficiency of Organically modified zeolites in petroleum compounds spill cleanup. This study addressed the sorption of gasoline, diesel fuel, motor oil and used motor oil by various organo-zeolites.The results showed the materials prepared were effective in sorbing petroleum compounds, and that zeolite Na-P1 was the most efficient in the removal of petrochemicals. Also,the absorbability of gasoline, diesel, engine oil and used engine oil occurred in the following order: Used engine oil > diesel > engine oil > gasoline (Muir, Barbara, and Tomasz Bajda, 2016).

Carmody et al,investigated the adsorption of hydrocarbons on organo-clays which were synthesised by the ion exchange of sodium in Wyoming Na-montmorillonite (SWy-2-MMT) with three surfactants for oil spill remediation. It was found that the hydrocarbon sorption capacity of the organo-clays depended upon the materials and surfactants used in the organo-clay synthesis. Greater adsorption was obtained if the surfactant contained two or more hydrocarbon long chains.They figured out the use of organo-clays for cleaning up oil spills is feasible due to its many desirable properties such as high hydrocarbon sorption and retention capacities, hydrophobicity (Carmody et al., 2007).

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[1] http://www.parkersystemsinc.com/general-info/recovery-oil/
[2] Ibid

BTEX removal from aqueous solutions by HDTMA-modified Y zeolite has been studied by Vidal et al in 2012. In this work, a hexadecyltrimethyl ammonium (HDTMA) surfactant-modified synthetic zeolite was investigated for its efficiency in removing BTEX from aqueous solutions. The results of the BTEX adsorption experiments onto both synthetic zeolite and surfactant-modified zeolites (SMZ) showed that the SMZ-100 (zeolite modified with surfactant levels at 100% of CEC) was the most efficient modified zeolite for BTEX removal (Vidal et al., 2012).

Ribeiro et al used a Dried Hydrophobic Aquaphyte as an Oil Filter for Oil/Water Emulsions.The dead biomass derived from a hydrophobic aquatic plant, a Salvinia sp. found in Southern Brazil, was studied as an oil filter for oil/water emulsions. For Salvinia sp, The amount of oil retained was 9.53 or 1.33 g oil/g biomass. Thus, 90% of the oil in 18.7 l emulsion was retained by the biomass. They used Peat Sorb which were performed under the same conditions. The amount of oil retained was 1.66 or 0.26 g oil/g Peat Sorb. Thus, the Peat Sorb retained 62% of the oil in 4.0 l emulsion.They found that the hydrophobicity and salivion structure of the salvinia prevents water adsorption by adsorbent and leads to high adsorption capacity (Ribeiro et al., 2003). Banerjee et al,investigated the adsorption kinetics of o-xylene by flyash in 1997.They conducted an investigation about the preparation of activated carbon which is made by heating crushed coconut peel Stained with $ZnCl_2$ at 700 ° C. The activated carbon was obtained with a special surface area around 800 m^2/g . An examination of thermodynamic parameters showed that the adsorption of o-xylene by fly ash is an exothermic process and is spontaneous at the temperature investigated. Also,activation energies for the sorption process ranged between 3.1 and 4.3 kcal/mol (Banerjee et al., 1997).

In another research,The cotton Nonwivens as Oil Spill Cleanup Sorbents has been investigated by Choi et al in 1993.The results indicated that with light crude oil,oil sorption capacities of the needlepunched cotton-containing sorbents were slightly greater than those of sorbents made from 100% polypropylene fibers.It worth to mention that the cotton-containing sorbents were reusable after a simple mechanical compression.Also, the results revealed that the crude oil sorption of cotton fiber was conducted by adsorption on the fiber surface and capillary action through its lumen. while, the most important mechanism for polypropylene was through capillary bridges between fibers (Choi et al., 1993).

