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PROPERTY OF ADSORPTION OF METAL IONS BY LOW COST ACTIVATED CARBONS

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ABSTRACT:

Wastewater containing heavy metals is increasingly release into the environment directly or indirectly, particularly in developing countries. Unlike other contaminants found in wastewater, heavy metals are known to be toxic, non-biodegradable and have long half-life. The existence of heavy metals in contaminated water has been a matter of interest to the public because of their toxicity effect in the discharging environment. Elimination of these heavy metals from wastewater has become a point of concern, especially in places where recycling of the water is mainly practiced, the recovery of these heavy metals from wastewater is a significant environmental debate in recent time. Treatment of wastewater containing heavy metals can be accomplished through conventional treatment techniques such as ion exchange, floatation, chemical precipitation, membrane filtration, electrochemical process, adsorption and biological systems. These techniques were found to have some drawbacks, which includes incomplete metal removal, production of excess toxic sludge which requires special disposal method, high initial and operation cost, and demand for high energy.

Key words: Environment, treatment

INTRODUCTION:

Scientific and engineering researches are also playing an increasing role in protecting in the environment. Research has demonstrated the importance of the environment to human health economic, social and aesthetic harm. Scientific and engineering research has provided to reduce the pollution in air and water in the world. An environment, which is hygienically safe and aesthetically acceptable, should provide us sufficient clean water, soil and natural resources necessary for our modern man. Initially man relied on inexhaustible resources as the planet appeared to be without limits and the laws of nature directed our evolution. Later we started to supplement our muscle power with exhaustible energy sources, coal, oil and uranium and to substitute the routine functions of our brains by machines. As a result, in some respects, we have conquered nature but we are directing our own evolution.

Environment is interconnected with human life. It is common for all. The Physical, Chemical and Biologicals presence of living and non- living things are present in it. They caused to land, water, air and other natural resources are termed environmental pollution. According to ISO 14001, Environment can be defined as surroundings in which an organisation operates including air, water, land and natural resources. The life supporting environment of planet, earth is also composed of air, water and land. Holdgate defined pollution as the introduction by man into the environment of substances or energy liable to cause hazards to human health, harm to resources and ecological damage or interface with legitimate use of the environment depending on the activity responsible for the release of pollutants.

The environment is mainly contaminated by industrial wastes. Increasing population, industrialisation, modern civilisation and automobiles alter the natural environment. Toxic substances are mixed with air, water and land which produce pollution in the affect the human health, plants and animals.

METAL IONS AS POLLUTANTS

Waste water contains organic, inorganic and toxic pollutants. Most of the metals (Cd, Cr, Co, Cu, Zn, Pd, Hg, Ni and Ag) and metalloids (Se, As and Sb) causes hazard. Inorganic Pollutants consists of metal compounds and mineral acids. They may toxic and disturb the bio-chemical processes. In the 20th century large quantities of various metals have been required. So the usage of metals increased and the pollution will be also increased.

Metal pollutants are primarily disturbed in the atmosphere, water, soil and sediments. Atmospheric metal pollution arises mainly from the mining, smelting and refining of metal ores. High metal concentrations have rendered 9.5% of Japanese rice paddies incapable of producing consumable products.

CHROMIUM POLLUTION

Chromium and its compounds form a large and varied group of chemicals which present a variety of risks to workers' health. They are known by the terms, chromium metal (0) chromium (II), chromium (III) (known as trivalent compounds), chromium (IV) and chromium (V1) (known as hexavalent) compounds.

Chromium is a hard, silver metal which is used for chrome plating and in the manufacture of stainless steel. It is not usually considered a health hazard. However, some chromium compounds such as hexavalent compounds are toxic. They include chromium trioxide and chromic acid. Other compounds called trivalent compounds include chromic oxide and chromic sulphates are non toxic. Chromium compounds are used in dying textiles like silk and wool, in pigments for paint and pottery, in wood preservatives and in catalysts in the chemical manufacturing industry.

Chromium poisoning may occur at work in the industry if the necessary protective clothing is not used. Exposure can occur by breathing in dust, by skin contact with solutions or solids or by eating, drinking or smoking in areas where chromium is used. Members of the public could be exposed to it due to a spillage or inadequate safety measures during disposal. All Chromium compounds may cause dermatitis and some may cause occupational asthma. They can also cause chrome ulcers which form little holes in the skin. Chromium compounds Produces irritation and inflammation of the nose and upper respiratory tract. The inhalation of a large concentration of hexavalent compounds may lead to coughing, wheezing, inspiratory pain, fever and loss of weight.

Chromium (V1) compounds are more dangerous than other compound. They are irritants, corrosive and inhaled. They can cause lung irritation, obstruction and lung cancer. Prolonged skin contact may lead to irritation and, if skin damage is extensive, sufficient of the compound may be absorbed to cause renal damage and death.

