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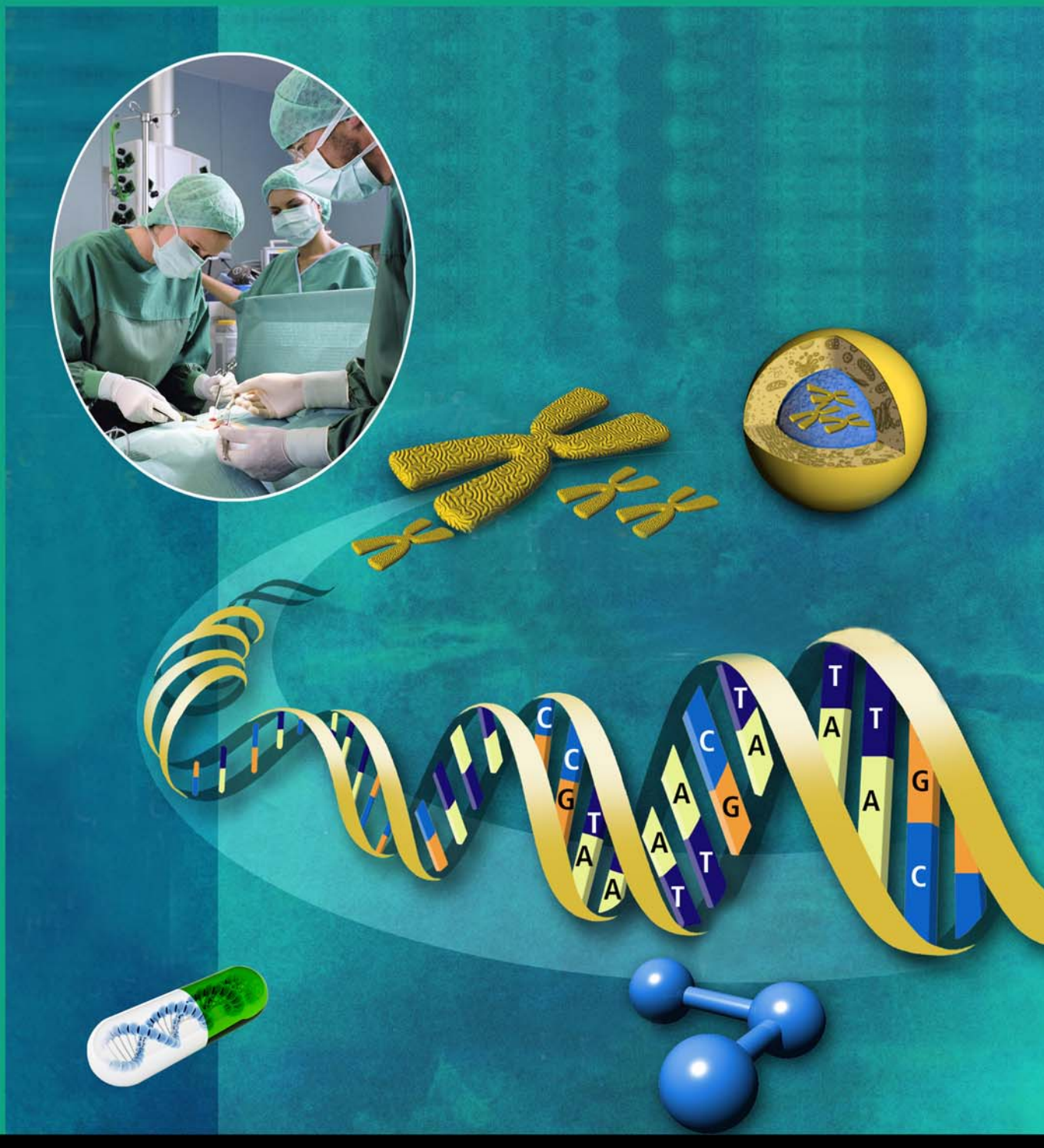

