ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 12, June 2014

Removal of Iron from drinking / ground water by using agricultural Waste as Natural adsorbents

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Abstract: - Sustainability of good health depends upon the purity of water. However groundwater may be exposed towards to contamination by various anthropogenic activities such as agricultural, domestic and industrial. Groundwater quality problem are typically associated with high level of iron concentration in West Mugapair, Chennai. The normal drinking water contains permissible limit of iron concentration 0.3mg/l but the West Mugapair Groundwater contains 17mg/L of iron concentration. In the present study sugarcane bagasse (SCB) and Coconut coir (COC) from agricultural waste have been selected as solid phase extractor for removal total iron. Sugarcane bagasse, Coconut coir exhibits remarkable binding characteristics for removal total iron, so special interest was devoted for optimizing its uptake and studying its selectivity properties under static and dynamic conditions. The parameters such as effect of pH, adsorbent dosage, contact time, initial concentration, etc., were studied. Maximum removal of total iron was observed in the pH range of 4-5. The highest percentage removal of total iron was observed at Coconut coir (96%) compared than sugarcane bagasse (93%).

Key words: **Groundwater, Sugarcane bagasse, Coconut coir, Biosorbents.**

I. INTRODUCTION

In human most of the diseases comes from the polluted water. So water's purity is major factor for good health.Heavy metal pollution is a common environmental problem facing many places worldwide with the rapid development of technology and industries [1]. Heavy metals cause serious health effects, including reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death[2]. Iron is one of the earth's most plentiful resources making up about 5% of the earth crust. Iron is one of the major impurities that is commonly found in many sources of water [3]. They are so many methods for removal of iron from ground water.The methods are oxidation with chlorine and potassium permanganate treatment with limestone, liquid–liquid extraction, ion exchange, chemical precipitation, bioremediation, use of activated carbon and other filtering materials[4-12]. The utilization of above methods becomes economically not feasible for the removal of heavy metals. The environmentally attractive solution for iron removal method is the utilization of activated carbon from natural sources. Because it doesn't requires much chemicals, simple to implement, process are very fast. In recent years, research interest has increased in terms of the use of natural and/or agricultural adsorbents to overcome the environmental pollution [13]. Nowadays efforts have been made to use cheap and available agricultural wastes/Natural products such as sugar cane bagasse, coconut shell, orange peel, rice husk, peanut husk, pecan shells, jackfruit, maize cob, apple waste and sawdust as adsorbents to remove heavy metals from Ground water/waste water[14-20].The major composition of Sugarcane bagasse contains cellulose 32 to 48%, hemicellulose 19 to 24% and lignin 23 to 32 % [21].Coconut coirpith constitutes as much as 70% of the husk, and is a light, fluffy material generated in the separation of the fiber from the husk[22]. Bagasse and Coconut coir activated carbons having good porosity and high surface area. The adsorption properties of coconut shell are due to the presence of some functional groups, such as carboxylic, hydroxyl, and lactone, which have a high affinity for metal ions [23]. Nowadays activated carbons are widely used in water treatment methods. Because of easily available in local areas, low cost and highly effective in water treatment methods and Sugarcane bagasse, Coconut coir having very good tendency for removal of total iron. The present study aims to develop a cheap and easy technology to prevent health disorders due to the presence of excess iron in drinking water/ground water. In this study, agricultural waste as natural adsorbents derived from Sugar cane bagasse, Coconut coir were chosen as raw materials for removal of total iron from ground water samples at west mugapair in Chennai. This work was to investigate the feasibility of activated carbon for the maximum removal of total iron from Ground water at optimized parameters such as pH, adsorbent dosage, contact time, initial concentration and temperature.

II. MATERIALS AND METHODS

A. Reagents

The chemicals used were Hydrochloric acid, hydroxylamine hydrochloride,1,10 Phenonthroline, ammonium acetate and Ferrous ammonium sulphate were analytical grade and purchased from E. Merck in India. NaOH and pH buffer solutions (E. Merck) were used to adjusted pH values of samples. Water samples including: Ground water (GW) and drinking, tap water (DTW) were collected from West Mugapair, Chennai. Doubly distilled water (DDW) is obtained from our lab.

B. Instrumentation

UV-VIS spectra of SCB, Coconut coir before and after total Iron adsorption were obtained using ELICO SL159 UV-VIS spectrophotometer. A ELICO pH meter model

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L1120 calibrated against two buffer solutions at pH 4.0 and 9.2 was used for all pH-measurements. Magnetic stirrer (REMI 1MLH) was used for stirring experiments.

C. Preparation of the SCB and Coconut coir adsorbent

SCB and Coconut coir were first washed thoroughly with distilled water to remove the dust particles, then soaked overnight in 0.1 N NaOH solutions and again washed well with DDW. Then they were soaked in 0.1 N CH3COOH for a period of 2–3 h to remove the traces of NaOH. It was thoroughly washed again with DDW till the wash water became colourless and then filtered, well dried, powdered and sieved before use [24].