In many studies, carbon produced from petroleum products has been used . For example, in 1976 Fasoli and Genon,used activated carbon by pyrolysis of organic sludges. In this study, the feasibility of using organic materials in wastewater in purification of the water itself has been reported . In this study, the oil filtered in sand granules was carbonated in different gas atmospheres for different periods. The carbon quality obtained was characterized by the performance of the oil-carbon transformer, the adsorption capacity and content of the remaining hydrocarbons and comparable to commercial activated carbon (Fasoli and Genon, 1976).

Sorption capacities of some natural and modified adsorbents are summarized in Table 1.

Table 1: Sorption capacities of adsorbents towards petroleum substances in the form of oils (Bandura et al., 2017).

Sorbent	SC (g/g)	SBET (m^2/g)
	Clay minerals	
vermiculite	1.3	
sepiolite	0.97–1.2	258
talc	0.33	17
	Silica Rocks	
diatomite	0.17-0.26	30
chalcedonite	1.15-1.18	3
	0.2-0.3	
Quartz sand	0.03-0.05	
	0.17	
	Modified minerals/organo-minerals	
PTMA-montmorillonite	0.30	
ODTMA-montmorillonite	0.37	
	1.2-1.6	
DDDMA-monmorillonite	3.6-5.2	
DDDMA-bentonite	2.1-3.5	

However, other pollutants in aqueous system such as heavy metal ions and some organics will exist which will be discussed below.