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Research Paper

ARSENIC REMOVAL FROM GROUND WATER: A LOW COST FILTER MEDIA

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Arsenic is a major environmental pollutant and exposure occurs through environmental, occupational medicinal sources. Arsenic contamination of groundwater is a naturally occurring high concentration of Arsenic in deeper levels of ground water. The contaminated drinking water is the main source of exposure and affected countries are India (West Bengal), Bangladesh, China, Taiwan, Thailand, Chile, Argentina and Romania. Concentrations of arsenic in affected areas are several times higher than the Maximum Contamination Level (MCL) (10 µg/L). Arsenic exposure to human results in degenerative, inflammatory and neoplastic changes of skin, respiratory system, blood, lymphatic system, nervous system and reproductive system. There is no particular remedial action for chronic arsenic poisoning. Low socioeconomic status and malnutrition may increase the risk of chronic toxicity. Early intervention and prevention can give the relief to the affected population. A 2011 study found that over 1 in 1000 people in more than 70 countries are probably affected by Arsenic poisoning. Like many places of India, Arsenic in ground water is a serious problem at Eastern belt of West Bengal, Bharatpur city of Rajasthan, Aligarh in Uttar Pradesh and many more. This study was done to check potential of removing Arsenic from ground water by available waste of common Iron rust, which is chemically Fe_2O_3. It was found that the Arsenic removal capacity of this media is more than 90% and which is superior to using hydrous ferric oxide (FeOOH) gel, for removing Arsenic, TDS and color too. In this work various experiments were done to prove the better Arsenic removal capacity of rust, which were compared with the results of FeOOH for various water parameters. Lastly it was found that using Iron rust is more efficient in removing Arsenic from ground water.

Keywords: Arsenic, Arsenic contamination, Groundwater, Water supply, Asia

INTRODUCTION

The problem of Arsenic pollution of ground water has been creating serious threat to a number of districts in West Bengal and some selected pockets of other parts of India like Bharatpur City (Rajasthan), Aligarh (UP), Darbahnga (Bihar). It has been reported that in the above part of India with a population of about 30 million, the Arsenic content is much higher than the WHO limit. It may be noted here that Bureau of Indian Standards

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(BIS) has also revised the limit of Arsenic in drinking water from 0.05 to 0.01 mg/L (5 to 1 ppb) w.e.f. 2003.

Table 1: Affected Areas by Arsenic Toxicity

District and City	Concentration in mg/l
South 24 Parganas, West Bengal	0.06-3.20
North 24 Parganas, West Bengal	0.06-1.28
Malda, West Bengal	0.05-1.434
Nadia, West Bengal	0.05-1.00
Murshidabad, West Bengal	0.05-0.90
Bharatpur City, Rajasthan	0.4-0.5
Darbahnga, Bihar	0.05-0.1

(Source: A Study on Arsenic Contamination in Indian Urban, Sub-Urban & Rural Area - WHO Report)

These results provide substantial evidence of prolonged Arsenic ingestion by the people through food chain as well as drinking water sources. Hair, nails, scales, urine and liver tissue analyses of people living in affected areas show elevated levels of Arsenic. The source of Arsenic is geological. The contamination is mostly reported from aquifers at a depth of 20-80 m below ground.

LITERATURE REVIEW

Arsenic is a heavy metal that is placed in the group of Inert Metal group. The presence of it in a small quantity in water or food may affect the Human health drastically and some time may leads to Death. The speciation of arsenic governs its availability, accumulation, and toxicity to organisms as well as its mobility in the environment. Arsenic (V) is the form that is more readily precipitated with or adsorbed onto metal oxides. An ingested dose of 70-180 mg of arsenic trioxide (As_2O_3) is lethal to humans. Somewhat lower doses produce subacute effects in the respiratory, gastrointestinal, cardiovascular, and nervous systems. Chronic exposure to arsenic in drinking water has been linked to serious dermatological conditions; including black-foot disease, epidemiological studies have linked arsenic in drinking water with cancer of the skin, bladder, lung, liver, and kidney and other ailments. Both As (III) and As (V) are strongly adsorbed in the human body.

Arsenic Test: Arsenic concentration in water was tested by a highly sensitive arsenic test kit by Merck KgaA, Germany. Measuring range (color scale graduation): 0, 0.005, 0.01, 0.025, 0.05, 0.1, 0.25, 0.5 mg/L. The kit work on the principle that, When zinc and a solid acid are added to compounds of arsenic (III) and arsenic (V), arsenic hydride is liberated, which in turn reacts with mercury (II) bromide contained in the reaction zone of the test strip to form yellow-brown mixed arsenic mercury halogenides. The concentration of arsenic (III) and arsenic (V) is measured semi-quantitatively by visual comparison of the reaction zone of the test strip with the fields of a color scale.