D. Preparation of synthetic iron solution

The standard iron solution 1000mg/L was prepared by adding calculated amount of ferrous ammonium sulphate in double distilled water. Then 5mg/L synthetic solution was prepared from the stock solution.

E. Raw water sample collection

Ground water samples were collected from tube wells at west Mugapair, Chennai, India.

III. RESULTS AND DISCUSSION

A. Physicochemical characteristics of raw water

The physicochemical characteristics such as turbidity, alkalinity, hardness, TDS, Chloride and other ions concentration was measured for ground water and given in Table 1.

Table 1 Characteristics of Ground water at West Mugapair

S.NO	Parameters	Values
1	Turbidity	50
2	pH	7.1
3	Conductivity(μscm^{-1})	1309
4	Dissolved oxygen(mg/L)	8.0
5	Chloride(mg/L)	203
6	Alkalinity(mg/L)	236
7	Calcium Hardness as	178
8	$CaCO_3$(mg/L)	122
9	Magnesium Hardness as	300
10	$CaCO_3$(mg/L)	940
11	Total Hardness as $CaCO_3$(mg/L)	840
12	Total Solids(mg/L)	100
	Total Dissolved solids (mg/L)	
	Total Suspended Solids (mg/L)	

B. Effect of pH

The effect of pH on the removal of total iron by Sugarcane bagasse, Coconut coir adsorbents were studied as in Fig.1. The pH of the aqueous solution is an important operational parameter in the adsorption process because it affects the solubility of the metal ions, concentration of the counter ions on the functional groups of the adsorbent and the degree of ionization of the adsorbate during reaction [25]. The pH of synthetic iron solution was varied from 2 to 8, initial concentration 5mg/L, dosage of adsorbent is 50mg, and shaking time 60minutes, Temperature 30 ° C and agitation speed were kept at 600 rpm, respectively. From Fig.1 it's shown that increasing pH of the solution from 2 to 5 caused linear increase in iron removal efficiency. Therefore, at low pH values (pH < 2) SCB,COC showed very low tendency for removal iron due to protonation of its functional groups or competition of H^+ with metal ions for binding sites [26]. The maximum percentage removals of both adsorbents at pH=5. Above pH > 5 the removal efficiency gradually decreased.

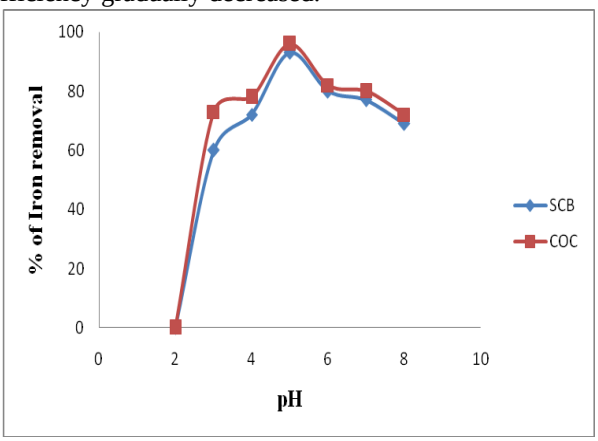

Fig.1.Effect of pH (Experimental condition: Initial concentration=5mg/L, adsorbent dose=50mg, Time=60mins, Temperature=30°C and pH=2to8

C. Effect of adsorbent dose

The results for adsorptive removal of synthetic iron solution with respect to adsorbent dose are shown in Fig.2. The weight of SCB, COC was varied from 25 to100 mg keeping all the other experimental variables, viz pH 5.0, initial concentration (5mg/L), and contact time 60 min. It is shows that there is a sharp increase in percentage removal with increasing adsorbent dose for total iron. The highest removal efficiency 100% is observed at dosage of 100mg for both adsorbents. This is expected because more binding sites for metal ions are available at higher dose of adsorbents.

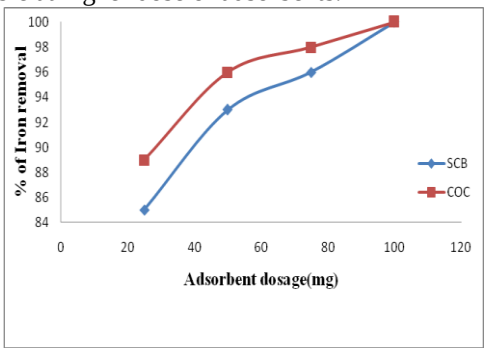

Fig.2.Effect of adsorbent dose (Experimental condition: Initial concentration=5mg/L, pH=5, Time=60mins, Temperature=30°C and adsorbent dose=25to100mg.