Heavy metal ions

Contamination of heavy metals in water supplies has steadily increased over the last decades as a result of over population and expansion of industrial activities. The presence of heavy metals in the environment is a major concern due to their toxicity. It has been found that many heavy metal ions produce strong health problem and damage to plants and animals (Wang, Shaobin, and Yuelian Peng, 2010). The source of heavy metals in the environment are come from several industrials activities involves mining, smelting, surface finishing industry, metallurgy etc. The heavy metals are toxic at low concentration and directly related with biological toxicity problems and environmental pollution (Moosa et al., 2016). In the past, a lot of research has been conducted using natural absorbents or modified form for metal ions .For example, In 2008,Aziz et al,studied on Chemically modified olive stone as a low-cost sorbent for heavy metals and basic dyes removal from aqueous solutions. The preliminary results indicated that TOS(treated olive stones) exhibit a better efficiency in terms of sorption capacities toward the two pollutants (128.2 and 526.3 mg/g for cadmium and safranine, respectively) than those reported so far in the literature. Moreover, the sorption process is ascertained to occur fast enough so that the equilibrium is reached in less than 15 min of contact time (Aziz, Abdellah et al., 2009). Removal of lead from aqueous solutions by adsorption onto coconut-shell carbon was investigated by sekar et al in 2004. Batch adsorption experiments were performed to find out the effective lead removal at different metal ion concentrations. Adsorption of Pb^{+2}ion was strongly affected by pH. The coconut-shell carbon (CSC) exhibited the highest lead adsorption capacity at pH 4.5.Also, the thermodynamics of Pb(II) on CSC indicated the spontaneous and endothermic nature of adsorption. Quantitative desorption of Pb(II) from CSC was found to be 75% which facilitates the sorption of metal by ion exchange (Sekar, Sakthi and Rengaraj, 2004). The different waste products used for generating low cost adsorbents are given in Table 2 (Ali, Imran, Mohd Asim, and Tabrez A. Khan, 2012). Haluk Aydin et al, investigated The efficiency of the adsorption of Cu(II)ion in aqueous solution by various biocompatible adsorbents such as lentil, wheat and rice peel, in different laboratory conditions,such as contact time, temperature, pH, and adsorbent dose.The results showed the maximum amount of copper ion adsorption capacity for lentil, wheat and rice peel were 8.977,9.510 and 9.588 mg / g, at 293° K and 7.391, 16.077, 17.422 mg / g at 313° K. The results of the experimental data indicated that, among the adsorbents used in this study, rice peel has a higher efficiency for copper ion removal, and with increasing temperature to 313° K, the efficiency of the adsorption process increases (Aydın et al., 2008). In another research,Removal of heavy metals from wastewater using agricultural and industrial wastes as adsorbents has been studied by hala Ahmed hegazi. Based on the information data in this study, the objective of research Was to study the utilization possibilities of less expensive adsorbents for the elimination of heavy metals from wastewater. Agricultural and industrial waste by-products such as rice husk and fly ash have be used for the elimination of heavy metals from wastewater. Results showed that low cost adsorbents can be fruitfully used for the removal of heavy metals with a concentration range of 20–60 mg/l also, using real wastewater showed that rice husk was effective in the simultaneous removal of Fe, Pb and Ni, where fly ash was effective in the removal of Cd and Cu (Hegazi, Hala Ahmed, 2013). In 2006,Shoabin Wang and Hongwei Wu conducted studies about using this low cost adsorbent instead of other adsorbents, such as zeolite and activated carbon, in various adsorption processes to remove environmental contaminants such as sulfur and nitrogen oxides (NOx, SOx), organic compounds and mercury in the air, as well as cathode and anode ions, colors and other organic materials in aquatic solutions. The results of these studies revealed that Fly ashes could be used as a suitable adsorbent with high adsorption efficiency to remove various pollutants. In addition, further research had shown that chemical modification of Fly ash can lead to further adsorption to clean up water and gas systems. It is important to mention that the presence of unburned carbon content in Fly ash plays an important role to increase the efficiency of this adsorbent dose (Wang, Shaobin, and Hongwei, 2006). Burakov et al,investigated the removal of Heavy-Metal Ions from Aqueous Solutions Using Activated Carbons.They used two commercial activated carbons (ACs), AG-5 and NWC coconut shell based, as adsorbents. The adsorbents were modified with carbon nanotubes (CNTs) by chemical vapour deposition. Experimental results showed that the nanomodification of ACs increased their equilibrium adsorption of heavy metals (Ni2+ and Co2+) by 10–30%.Also, experimental data on the adsorption of the heavy-metal ions on the nanomodified carbons were successfully fitted to the Langmuir and Freundlich models(Burakov et al., 2014). The removal of lead (II) from waste water was studied by Yarkandi ,in 2014.He used the natural American bentonite and activated carbon for the removal of Pb++ from aqueous solution.The results showed that by increasing the dosage, % removal increased till reached maximum at 1.0 g dosage of both activated carbon and bentonite.The amount of adsorption of Pb++ increases with initial metal ion concentration, contact time and solution pH but decreases with amount of adsorbent and temperatures (Yarkandi, Naeema, 2014).

Biosorption is a physiochemical process that occurs naturally in certain biomass which allows it to passively concentrate and bind contaminants onto its cellular structure.Biosorption can be defined as the ability of biological materials to accumulate heavy metals from wastewater through metabolically mediated or physico-chemical pathways of uptake. Adsorbing biomass, or biosorbents, can remove the harmful metals like: arsenic, lead, cadmium, cobalt, chromium and uranium.Biosorption may be used as an environmentally friendly filtering technique[3]. The following is a summary of the studies conducted in this area.

[3] Biosorption,Wikipedia,https://en.wikipedia.org/wiki/Biosorption.

