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STUDIES ON THE ADSORPTION OF FLUORIDE AND IRON FROM AQUEOUS SOLUTION USING LIMONIA ACIDISSIMA AS ADSORBENT

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ABSTRACT

In recent years the problem of water contaminant is drastically increasing due to the disposal of industrial wastewater containing iron, fluoride, mercury, lead, cadmium, phosphorous, silver etc into water bodies. Due to which, the contamination leads to serious health disorders and in some worst cases it causes permanent disabilities or even casual losses. In the present work an attempt has been made to remove such contaminants particularly fluoride and to study the efficiency of the removal of fluoride using a new material Limonia Acidissima which is commonly referred as wood apple. Accordingly a set of experiments have been conducted using batch and column processes, with the help of activated carbon prepared from the shell of wood apple. Experiments reveal that the adsorption capacity of the shell of Limonia Acidissima is significant as 64% to yield promising solutions.

INTRODUCTION

Iron and Fluoride are natural constituent of the Earth's crust and is present in varying concentrations in all ecosystems. It has drastically changed the biogeochemical cycles and in few cases it balances few classes of metals. The main anthropogenic sources of iron and fluoride are industrial sources viz. toothpowder manufacturing industries, foundry, metal plating industry and so on. In addition it also induces adverse effects on the environment and human health and moreover they are highly toxic even at low concentration to human beings and other living beings (Abya *et al.*, 2005). The removal of fluoride from synthetic solution can be done by adsorption technique using powdered activated carbon. Though the importance of this treatment is felt, its cost keeps the industrialists away from adopting the same (Abida *et al.*, 2008; Adeniyi *et al.*, 2010; Baisakh *et al.*, 2002; Balasubramanaiam *et al.*, 1997). It is also a fact that till date no material proves to be a better adsorbent than commercial activated carbon.

Since the cost of activated carbon and its reactivation costs are high, this particular technology remains at an inaccessible distance and its application does not find a significant place in the field of environmental engineering. Hence in this present work an effort has been made to introduce a new class

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of activated carbon, prepared from the shell of wood apple for the removal of such iron and fluoride content from wastewater.

During adsorption, the atoms within the structure of the adsorbent are attracted in all directions relatively equally, whereas the atoms at the surface exhibit an imbalanced attractive force, which the adsorbate molecules help to satisfy (Bansode *et al.*, 2003; Cormick *et al.*, 1999). The significant parameter, which popularizes an adsorbent, is the presence of a great amount of surface area; normally via the wall area or slots, capillaries of pores permeating its structure, in a very small volume and weight.

MATERIALS AND METHODS

Adsorption with Activated Carbon

Certain organic compounds in wastewater are resistant to biological degradation and many others are toxic or nuisance (odor, taste, color forming) even at low concentration. Low concentration materials are not readily removed by conventional treatment methods. Activated carbon has an affinity for organics and its use for organic contaminant removal from wastewater (Danica *et al.*, 2009; Ganapathy *et al.*, 2010; Halil Hasar *et al.*, 2003)

The larger surface area, a critical factor in the adsorption process, enhances the effectiveness of the activated carbon for the removal of organic compounds from wastewater by adsorption. The surface area of activated carbon typically can range from 500 - 1400 m^2/g. The effect of chemical nature of the carbons surface is less significant than the surface area. This chemical nature or polarity varies with the carbon type and can influence attractive force between molecules.

Experimental Methodology : Preparation of Adsorbent Using Wood Apple

The shell of wood apple as in Fig. 1 is a natural material which is thrown out as a waste. These wastes were collected and their size was reduced by breaking it into small size. Then they were dried in an oven at a temperature of 170 °C for 24 hrs. It was then packed in an air tight cylindrical iron container with top completely sealed with an iron cover to prevent the entry of air during the process of charring. The sealed iron container was heated in a muffle furnace by slowly raising the temperature up to 600 °C and subsequently it is maintained for the duration of one hour. The activated carbon thus prepared was subsequently washed with distilled water and oven dried.

Batch adsorption study was made by employing orbitrary shakers. 150 mL of desired concentration were agitated continuously with known amount of activated carbon by varying the dosage, Samples were taken and their residual concentration were monitored at regular intervals. After a lapse of a prefixed contact time, 50 mL sample was drawn from the samples, filtered and analyses for residual fluoride concentration.

To assess the influence of optimum pH, optimum dosage, time interval and isotherm, four different set of experiments were carried out, viz. a) Bottles with different pH ranging from 1 to 12 were varied and conditions were analysed for residual iron and fluoride concentration. b) Bottles with increasing doses ranging from 0.5g to 5 g of the adsorbent with fixed contact time were analysed. c) Bottles with optimized pH and sorbent dosage were agitated for varied timings ranging from 5 to 40 minutes and then analysed for residual fluoride concentration. d) Langmuir and Freundlich isotherms were plotted and the isotherm satisfies the equilibrium condition of the adsorbent.

Further the laboratory experiments were conducted with 45 mm diameter and 300 mm length column setup. The studies were carried out for a fixed flow rate of 2 mL/min and for which the depths of carbon are taken as 2.5 and 5 cm. The column was packed with adsorbents at various depths. The influent and effluent were adjusted to be 2 mL/min. Samples were collected at regular interval of 15 min and analyzed for residual concentration. The percentage removal was calculated till the carbon gets exhausted. The experiments were conducted for all the adsorbents and the results were compared. The results were plotted taking volume treated in mL as abscissa and residual metal obtained concentration in mg/L as ordinate.

