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Removal of Heavy Metals from Ground Water using Eucalyptus Carbon as Adsorbent

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Abstract: In the present study, Eucalyptus carbon powder was used as an adsorbent for the removal of Heavy metals such as Lead, Cadmium, Chromium, Manganese and Copper from Ground water was studied. Highest adsorption capacity of Copper was found with an initial concentration of 100 ppm solution. Hence the present study reveals that the low cost adsorbent of Eucalyptus carbon may be used for removing the above said heavy metals present in Ground water.
Key words: Heavy metals, Eucalyptus carbon, Adsorption.

Introduction

Water is the most common and widespread chemical compound in nature which is a major constituent of all living creatures. Heavy metal pollution of the environment has become a growing ecological crisis and concern and therefore the subject of many research(1)

These heavy metals are continuously released into the aquatic environment from natural process like volcanic activity and weathering of rocks. Industrial processes like electro plating, metal finishing, metallurgical, chemical manufacturing and mining industries have greatly enhanced the concentration of heavy metals in the water. Ions of heavy metals like copper, nickel, zinc, cadmium, lead, chromium and mercury have a significant impact on the environment(2)

They are highly toxic as ions or in compound forms; they are soluble in water and may be readily absorbed into living organisms(3). Chromium generally occurs in hexavalent and in trivalent form. Chromium is capable of causing skin disorders & liver damage(4)

Ground water has been used as a source of drinking water for millions of rural and urban families in India. The problem of ground water pollution due to trace metals has now raised concerns all over the globe and results reported by various researchers have been alarming. Ground water is an important resource and is the elixir of life. But peoples are not aware of disease caused due to water contamination. Drinking water with good quality is very important to improve the life of people and prevent disease(5).

Heavy metals are dangerous environment pollutions due to their toxicity and strong tendency to concentrate in environmental pollution and in food chain process. (6,7) Extensive use of chromium results in large quantities of chromium containing effluents need sufficient treatments. (8) Manganese is a pinkish-grey, chemically active element. It is a hard metal and is very brittle. It is hard to melt, but easily oxidised. The

uptake of manganese by humans mainly takes place through food such as spinach, tea and herbs. Grains, rice, soyabeans, eggs, nuts and olive oil.After absorption in the human body manganese will be transported through the blood to the liver, kidneys, pancreas and the endocrine glands. Manganese effects occur mainly in the respiratory system and in the brains. Symptoms of Manganese are hallucinations, forgetfulness and nerve damage. Shortage of Manganese can also cause health effects such as fatness, Glucose intolerance, Blood clotting, Skin problems, Skeleton disorders, Birth defects and Neurological symptoms. Humans enhance Manganese concentration in the air by industrial activities and through burning fossil fuels. Manganese that derives from human sources can also enter surface water, ground water and sewage water.

Copper is a reddish metal with fcc structure. It is malleable, ductile and an extremely good conductor of both heat and electricity. Copper has low chemical reactivity. In moist air, it slowly forms a greenish surface film called patina, this coating protects the metal from further attack. Rivers are depositing sludge on their banks that is contaminated with copper, due to the disposal of copper containing waste water. Copper enters the air mainly during the combustion of fossil fuels. Copper can be released into the environment by raining, metal production, wood production and phosphate fertilizer production. Most copper compounds will settle and be bound to either water sediment or soil particles.

When copper ends up in soil it strongly attaches to organic matter and minerals. As a result, it does not travel very far after release and it hardly ever enters ground water. Copper does not break down in the environment and because of that it can accumulate in plants and animals when it is found in soils. Cadmium is a lustrous, silver-white, ductile and a very malleable metal. Its surface has a bluish tinge and the metal is soft enough to be cut with a knife but tarnishes in air. Human uptake of cadmium takes place mainly through mushrooms, shellfish,cocoa powder and dried seaweed. Cadmium accumulates in kidneys which cause the excretion of essential proteins and sugar from the body and further kidney damage. It also cause bone fracture, infertility, damage to the central nervous system and damage to the immune system. Cadmium waste streams may also enter the air through household waste combustion and burning of fossil fuels. Animals eating or drinking cadmium sometimes get high- blood pressure, liver disease and nerve or brain damage.

Chromium is a lustrous, brittle, and hard metal. People can be exposed to chromium through breathing, eating or drinking and through skin contact with chromium or chromium compound. For most people eating food that contains Cr(III) is the main route of chromium uptake as chromium (III) occurs naturally in many vegetables, fruits, meat, yeast and grains. Cr (III) is an essential nutrient humans and shortages may cause heart conditions, disruptions of metabolisms and diabetes. But the higher concentration of Cr(III) can cause health effects as well for instance skin rashes. Cr (VI) is a danger to human health mainly for people who work in the steel and textile industry. People who smoke tobacco also have a higher chance of exposure to Chromium. Chromium (VI) is known to cause various health effect. When it is a compound in leather products. , it can cause allergic reactions such as skin rash. After breathing it chromium (VI) can cause nose irritations and nose bleeds Exposure to hexavalent Chromium will lead to lung and stomach cancer in the humans (9) Chromium enters the air water and soil in the Cr(III) and Cr(VI) through natural process and human activities. Lead can cause several unwanted effects such as disruption of the biosynthesis is of haemoglobin and anaemia, rise in blood pressure, kidney damage, disruption of nervous systems, brain damage and diminished learning abilities of children. Lead can end up in water and soils through corrosion of leaded pipelines in a water transporting system and through corrosion of leaded paints. It cannot be broken down, it can only be converted to other forms. Lead accumulates in the bodies of water organisms and soil organisms. This will experience health effects from lead poisoning. Lead is one of the potentially toxic heavy metals when adsorbed into the body(10).