MATERIALS AND METHODS

Column Filtration Method: The column filtration method was used in this practical work. This method requires a minimum financial investment and facilitates change of the filling material easily for cleaning and for any other corrections/ amendments. Three kinds of columns were used independently for comparing with each other to see the efficiency of particular column. Different Arsenic positive samples (0.10 to 2.00 mg/L) were passed through these columns at the same input flow rate (200 mL/h).

The filtered water was then tested for Arsenic, TDS and color, etc.; lastly the results were compared with each other. First Column contains

sand, gravels, sieve, cotton cloth, glass Beads and FeOOH gel, Second Column contains as above except the FeOOH gel and the waste Iron Rust instead. The third column has same as second but there is an extra layer of charcoal beneath Iron Rust layer. (NOTE: Back wash is recommended in all the three columns).

1. **FeOOH Gel Prepared For Column Treatment*:*** The gel of FeOOH can be prepared by using:
   - Sodium Hydroxide - NaOH - 500 mL
   - Ferric Chloride - $FeCl_3$ - 500 mL
   - Sodium Silicate - Na_2SiO_3 - 500 mL

   When they are all mixed in required proportions and stirred for about 1 to 2 h, a gel like substance is obtained which has a definite iron-like property.
2. **Treatment Using RUST*:*** A common type of Rust from a thrown Cooler as we have obtained is shown in Figure 1 and a set-up of RUST column in Figure 2 (this set-up also contains sand, gravels, glass beads, filter papers, sieve and cotton cloth).
3. **Treatment Using Rust + Charcoal*:*** The third and one of the most important methods for the removal of Arsenic from the ground water is through RUST and charcoal treatment.

Figure 1: Used Cooler As A Source Of Raw Rust

Figure 2: A Full Set-up Of Rust Column

Charcoal has the property to decrease the unwanted impurities like colour and some biological impurities from the water.

Table 2: Comparison Between Treatments Obtained By Three Columns (Bharatpur Sample)

S.No.	Parameters	FeOOH Gel		Rust		Rust – Charcoal	
		Initial	Final	Initial	Final	Initial	Final
01	Arsenic Concentration (mg/l)	0.5	0.1	0.5	0.05	0.5	0.05
02	Arsenic Removal in %	–	80%	–	90%	–	90%
03	Total Solids (mg/l)	2,100	2,900	2,100	2,200	2,100	1,900
04	Color	Clear	Reddish orange	Clear	Yellowish	Clear	Clear

Table 3: Comparison Between Treatments Obtained By Three Columns (Std. Sodium Arsenite Solution 2 Mg/Lit)

S.No.	Parameters	FeOOH Gel		Rust		Rust – Charcoal	
		Initial	Final	Initial	Final	Initial	Final
01	Arsenic Concentration (mg/l)	2.0	0.4	2.0	0.2	2.0	0.2
02	Arsenic Removal in %	–	80%	–	90%	–	90%
03	Total Solids (mg/l)	2.5	125	2.5	76	2.5	12.0
04	Color	Clear	Reddish orange	Clear	Yellowish	Clear	Clear

CONCLUSION AND RECOMMENDATION

This study proves that the waste iron rust has the capacity to adsorb Arsenic from Ground water even in greater strength in compare to FeOOH Gel. The Arsenic removal capacity of Gel was found to be 80% while the Arsenic removal capacity of rust was 90%. The backwash was required more frequently in the rust column otherwise the arsenic removal capacity was lowering down. The TDS and color were increased more in FeOOH Gel while less in rust column. In the test with third column (i.e., rust with charcoal) we found very good results, its efficiency was 90% Arsenic removal with no extra cost and color and TDS also remained constant. Through this study it is clear that rust technology is more effective and low cost and needs less effort, even maintains the solid waste problem of the area upto a level.