TREATMENT AND PREVENTION

The exposure must stop immediately. The symptoms can then be managed. The body normally removes chromium rapidly. Acute chromium poisoning may result in death as there is no proven antidote. In these cases, supportive measures may include mechanical ventilation, cardiovascular support and monitoring of kidney and liver functioning. For chromium (V1) compounds, exposure must be kept within the maximum exposure limit (MEL) of $0.05 mg/m^3$ averaged over an 8 hour working day. For other chromium compounds, exposure must be lower than the occupational exposure standard (OES) of 0.5mg/m3 averaged over an 8 hour day. Protective measures may include the use of extraction equipment, chemical / mechanical spray suppressants at plating baths, protective clothing and equipment, adequate washing facilities, skin creams and proper training.

Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat. An intake of 50–200 µg of Chromium (III) per day is recommended for adults. On the average, adults in the United States take in an estimated 60–80 µg of Chromium per day in food. Therefore, many people's diets may not provide enough Chromium (III). Without Chromium (III) in the diet, the body loses its ability to use sugars, proteins, and fat properly, which may result in weight loss or decreased growth, improper function of the nervous system, and a diabetic-like condition. Therefore, Chromium (III) compounds have been used as dietary supplements and are beneficial if taken in recommended dosages. Chromium (VI) is more toxic than chromium (III). Breathing in high levels (greater than 2 $\mu g/m^3$) of Chromium (VI) such as in a compound known as chromic acid or chromium (VI) trioxide can cause irritation to the nose, such as runny nose, sneezing, itching, nosebleeds, ulcers and holes in the nasal septum. Large amounts of chromium can causes stomach upsets ulcers, convulsions, kidney, liver damage, and even death. The metal chromium (0) is less common and does not occur naturally and does not cause any serious health risk. The maximum permissible level of chromium is 2.0 mg/l

IRON POLLUTION

Iron is the fourth most abundant element in the earth’s crust and the most abundant heavy metal. It is present in the environment mainly as Fe (II) or Fe (III). The most important commercial iron ores are magnetite, siderite, limonite and hematite. The main use of iron ores in India is steel production, which consumed more than 14 millions tones, one-half of which was supplied by iron and steel scrap metal recycling. Iron is also used in the production of paint pigments, polishing agents and electrical materials.

Iron is an essential element in human nutrition and it is an integral component of cytochromes, porphyrins and metalloenzymes. Dietary iron requirements vary according to sex and age, infants, children and women of menstrual age are most vulnerable to iron deficiency. The effects of iron deficiency can include impaired mental development and performance in children elevated catecholamine and restlessness in children, reduced work performance in adults and, in severe cases, anemia and impaired oxygen delivery.

In the bloodstream, iron binds to transferring and is transported to the spleen, bone marrow and liver, which are the main storage sites for endogenous iron. The reticuloendothelial cells of the liver, iron are bound to haemosiderin; in the parenchyma cells, it is bound to ferritin. Because absorption is low and because iron is recycled in the body, the amount of faucal iron is similar to the amount of dietary iron. Less than 1 mg/d of endogenous iron is lost by the skin, faces and urine.

The ingestion of large quantities of iron results in haemochromatosis. It is a condition in which normal regulatory mechanisms do not operate effectively, leading to tissue damage as a result of the accumulation of iron. This condition rarely develops from simple dietary overloading. Tissue damage has occurred, however, in association with excessive intake of iron from alcoholic beverages in some cases of alcoholism. Tissue damage has also resulted from prolonged consumption of acidic foodstuffs cooked in iron kitchenware.

Poisoning of small children has occurred following ingestion of large quantities of iron tablets. As adult iron tablets can contain considerably more elemental iron than children’s tablets, children who accidentally ingest iron supplements destined for adults risk being poisoned. Three grams of Fe (II) sulphate is regarded as the lethal dose of two-year-olds. Between 14 and 17.5 g is the lethal dose for an adult male. Iron supplements are commonly used (14% of premenopausal women in one study) without reported toxic effects, except for gastrointestinal upset.

Iron is generally present in surface waters as salts containing Fe (III) when the pH is above 7. Most of those salts are insoluble and settle out or are adsorbed onto surface; therefore, the concentration of iron in well-aerated waters is seldom high. Under reducing conditions, which may exist in some groundwater, lakes or reservoirs and in the absence of sulphide and carbonate high concentrations of soluble Fe(II) may be found. The presence of iron in natural waters can be attributed to the weathering of rocks and minerals; acidic mine water drainage, landfill leakages, sewage effluents and iron-related industries.

There is no evidence of dietary iron toxicity in the general population. Because absorption is regulate, body tissues are generally not exposed to high iron concentrations. Pharmaceutical sources and disease states, such as idiopathic haemochromatosis and thalassaemia major (which requires many blood transfusions), will result in elevated iron concentration. Those individuals who do develop an iron overload are reported to be at greater risk of developing neoplasm's The maximum permissible limit of iron is 0.30 mg/L.