Dhiraj Sud et al,reviewed the utilization of agricultural waste material as potential adsorbent for sequestering heavy metal ions from aqueous solutions. They pointed out the Conventional treatment technologies for the removal of toxic heavy metals are not economical and further generate huge quantity of toxic chemical sludge ,As the result of this, Biosorption is emerging as a potential alternative to the existing conventional technologies for the removal and/or recovery of metal ions from aqueous solutions. They referred to some important advantages of biosorption over conventional treatment methods include: low cost, high efficiency, minimization of chemical or biological sludge, regeneration of biosorbents and possibility of metal recovery. It worth to mention that Cellulosic agricultural waste materials are an abundant source for significant metal biosorption. The functional groups present in agricultural waste biomass viz. acetamido, alcoholic, carbonyl, phenolic, amido, amino, sulphydryl groups etc. have affinity for heavy metal ions to form metal complexes or chelates (Sud, Dhiraj, Garima Mahajan, and Kaur, 2008). In 2012, Wang used Saccharomyces cerevisiae for biosorption of Cadmium, Zinc and Copper in an aqueous solution. Optimization of Cd (II), Zn (II) and Cu (II) biosorption from contaminated water were performed as function of parameters (pH, contact time, initial metal ions concentration and yeast dose). The experimental results showed that the highest equilibrium adsorption capacity at the optimum pH were 8.5 for Cd (II) and 6 for Zn (II) and 6 for Cu (II). This study revealed that use of baker's yeast is suitable for removal of these ions from contaminated water in order Cd > Zn > Cu at these conditions (Wang, Yong, 2012). Assessment of Copper and Lead Biosorption from Aqueous Solutions by Brewer's Yeast has been studied by Mihaiescu et al. The impacts of various parameters such as contact time, pH and biosorbent dose on the removal efficiency were assessed. The results demonstrate that the brewers yeast adsorption capacity of metals increases with yeast-metal solution contact time, until reach maximum at 60 minutes, which indicates that the systems has reached equilibrium. The optimum results were obtained for the biosorbent concentration of 0.5% and contact time 60 min., copper at pH 6, and lead at pH 5 respectively (Mihăiescu et al., 2016). In 2017,Smail et al,used different types of synthesized zeolite for Removal of Lead from Aqueous Solution. The adsorption of heavy metal Pb (II) on four different prepared zeolites (LTA)from Montmorillonite clay, FAU(Y)-B.H (G2) from Barley husk, Mordenite (G1) from Chert rock, FAU(X)-S.C (G3) from shale clay & modified Shale clay by oxalic acid (N1) & sodium hydroxide (N2)), were compared with the adsorption of their sources by using static batch experimental method. The major factors affecting the heavy metal ion sorption on different synthesized zeolites & their sources were investigated.The obtained results in this study showed that the different synthesized zeolites were efficient ion exchanges for removing heavy metal, in particular, the modified zeolite from shale clay by oxalic acid (Smail et al., 2017). Lead biosorption onto waste beer yeast by-product has been investigated by Parvathi et al in 2007.They studied the potential of waste beer yeast Saccharomyces cerevisiae in biosorbing lead from battery manufacturing industrial effluent. Experiments were carried out as a function of pH, biosorbent concentration, lead concentration and agitation speed. Sorption capacity of lead ions of 2.34 mg/g was recorded and the experimental data fit well with Freundlich and Langmuir models with K_f and Q_{max}values of 0.5149 and 55.71 mg/g (Parvathi et al., 2007). Jiang JQ reviewed removing arsenic from groundwater for the developing world.This research is concerned with summarising the experience to date of treating arsenic containing ground/surface water by oxidation, coagulation/precipitation and adsorption processes. The study demonstrated that these technologies can remove arsenic from ground/surface water efficiently and according to the data results,the residual arsenic concentration in the effluent could be in the range of 5-10 pg/l, against the influent arsenic concentration in the range of 10-500 pg/l. He concluded that when using these methods, issues such as cost, availability and efficiency especially in developing countries Should be considered (Jiang, 2001). Haq Nawaz Bhatti investigated the efficacy of Daucus carota L. waste biomass for the removal of Cr(III) and Cr(VI) from aqueous solutions.Based on the results from experimental data, Maximum uptake capacity of D.carota L. waste biomass for Cr(III) (86.65 mg/g) and Cr(VI) (88.27 mg/g) was observed at pH 1 and 5 respectively.It should be noted that optimum biosorbent dose (0.1 g), biosorbent size (0.250 mm), initial concentration (100 mg/L), temperature (30 °C) and contact time (240 min) gave maximum biosorption. The results also demonstrate that chromium uptake capacity of D.carota L. waste biomass was comparatively higher than most of early reported work (Bhatti et al., 2010).