RESULTS AND DISCUSSION

With reference to the discussion in the above section experiments were successfully conducted to study the influence of pH on the efficiency of fluoride removal. Accordingly the pH was varied with an increment of 2 for a range of 9 to12. From the experiments it is found that the hydrogen ion concentration plays a critical role on the adsorption capacity of wood apple shell. It is found that for a pH of 7, the efficiency was found to

Fig. 1 Wood Apple Shell

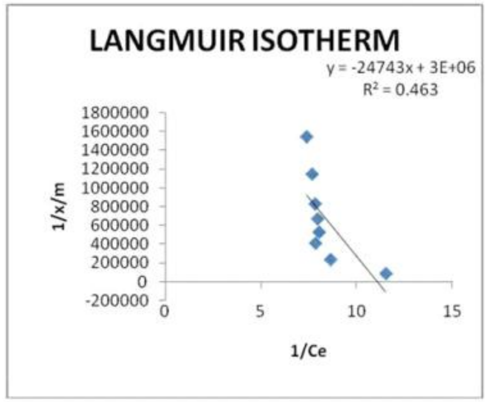

Fig. 2 Langmuir Isotherm for Fluoride removal.

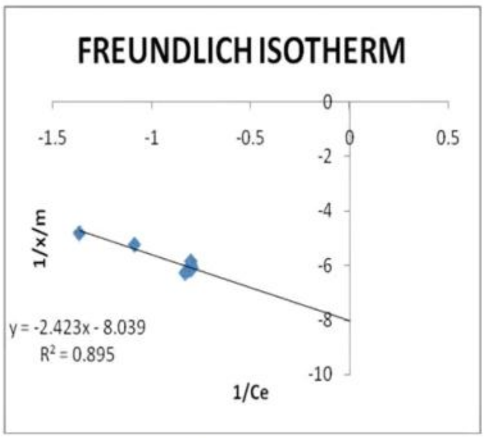

Fig. 3 Freundlich Isotherm for Iron removal.

be better for fluoride whereas for iron the efficiency was found to be better at pH of 5 .Further another set 9 experiments were conducted to determine the influence of dosage on the removal efficiency. Dosage was varied from 0.025g to 0.6g with an interval of 0.025g and it has been found that the dosage variation plays a significant role in determining the removal efficiency. It is found that for a dosage of 1.5g, the removal efficiency has an appreciable increase for fluoride and for iron it was 2 g.. Similarly 8 set of experiments were conducted and the influence of time interval for fluoride removal was determined by varying the time interval from 5 minutes to 40 minutes with an interval of 5 minutes. It has been found that time also plays an important role in addition to pH and dosage. By varying the time interval it was found that at the contact time of 15 minutes, the removal efficiency has an appreciable increase. From the results obtained from the laboratory experiments a Langmuir isotherm and a Freundlich isotherm was plotted to generate the adsorption pattern as in Figs. 2 and 3.

CONCLUSION

The efficiency of a new variety of adsorbent prepared from the seeds of Limonia Acidessima has been successfully demonstrated through series of laboratory experiments by varying the values of pH, dosage and time for the synthetic solution. The experiments were carried out for fluoride removal and the results reveal that the shellof Limonia Acidessima has much potential for a pH of 7, dosage of 1.5g and contact time of 15 minutes and similarly for iron removal results reveal that the shell of Limonia Acidessima has much potential for a pH of 5, dosage of 2 g and contact time of 25 minutes.

REFERENCES

Abia, A.A., Horsfall, M. and Didi, O. 2005. The use of chemically modified and unmodified cassava waste for the removal of Cd, Cu, Zn ions from the aqueous solution. *Bioresource Technology*. 90 (3) : 345-348.

Abida Begum, Hari Krishna, S. Irfan Ullakhan and Veena, K. 2008. Removal of heavy metals from waste water using Trimercaptotriazine, sodium Dimethyldithi-

Ocarbamate and 1,4 (21-Hydroxyphenyl- 1 Yl) Diamino Azine as Chelating Agents. *Environmental Pollution Control Journal*. 11 (4) : 69-72.

Adeniyi, S. Ogunlaja, Olalekan, S. Alade and Funmilola, Y. Oladipo, 2010. Preparation of Co – Mo catalyst using activated carbon produced from egg shell and SiO_2 as support the pacific. *Journal of Science and Technology*. 11 (1) : 383 -389.

Baisakh, P.C. and Patnaik, S.N. 2002. Removal of hexavalent chromium from aqueous solutions by adsorption on coal char. *Indian Journal of Environmental Health*. 44 (3) : 189-196.

Balasubramanian, N. and Ahmed, J. 1997. Adsorption dynamics- removal of Lead by lignite-Langmuir mode. *Indian Journal of Environmental Protection*. 18 (4) : 281-284.

Bansode, R.R., Losso, J.N. Marshall, W.E. Rao, R.M. and Portier, R.J. 2003. Adsorption of metal ions by pecan shell-based granular activated carbon. *Bioresource Technology*. 89 : 115-119.

Cormick, M.W. and Fred, C.S. 1999. Enhanced copper removal from activated sludge usingbio ferric/ selectors. *Journal of Environmental Engineering*. 125 (5) : 470-478.

Danica Barlokova and Jan Ilavsky, 2009. Iron and manganese removal from small water resources. *Water Management and Hydraulic Engineering*. 499-507.

Ganapathy Alagumuthu, Vellaisamy, Veeraputhiran, Ramaswamy and Venkatraman, 2010. Fluoride sorption using cynodon dactylon - based activated carbon. *Hem. Ind*. 65 (1) : 23-25.

Halil Hasar, 2003. Adsorption of nickel (II) from aqueous solution onto activated carbon prepared from almond husk. *Journal of Hazardous Materials*. B97 : 49-57.