

REMOVAL OF ARSENIC (III) FROM AQUEOUS SOLUTION BY ADSORPTION ON MODIFIED ACTIVATED CARBON

*Rajeev Goel, Vivek Kumar, Satish Kumar, Kshipra Misra, S.K.Kapoor
&
R.K.Sharma**

*Centre for Environment & Explosives Safety,
Metcalfe House,
Delhi-110054, India*

**Department of Chemistry,
Delhi University, Delhi-110007, India*

Introduction

Most of the reported arsenic problems in water supplies are found in ground water containing geogenic arsenic in elevated concentrations. Arsenic may also be an anthropogenic pollutant of ground or surface water derived from chemical wastes and waste water. Arsenic in drinking water is posing a serious health hazard in human beings(1).

Hyperpigmentation, skin & liver cancer and circulatory disorders are some of the major effects attributed to arsenic poisoning. World health organization (WHO) has established permissible value of 0.01 mg/ l (10ppb) for arsenic in drinking water and EPA also has brought it down to 10ppb from 50ppb(2) whereas results of analysis of drinking water samples of west Bengal and Bangladesh as carried out by WHO , National Institute of preventive and Social medicine (NIPSOM), Dhaka, Chief Engineering, Public Health Engineering Department, West Bengal and Harvard School of Public Health, Harvard University, USA has shown arsenic concentrations ranging from **0.05 mg/l to 3.2mg/l** , which is far more than the permissible level.

Number of studies(3-5) have been carried out to remove arsenic from water (ground water as well as drinking water) in different parts of world. All these studies indicate that only As(V) can be separated from the aqueous phase effectively and that the removal of As(III) which is about four times more toxic than As(V) is very difficult. Activated carbons are known to have tremendous adsorptive capacity and an ability to be custom tailored for specific applications. Therefore, the present work was taken up to study the adsorption of arsenic(III) on different type of activated carbons from aqueous solutions.

Experimental

Two different grades of indigenously available coconut based granular activated carbons(GAC) received from M/S Active Carbon India Limited, Hyderabad and a pitch based spherical activated carbon (SAC) obtained from M/S Krehan, USA were used for adsorption studies.

Surface treatment on granular activated carbon (GAC-60) of surface area 1100m²/g was carried out using iron oxide and manganese dioxide at alkaline pH.

100g of GAC-60 was washed with Milli-Q water and dried at 105°C till the constant weight was achieved. 240 ml of 2M solution of Fe(NO₃).9H₂O was added to the dried GAC and pH of the solution was adjusted to ~12.by the addition of conc. solution of NaOH The carbon was kept in an oven for twenty four hours at ~ 110°C. Treated carbon was then washed with Milli-Q water till colorless and finally dried to constant weight.

Surfaces treatment of GAC-60 by manganese dioxide was carried out by mixing 100 g of washed and dried carbon with 200 ml of 0.2 M of KMnO₄ solution. To this about 200ml solution of 0.3 M MnCl₂ was added slowly . The pH of the solution was maintained ~12 by the addition of concentrated solution of NaOH. The carbon treated so was kept in oven for twenty four hours at ~ 120°C, washed , dried and stored in stoppered bottles.

Adsorption isotherm studies of sodium arsenite (As⁺³) were carried out using 50 ml , 1ppm solution with varying doses (5g-80g/l) of different types of activated carbons in stoppered glass bottles. All the carbons were thoroughly washed with Milli -Q water and dried at 120°C till constant weight before use. Contents were then shaken for 24 hrs on a thermostatic shaker maintained at 30±1°C.

The solutions were allowed to settle and then filtered using Whatman filter paper No.1. Arsenic concentration before and after adsorption were determined using GBC-HG-3000 Atomic absorption spectrophotometer.

All the reagents used were of AR quality and only Milli-Q water was used for solution preparation and washings.

Results and Discussion

Analysis of untreated and treated GACs as well as SAC was carried out for different physical parameters and chemical composition. Results as given in table-1 show 4% and 0.22 % impregnation of iron and manganese respectively on GAC-60 sample. Little increase in surface area has also been observed after impregnation.

Results of Adsorption isotherm studies as shown in figure- 1 indicate that a dose of 35g/l of various treated and untreated GACs is sufficient for the maximum removal of As (III), whereas a dose of < 10 g/l for spherical activated carbon is quite sufficient for almost 100 % removal of As(III) from the solution. No significant effect of surface area of GAC has been observed on adsorption of As(III).