Table 2: Waste products used for generating low cost adsorbents.

House hold wastes	D. Sea materials
a. Fruit waste	a. Chitosan and seafood processing wastes.
b. Coconut shell	b. Sea weed and algae
c. Scrap tyres	c. Peat moss
	d. Miscellaneous waste
B. Agricultural products	
a. Bark and other tannin-rich materials	E. Soil and ore materials
b. Saw dust and other wood type materials.	a. Clays
c. Rice husk	b. Red mud
d. Other agricultural	c. Zeolites
	d. Sediment and soil
	e. Ore minerals

C. Industrial waste	
a. Petroleum wastes.	
b. Fertilizer wastes	
c. Fly ash	
d. Sugar industry wastes	
e. Blast furnace slag	

Dye adsorption

Dyes are important pollutants in wastewater, which are mainly discharged from textile, printing, food and leather industries. Various types of dyes including basic, acidic, reactive, and dispersive dyes are widely used. Dyes in waters affect the nature of the water, inhibiting sunlight penetration into the stream and reducing the photosynthetic reaction. Some dyes are also toxic and even carcinogenic (Wang, Shaobin, and Hongwei, 2006). Dyes represent one of the problematic groups; they are emitted into wastewater from various industrial branches, mainly from the dye manufacturing and textile finishing and also from food coloring, cosmetics, paper and carpet industries. It is well known that the dye effluents from dyestuff manufacturing and textile industries, may exhibit toxic effects on microbial populations and can be toxic and/or carcinogenic to mammalian animal. Most dyes used in textile industries are stable to light and are not biologically degradable. Furthermore, they are resistant to aerobic digestion. Some adsorbents used for dyes removal from polluted water are listed in Table 3 (Rashed et al., 2013). Among different materials, economical and abundant; Adsorbents are used to remove dye pollutants from aqueous solution.For example, Han et al,researched the dsorption equilibrium and kinetic of methylene blue (MB) onto natural zeolite in a batch system. The results showed the solution pH affected the values of qe.When the value of pH was from4 to 10, the adsorption quantity was approximately constant. As the initial pH of MB solution is near 7.5, the pH of experimental solution was not adjusted. The effect of ionic strength (or salt concentration) was also investigated.The results showed NaCl and $CaCl_2$ existed in solution affected the MB adsorption onto zeolite. It was seen that the increase in the saltconcentration resulted in a decrease of MB adsorption.In addition, Equilibrium uptake increased with the increasing of initial MB concentrations at the range of experimental concentration because of the increase in the driving force from the concentration gradient (Runping et al., 2009). In 2001, a study on the effectiveness and efficiency of orange peel on the removal of acid violet 17 from aqueous solutions was analyzed by Rajeshwari Sivaraj, Namasivayam and K Kadirvelu. The results indicated that experimental data were well correlated with both Langmuir and Frendlich isotherms, and the adsorption capacity was 19.88 mg / g in the range of pH: 6.3 (Sivaraj et al., 2001). Ashish S. Sartape et al,prepared Limonia acidissima (wood apple) shell as low cost adsorbent to remove the malachite green dye from aqueous solution with adsorption technique.The results indicated that the experimental data fit well with Langmuir isotherm with 80.645 mg/g as maximum adsorption capacity at 299 K. It is noted that the Lagergren's model could be used for the prediction of the system's kinetics (Sartape et al., 2017). In another study, Santhi et al characterized a new alternative adsorbent for the removal of Malachite green (MG) and Methylene blue (MB) from aqueous solution. Results revealed that the removal efficiency of Malachite green and Methylene blue at 27 ± 2ºC exceeds 75.66% and 24.33% respectively, and that the adsorption process is highly pH-dependent.Results showed that the optimum pH for dye removal is 6.0.Also, the amount of dye adsorbed from aqueous solution increases with the increase of the initial dye concentration (Santhi et al., 2016). In 2016, The Adsorption of Rhodamine B in Water by Modified Zeolites was carried out by Cheng et al . The experimental results demonstrated that, in terms of the adsorption capacity of Rhodamine B in water, the modified zeolites were more favorable than the raw zeolites. When the dosage of adsorbent increased, the removal percentage of Rhodamine B in the water increased, while the unit adsorption capacity decreased.It worth to mention that the experimental data had a higher correlation with Freundlich isothermal model (Cheng et al., 2016).