REVIEW OF LITERATURE:

Nigmananda Das and Jana (2012) studied the batch isothermal adsorption experiments to evaluate the effectiveness of the water- washed leached residue for removal of different bivalent metal ions from aqueous synthetic solutions. The effects of pH, initial metal ions concentration, amount of adsorbent, interfering ions, and heat treatment were also investigated. The uptake of metal ions increased with increasing pH. Under identical conditions the adsorption capacity increased in the order Cd(II)<Cu(II)<Pb(II). The adsorption kinetics was found to follow a first- order rate expression and the experimental equilibrium adsorption data fitted reasonably well to both Langmuir and Freundlich isotherm models**.**

Raul Munoz and Co-workers (2008) examined the residual algal-bacterial biomass from photosynthetically supported organic pollutant biodegradation processes, in enclosed photo bioreactors. It was tested for its ability to accumulate Cu (II), Ni(II), Cd(II), and Zn(II). The algal –bacterial biomass combined the high adsorption capacity of micro algae with the low cost of the residual biomass, which makes it an attractive biosorbents for environmental applications. There was no observed competition for adsorption sites, which suggested that Cu(II), Ni(II), Cd(II) and Zn(II) bind to different sites and that active Ni(II),Cd(II), and Zn(II) binding groups were present at very low concentrations.

Isabel Villaescusa et al. (2009) revealed the sorption of Pb (II), Ni(II), Cu(II) and Cd(II). The kinetic studies show that the initial uptake was rapid and equilibrium was established in one hour for all the studied metals and that the data followed the pseudo-second order reaction. The Langmuir and Freundlich isotherm models described the equilibrium sorption data for single metal system at initial pH 5.5. However the non-competitive Freundlich model has been found to provide the best correlation.

Sona and D'souza (2005) reported the possibility of low grade phosphate for the removal of lead, copper, zinc and cobalt ions from aqueous solutions. Effects of contact time, amount of adsorbent and initial concentration of metal ions were studied. Adsorption of heavy metal ions was found to follow the order of Pb (II)>Cu (II)>Zn(II)>Co(II). Similarly Chockalingam and Subramanian reported the utility of rice husk as an adsorbent for metal ions such as iron, zinc and copper from acid mine water. The adsorption isotherms exhibited Langmuir behavior and were endothermic in nature. The free energy values for adsorption of the chosen metal ions onto rice husk were found to be highly negative attesting to favorable interaction. Over 99% Fe(III), 98% of Fe(II) and Zn (II) and 95% Cu(II) uptake was achieved from acid mine water, with a concomitant increase in the pH value by two units using rice husk indicated successful growth of *Desulfotomaculum nigrificans(D.nigrificans*). The possible mechanism of metal ion adsorption onto rice husk is discussed.

RESULT

The amount of ferrous ion adsorption increased with the increase in carbon dose and reached a maximum value after a particular dose (table). Taken an initial metal ion concentration of 20 mg/L, complete metal ion removal was obtained at a maximum carbon dose of 100 mg. The increase in the adsorption of metal ion with carbon dose was due to the introduction of more binding sites for adsorption and the availability of more surface.

Table 1 : Equilibrium Parameters for the adsorption of ferrous ion on to acid activated Carbon Ce (mg/L) Qe (mg/g) Metal ion Removed (%)

	30^0	40^0	50^0	60^0	30^0	40^0	50^0	60^0	30^0	40^0	50^0	60^0
5	0.4141	.4254	0.315	.3142	4.2321	4.5623	4.2323	4.2625	90.22	91.21	92.22	94.21
10	0.9246	0.8522	0.7641	0.6428	9.0724	9.1471	9.2371	9.3672	90.75	91.47	92.37	93.67
15	1.6259	1.5023	1.3548	1.2242	13.3741	13.4972	13.6462	13.7858	89.16	89.98	90.97	91.90
20	2.4126	2.2013	2.1459	1.9246	17.5844	17.7988	17.8541	18.0154	87.93	88.97	89.27	90.07
25	4.1028	4.0522	3.4934	3.3312	20.842	20.9474	21.5076	21.6988	83.58	83.78	86.03	86.79
30	5.2212	5.1421	4.9127	4.7250	24.748	24.8574	25.0863	25.5550	82.59	82.85	83.62	84.18

CONCLUSIONS:

The work reported in this thesis deals with the investigation on the equilibrium, kinetic and thermodynamic aspects of the adsorption of metal ions such as Fe(II), Cu(II) and Cr(VI) and dyes namely Malachite green and Rhodamine B onto the two chosen adsorbents viz. BC and PSC. The different parameters were pertaining the adsorption at equilibrium are determined in order to establish the behaviour of the adsorption process. The adsorption of metal ions on the surface of the carbons, being a solid solution reaction. The extent of adsorption is directly proportional to the contact time and adsorbent concentration. The adsorption of metal ions increased up to 20 to 40 min, beyond which the equilibrium was reached. The percentage adsorption for a given adsorbent dose, decreased with increase in initial metal ion concentration and increased with increase in temperature. It was seen that the increase in dose of adsorbent, increased the percentage of metal ion removal.

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