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D. Effect of initial concentration

The effect of initial concentrations (5 to 30 mg L^{-1}) of the removal of total iron (in terms of percentage removal) on both SCB, COC adsorbents was studied as shown in Fig.3. The pH of synthetic metal ion the solution was adjusted to 5 and then fixed dosage of adsorbent is 50mg is added and shaking for 60mins.It can be seen from the figure that the percentage removal decreases with the increase in initial metal ion concentration. At lower initial metal ion concentrations, sufficient adsorption sites are available for adsorption of the heavy metals ions. However, at high concentration the available sites of adsorption become fewer and hence the percentage removal of heavy metal is dependent upon the initial concentration.

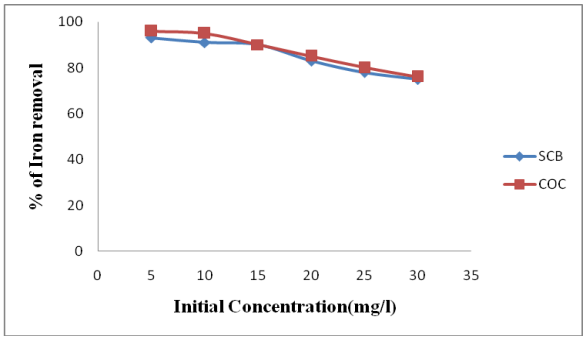

Fig.3. Effect of initial iron concentration in mg L^{-1}(Experimental condition: pH=5,Time=60mins, adsorbent dose=50mg, Temperature= 30°C, initial concentration=5to30mg/L)

E. Effect of contact time

The experiments were carried out at different contact times 5 to 150 min using Magnetic stirrer at 600rpm with adsorbent dose (50 mg), initial concentration (5mg/L) at a pH of 5.0 and 50.0 ml contact solution. The Percentage removal of iron was shown in Fig. 4. The equilibrium is reached within the first 60 min of shaking time and reached a saturation level. The highest percentage removals SCB, COC adsorbents were 93%, 96%. As the contact time increased the active sites on the sorbent were filled.

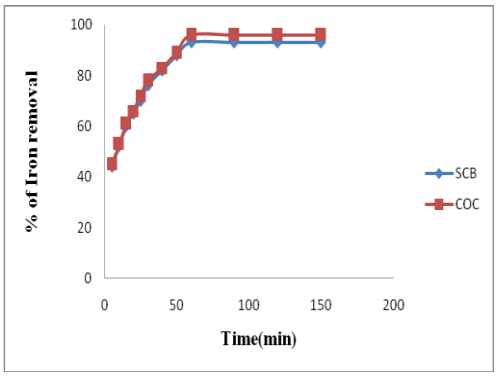

Fig.4. Effect of contact time (Experimental condition: Initial concentration=5mg/L, pH=5, adsorbent dose=50mg, Temperature= 30°C, Time=60mins)

F. Effect of Temperature

The effect of temperature on the removal of total iron by both SCB,COC adsorbents were studied with different temperatures of 30 ° C to 50 ° C.When we increasing the temperature the adsorption efficiency of both adsorbents is increases due to the attractive forces between the adsorbents surface and iron metal ions is increases. The increase in adsorption efficiency with temperature indicated that the reaction follows the endothermic pathway.

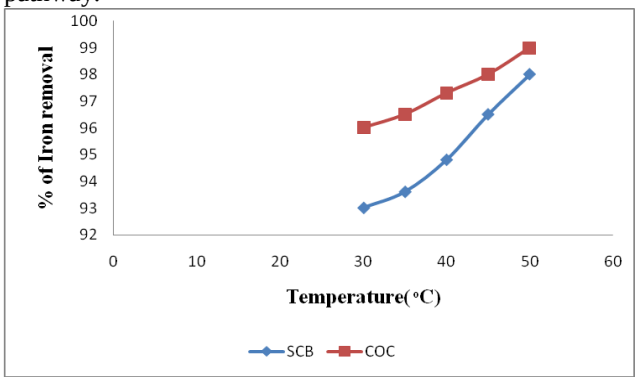

Fig.5.Effect of Temperature (Experimental condition: Initial concentration=5mg/L, adsorbent dose=50mg, pH=5, Time=60mins and Temperature=30°C to50°C)

IV. CONCLUSION

The present study deals that activated carbon prepared from Sugarcane bagasse and Coconut coir can be used very well for removal synthetic iron (5mg/L), ground water, double distilled water samples. When comparing both natural adsorbents the iron removal for Coconut coir carbon is higher than SCB carbon. The percentage removals (93, 96) of SCB, COC adsorbents were maximum at pH 5 and the removal efficiency increases with lower initial metal concentration and with higher adsorbent dose. Since sugarcane bagasse and Coconut coir is an agricultural solid waste, easily available, it can be used in Ground water treatment industries and wastewater treatments. The natural agricultural waste as environmentally friendly material for removal of iron from ground water.

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ISSN: 2277-3754
ISO 9001:2008 Certified
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Volume 3, Issue 12, June 2014

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