Table 3: Some adsorbents used for dyes removal from polluted water

Dye	Adsorbent	Adsorption Capacity
Methylene Blue	Activated carbon from flamboyant pods(Delonix regia)	890 mg/g
Methylene Blue	activated carbon from from Oil palm wood-based	90.9 mg/g
Methylene Blue	activated carbon from Oil palm shell-based	243.9 mg/g
Reactive Blue 2	activated carbon	0.27,mmol/g
Reactive Red 4	activated carbon	0.24 mmol/g
Reactive Yellow 2	activated carbon	0.11 mmol/g
Everzol Black B	Sepiolite	120.5 g/kg
Everzol Red 3BS	Sepiolite	108.8 g/kg
Acid Green 28	amino-functionalized nanoporous silica SBA-3	333 g/kg

Acid Orange 67	amino-functionalized nanoporous silica SBA-3	2500 g/kg
Acid Blue 25	waste tea activated carbon	203.34 mg/g

Dye sequestration using agricultural wastes as adsorbents was investigated by Adegoke and Bello. They studied the effect of operational parameters on dye sequestration using Agricultural wastes.The results showed the efficiency of dye removal was increased as the contact time Increased and lowers initial dye concentration .Optimal Equilibrium time of various dyes with different charcoal adsorbents from agricultural residues(bagasse,groundnutshells,pea shells, tea leaves and wheat straw)is between4and5h. In general,adsorption of dyes increased with increasing of sorbent dosage. For acidic dyes the ratios of dyes sorbed had approached maximum values when sorbent dose of5(g/L)was used.Fig. 1 shows the effect of initial concentration and contact time on various adsorbents (Adegoke et al., 2015). The effect of pH on dye uptake was also discussed.The results indicated that the initial pH of solution can significantly influence adsorption of dyes.Maximum adsorptions of acidic dyes were obtained from the solutions with pH8–10 (Adegoke et al., 2015). In another study, the removal of dye compounds from industrial waste materials by Fly ash was studied by Boyd in 1982. The results of the study revealed that the maximum removal of acid dyes by activated carbon in the range of pH 5-6 would be achieved. Moreover, by increasing initial amount of color, the adsorption capacity was increased, but the efficiency of oil removal was reduced (Boyd, Stephen, 1982).