- It is strongly recommended that Arsenic contaminated water should not be used for drinking but for cooking, washing, bathing and irrigation/agricultural purposes, a proper scientific study has to be carried out. Also, the issue of permissible limits of Arsenic in vegetables / fruits / crops, etc., has also to be looked into.
- Treatment options for Arsenic removal have to be foolproof with zero environmental impact and inbuilt arrangement for sanitary disposal of Arsenic bearing sludge.
- Best long term/medium term/techno-economically viable options need to be prescribed on absolute terms on the parameters such as capital cost, recurring cost, capability of decentralized management and utilization of technologies/options in the field and best technological options on least cost basis.
- Many technologies meant for removing Arsenic also removed iron from the water. Therefore, stringent monitoring mechanism is required. It was also observed that presence of Iron along with Arsenic in drinking water improved the Arsenic removal in adsorption process.
- Any Arsenic Removal package must comprise both the technology for sludge disposal as well as a package for technical education for the users and also should ensure a continuous supply of chemicals/media, etc.
- Treatment of Arsenic – affected water appears to be feasible only in areas where piped water supply cannot reach. Arsenic removal using different technologies will work only if the

methodology is backed by ways and means to educate all affected villagers in the working of the plant.

- Rain Water Harvesting should be in place as a local solution wherever it is feasible.
- The State has increasingly gone in for surface water and its efforts in this direction are commendable. It may be safe to completely stop using affected water.
- It may be necessary to treat water from ponds / pools to remove contamination and supply it as piped water wherever feasible.
- Standard methods need to be explained regarding safe disposal of sludge that comes out of arsenic treatment plant at the community as well as district level. Central Pollution Control Board standards need to be clearly indicated in this regard.
- It may also be noted that although the contract is given to Agency for installation, operation and maintenance and safe disposal of sludge but, in reality, once the arsenic contaminated sludge is taken away by the Agency from the treatment site, one does not know whether the sludge is disposed off in a safe manner.
- Sludge Disposal Methods have to be foolproof, user-friendly and environment friendly.
- It was strongly felt that whichever technology is being adopted there should be very strong monitoring mechanism to control the filtered water quality.

REFERENCES

1. *Aqueous Environmental Geochemistry* (2003) Prentice Hall, New Jersey. pp. 334-337
2. *Arsenic Filtration Units. (2000)* Prepublication Report. Sono Diagnostic Center Environment Initiative, Kushtia, Bangladesh.
3. Chatterjee A, Das D, Mandal B K, Chowdhury T R, Samanta G and Chakraborti D (1999), "Arsenic in groundwater in six districts of West Bengal, India: The biggest arsenic calamity in the World", Part 1. Arsenic species in drinking water and urine of affected people. Analyst, Vol. 120, p. 643-650.
4. Joshi A and Chaudhuri M (1996), "Removal of Arsenic from Ground Water by Iron Oxide-Coated Sand", *ASCE Journal of Environmental Engineering,* Vol. 122, No. 8, p. 769-771.
5. Khair A (1999), "Arsenic removal from drinking water by low-cost materials, Paper presented at the International Conference on Arsenic in Bangladesh Groundwater: World's Greatest Arsenic Calamity", USA, February 27-28.
6. Mamtaz R and Bache D H (2001) – (J water SRT Aqua 50 (page 313 – 324)) Low cost Techniques of Arsenic Removal from Water and its removal mechanism.
7. BIS. Indian Standard Drinking Water-Specification (First revision 2003). Fifth reprint; Report No. ISO 10500; BIS: New Delhi, India.
8. Driehaus W, Jekel M and Hildebrandt U (1998), "Granular ferric hydroxide – a new adsorbent for the removal of Arsenic from natural water", *Aqua J.Water Supply Res.Technol,* pp. 30–35.

9. Hydrous Ferric Oxide (1999), Wiley-*Interscience*, New York, pp. 89-95
10. WHO (2002*), Arsenic and arsenic compounds. Environment Health Criteria,* Geneva.
11. WHO (2009), Arsenic in Drinking Water. Fact sheet. No. 210 Retrieved June 6, http://www.who.int/mediacentre/factsheets/fs210/en/
12. WHO (2004), *Guidelines for Drinking-Water Quality;* 3rd ed.; Vol. 1, Recommendations; World Health Organization: Geneva.
13. www.epa.gov
14. www.merck-chemicals.com/test-kits
15. www.sciencedirect.com/arsenic_removaltechniques

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