Materials and methods

The raw material of Eucalyptus bark was collected locally from Keeranur. It was cut into small pieces and dried. It was then carbonised in a muffle furnace to 200^0C to remove all the moisture content present in the Eucalyptus bark. It was then taken in a clean beaker and made into slurry by using 4N Nitric acid. It was heated for about 30 minutes in a hot water bath at 100^0C and kept aside for overnight. It was then washed several times with distilled water to remove acid and any impurities present in it. It was dried in an air-oven at 120^0C for about six hours. The dried materials were grinded and sieved into 90micron particles and were used as an adsorbent for overall studies. The sieved adsorbent was stored in an air-tight container. No other chemical modification was taken place.

Batch adsorption studies

The metal solution used in this study were prepared as the stock solution containing 1000ppm of each metal such as Lead, Copper, Chromium, Zinc and Cadmium. It was then suitably diluted to the required initial concentration of 100 ppm with distilled water. 100 ml of the adsorbate solution of known concentration (100ppm) was taken in six different 250 ml leak proof corning reagent bottles. To that solution, accurately weighed 1gram of Eucalyptus carbon particle powder was added in each bottle. These bottles were placed in a mechanical rotary shaker and shaken vigorously without any pH modification. A stop watch was started simultaneously to note the time. The bottles were withdrawn at different time intervals of 30, 60, 90,120,150 and 180 minutes. After that the solution was filtered by Whatmann 42 filter paper. The concentration of heavy metal was determined by Atomic Absorption Spectrophotometer (11).

The percentage removal was determined by the following expression.

$$\text{Adsorption percentage} = \frac{C_o - C_e}{C_o} \times 100$$

Where C_o is the initial concentration of sorbate solution in (mg/l) and the C_e is the concentration of the sorbate solution at equilibrium (mg/l). (12)

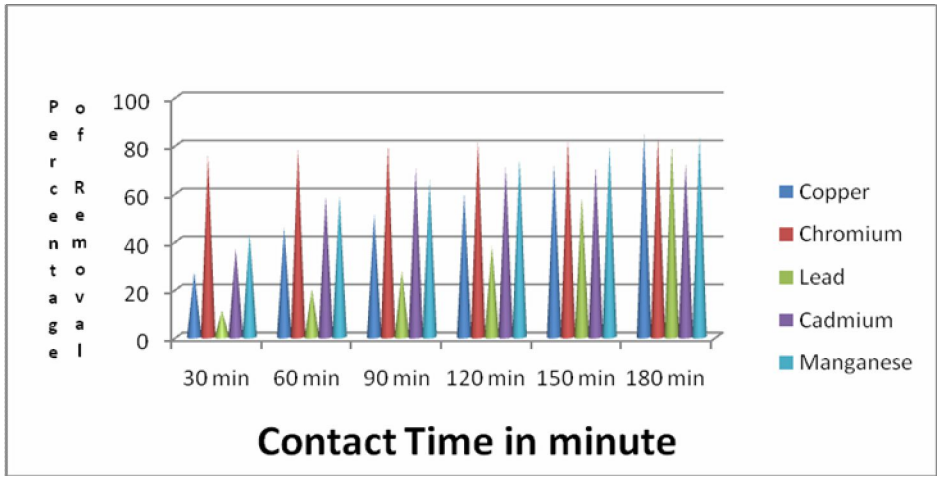

Figure 1. Percentage Removal of Cd, Cr,Cu,Mn and Pb

Results and Discussion

Effect of Contact Time on Adsorption of Heavy Metals

The relationship between contact time and the percentage removal of heavy metals from groundwater with eucalyptus carbon powder is shown in figure-1. The effect of contact time was studied at a room temperature at intervals of 30mins for 3hrs. The percentage of adsorption is found to increase continually with time till the equilibrium is attained with saturation at 180mins. The percentage reduction of Copper from27 to 84, Chromium from 75 to 83, Lead from 11 to 79 and Manganese from 43 to 83 for adsorbent of eucalyptus carbon powderhas slightly increased. This may be due to utilization of active sites is larger surface area. The percentage reduction of Cadmium from 36 to 72. The decreased adsorption efficiency is due to less adequate availability of active sites on the adsorbents (13). The high percentage reduction of Copperis found to be 27 to 84 is rapidly increased. The reduction efficiently is increased. This increase maybe due to the utilization of active sites availing the larger surface area (14). Hence the present study reveals that the low cost adsorbent of eucalyptus carbon may be used for removing heavy metals from ground water. From the obtained result, it shows that the removal of metal ions increased as contact time increases (15)

Conclusion

If low cost adsorbents perform well is removing heavy metals at low cost, they can be adopted and widely used in industries not only to minimize cost is efficiency, but also improve profitability. Thus, the use of low – cost adsorbents may contribute to the sustain ability of the surrounding environment. Undoubtedly low cost adsorbents offer a lot of promising benefits of commercial purpose in the future.

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