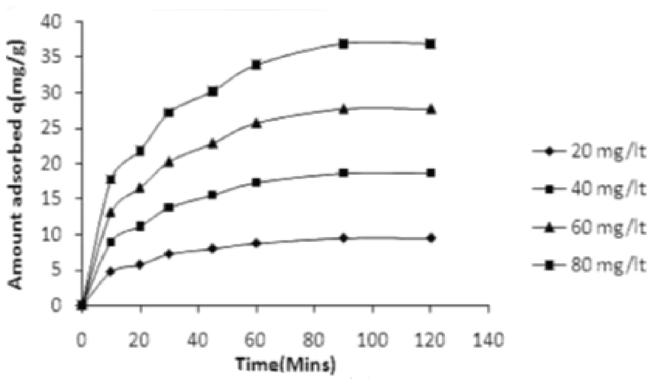

Fig. 1. Effect of initial concentration and contact time

Adsorption of Phenoles

Phenolic compounds exist in water bodies due to the discharge of polluted wastewater from industrial, agricultural and domestic activities into water bodies. They also occur as a result of natural phenomena. These compounds are known to be toxic and inflict both severe and long-lasting effects on both humans and animals. They act as carcinogens and cause damage to the red blood cells and the liver, even at low concentrations. Interaction of these compounds with microorganisms, inorganic and other organic compounds in water can produce substituted compounds or other moieties, which may be as toxic as the original phenolic compounds (Anku et al., 2017). Recovery of phenolic compounds from an aquatic environment is a legal requirement for the protection of human life and aquatic organisms. Adsorption of Phenol from Industrial Wastewater Using Olive Mill Waste has been carried out by Abdelkreem to diminish this pollutant from aquatic environment. The adsorption mixture reached equilibrium after 100 min.The results showed that the amount adsorbed increased with the increase in the concentration of solution. When the initial phenol concentration was increased from 100 to 600 mg/L, the adsorption uptake of olive mill waste increased.Also, the maximum removal expressed as a percentage removal was about 85% from initial phenol at dosages 1 g of olive mill waste. Phenol removal increased quickly from 52% to 85% when the olive mill waste dosage increased from 0.25 g to 1 g and reached a maximum for 1 g olive mill waste. It shold be noted that the Dubinin-Radushkevich (D-R) adsorption isotherm was found to have the best fit to the experimental data. The adsorption kinetics can be predicted by pseudosecond-order kinetic (Abdelkreem, 2013). In 2012,Larous and Meniai investigated the use of sawdust as by product adsorbent for the adsorption of phenol.The results revealed that the percent adsorption increased as the CAS dose was increased (1-20g/l) at 20mg/l phenol concentration.Also, for carbonized sawdust,the amount of adsorption increased from 5.50032, 1.95086, 1.39448, 0.87886, 0.68454 mg/g as the carbonized sawdust dose was increased from r=1g/l, r=5g/l,r=10g/l , r=15g/l, r=20g/l, respectively. Increase of concentration decreased the percentage adsorption. As phenol concentration increases from 5 to 100 mg L^{-1}, percentage removal was decreased from 70.54 % to 53.56 %.Experimental data correlated well with Pseudo second-order and Frendlich models (Meniai, 2012). Removal of phenols from water environment by carbonaceous materials has been studied by Mukherjee et al ,in 2005.This research involved an investigation of the use of three carbonaceous materials,activated carbon (AC), bagasseash (BA) and wood charcoal (WC), as adsorbents for removal of phenol from water. Experimental results showed that for phenol–AC, phenol–WC and phenol–BA adsorption systems, approximately 98%, 90% and 90% removal efficiencies were achieved at given adsorption conditions.

The kinetic study indicates that the phenol removal with the selected adsorbents is a first order adsorption. Freundlich isotherm model was found to fit the data for adsorption of phenol with the adsorbents (Mukherjee, 2007).

Conclusion

Environmental Pollutants in the ecosystem are one of the most important environmental issues in the world.According to leacture reports, the use of organic pollutants has increased over the past years. Regarding this, the need to use efficient techniques for the removal of highly toxic organic compounds from water and wastewater has attracted the attentions. Among these methods, the adsorption mechanism is known as an effective and cost-effective method for removal.As mentioned before, low-cost and ecofriendly adsorbents as well as the biosorbents with high adsorption efficiency are mainly used instead of other high-cost techniques.Also,base on the information of this review article, Researchers have found that natural and low-cost adsorbents have many advantages in water and waste water treatment. It should be noted that the low cost adsorbents are widely used in the removal of metal ions and and different types of organic pollutants such as dyes,phenols and petroleum compounds in aqueous solution , as the result of this, the application of these ecofriendly sorbents should be considered in developing countries.

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