Effect of pH on adsorption behavior was studied and it has been found that adsorption increases with increase in pH of the solution in 4-11pH range.

No change in the adsorption of As(III) was observed by changing the concentration of the solution(1 to 6 ppm range).

Experiments are also under progress for the disposal of used carbon in the form of cement matrix (6) in order to make the technology environment friendly and cost effective. This cement matrix will be in the form of M-25 standard grade(7) impermeable concrete blocks used in construction industry.

Conclusions

From the work carried out so far it can be concluded that iron impregnated GAC and Spherical activated carbon can be successfully used for the removal of As(III) from water.

Technology can be used for the development of cost effective , simple and environment friendly home drinking water treatment kits.

Acknowledgement

Authors wish to record their sincere gratitude to Dr. A.K. Datta, CCR&D(M), DRDO and Dr. S.K. Salwan, Director,

CEES, for giving opportunity to work on this burning problem and granting permission to send the paper.

Authors also wish to pay thanks to Mr. Ashok Kumar Rawat for carrying out analysis.

References

- (1) Zaman,K.,Anwar,S.K.andRahman,M., proc.International Symposia on New Strategies in Waste management and 3rd Symposia on impact of Toxic Chemicals on Bengal basin Economics, Kolkata,2001, p.37.
- (2) EPA, USA, Office of Water, Federal Register: , January 2001:Vol. 66, No. 14.
- (3) Robert T. Deithornand Anthony F. Mazzani, Water Technology, 1986, Vol. 9, No. 8 , p.26-29.
- (4) Clifford, D., Environ. Sci. Technol. 20, 1986 p. 1072.
- (5) Gottschalk, C., Schmitz, S., Driehaus, W., and Jekel, M., Vom Wasser , 1992 :79, p. 225.
- (6) Palfy, P., Vircikova, E. and Molnar, L., Waste Management , 1999:19, p. 55.
- (7) Singh Gurbachan, Hand Book of Civil Engineering, Part II ,1982, p.29.

Table -1 : Physical Characteristics Of Activated Carbons

S. No.	AC	pH (in water)	pH (in As sol)	Fe (%)	Al (%)	Mn (%)	Si (%)	Surface area (BET) m ² /g
1.	ACG - 60	9.7	10	T	T	T	T	1117
2.	ACG - 70	10.2	10.5	T	T	T	T	1264
3.	ACG-60-Fe	7.9	8.77	4.0	T	T	T	1306
4.	ACG-60-Mn	10.3	9.8	T	T	0.24	T	1300
5.	SAC	7.5	7.8	nd	nd	nd	0.12	1200

nd- not detected, T-trace

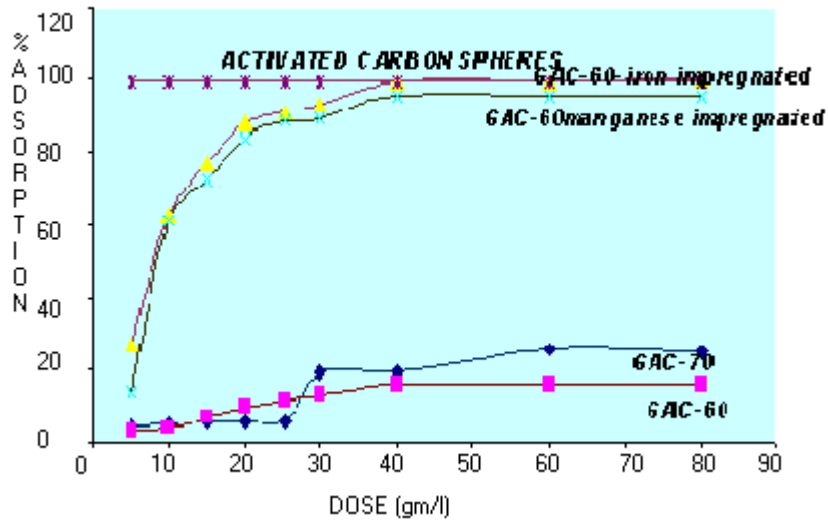


Figure-1 : Adsorption of As (III) on Activated Carbons