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A Study of Impact of Groundwater Arsenic Contamination in West Bengal

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ABSTRACT

Arsenic is causing significant health problems, socio-economic and cultural issues worldwide. Significant social and cultural impacts including difficulties in getting safe drinking and irrigation water, mental and psychological harm, difficulties in getting education and marriage, social exclusion, superstition and migration. Significant economic impact includes difficulties in income and livelihood generation due to arsenic induced diseases, incapable in performing economic activities, low agricultural productivity due to insertion of arsenic in the food chain, vegetables, fodders, grains, animals and their products like, milk, meat, fish, sweets etc. Immediate preventive and curative measurements can only lead to mitigate the problem

INTRODUCTION

Arsenic has the symbol As and Atomic No.-33. It is present in group 15, 4 th period and p block element in the periodic table. This is a notoriously poisonous metalloid that has many allotropic forms such as yellow, black and grey. Arsenic is a nicknogen that occupies the thirty third position of the modern periodic table. It is situated in the fourth period and in Group 15 (which also embraces nitrogen, phosphorus, antimony and bismuth, having the electronic configuration ns2 np3, where n is the principal quantum number of the ultimate shell of each of the aforesaid elements) The configuration of arsenic is 4s2 4p3. Remarkable physical properties of the element are presented below. As the normal electrode potentials of bismuth and copper are respectively 0.226 and 0.344 volt, arsenic should come between these two elements in the electrochemical series.

Arsenic affected throughout West Bengal

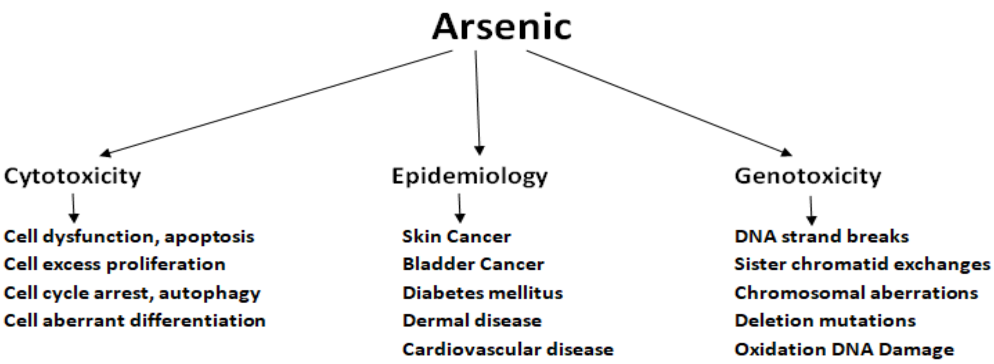
Year	**Incident**
1976	Arsenic contamination and its hazardous effect on human life were first reported from Chandigarh in North India.
1984	The next arsenic contamination problem was observed in the plains of the Lower Ganges in West Bengal.
1988	The School of Environmental Studies (SOES) began analysing the arsenic pollution in the groundwater of West Bengal.
1995	An international arsenic conference was held in Kolkata for 5 days with the help of SOES.
2002	The groundwater arsenic contamination was reported in West Bengal and several discussions were held regarding the attitude of the government and other organizations towards this critical problem.
2009	The condition of groundwater arsenic contamination from 1988 to 2009 in West Bengal was reported which also had an additional report on Kolkata city itself. i. 19 districts of West Bengal were analysed for 140,150 hand tube wells. ii. The groundwater arsenic concentration exceeded the World Health Organization (WHO) guideline value (10 µg/l) in 13 districts. iii. Arsenical skin symptoms are observed in 9 districts that had groundwater arsenic concentration above 300 µg/l. iv. Nine districts had tube-wells with an arsenic concentration above 300 µg/l: a. Bardhaman b. Hooghly c. Howrah d.Kolkata e. Malda f. Murshidabad g. Nadia h. North 24 Parganas i. South 24 Paraganas
2020	The major challenges in West Bengal are the water quality problems, especially in rural areas. Out of 23 districts, three Divisions (Burdwan, Presidency and Jalpaiguri Division), 66 Sub Divisions, 341 blocks, 121 Municipalities and 6 Municipal Corporations, the groundwater of 85 blocks are arsenic affected which affect over 4.2 million people.

Epidemiological studies [5,6] in the eastern and south-eastern part of West Bengal brought to light for the first time a large scale incidence of arsenical dermatosis due to the chronic consumption of groundwater containing arsenic in concentrations above the permissible level (0.05 mg L^{-1})as per the Bureau of Indian Standard).

District	Total no. of blocks	No. of arsenic affected blocks	Blocks with arsenic level > MPL (0.50 ppm)
Bardhaman	31	5	Purbasthali I and II, Katwa I and II, Kalna II
Hoogli	18	2	Balagarh, Pandua
Howra	14	2	Uluberia II, Bally-Jagacha
Maldah	15	7	English Bazar, Manikchak, Kaliachak I, II, II, Ratua I and II
Murshidabad	26	21	Raninagar I and II, Domkal, Nawda, Jalangi, Hariharpara, Beldanga I and II, Suti I and II, Bhaganwangola I and II, Behrampur, Raghunathganj I and II, Murshidabad-Jiagang, Farakka, Samserganj, Lalgola
North 24 Parganas	22	21	Habra I and II, Barasat I and II, Deganga, Basirhat I and II, Swarupnagar, Sandeshkhali II, Baduria, Gaighata, Rajarhat, Bagda, Amdanga, Bongaon, Haora, Hasnabad I and II
Nadia	17	17	Karimpur I and II, Tehatta I and II, Kaliganj, Nakashipara, Nabadwip, Hanskhali, Krishnaganj, Haringhata, Chakda, Santipur, Chapra, Ranaghat I and II, Krishnanagar I and II
South 24 Parganas	29	8	Baruipur, Sonarpur, Bhangar I and II, Bishnupur I and II, Joynagar I, Mgrahat II

District	Total no. of blocks	No. of fluoride affected blocks	Blocks with fluoride level > MPL (1.50 ppm)
Puruliya	20	17	Jaipur, Puruliya I and II, Para, Raghunathpur I and II, Neturia, Santuri, Kashipur, Hura, Panchua, Arsha, Jhalda I, Bagmundi, Balarampur, Arabazar
Bankura	22	10	Saltra, Gangajalghat, Chatna, Indpur, Bankura II, Barjora, Taldanga, Simlapal, Hirbandh, Raipur
Birbhum	19	7	Nalhati I, Rampurhat I, Mayureswar I, Rajanagar, Suri II, Sainthia, Khoyrasol
South 24 Parganas	29	1	Baruipur
Maldah	15	2	Ratua II, Bamongola
North Dinajpur	9	1	Itahar
South Dinajpur	8	5	Khushmundi, Gangarampur, Kumarganj, Tapan, Bansihari

TOXICITY OF ARSENIC



Arsenic is a potent carcinogen, leading to skin, bladder, liver, and lung cancers. Arsenic induces epidemiological toxicity. It results in the formation of excess ROS thereby damaging organisms Chronic exposure to arsenic can lead to arsenicosis, including skin lesions, nail deformities, black foot disease, peripheral vascular disease, and cancers.

Name-Unwilling to Reveal
Age-65
Gender-Male
Village-Canning II, South 24 Parganas

LARGE SCALE REMOVAL OF ARSENIC FROM THE GROUNDWATER

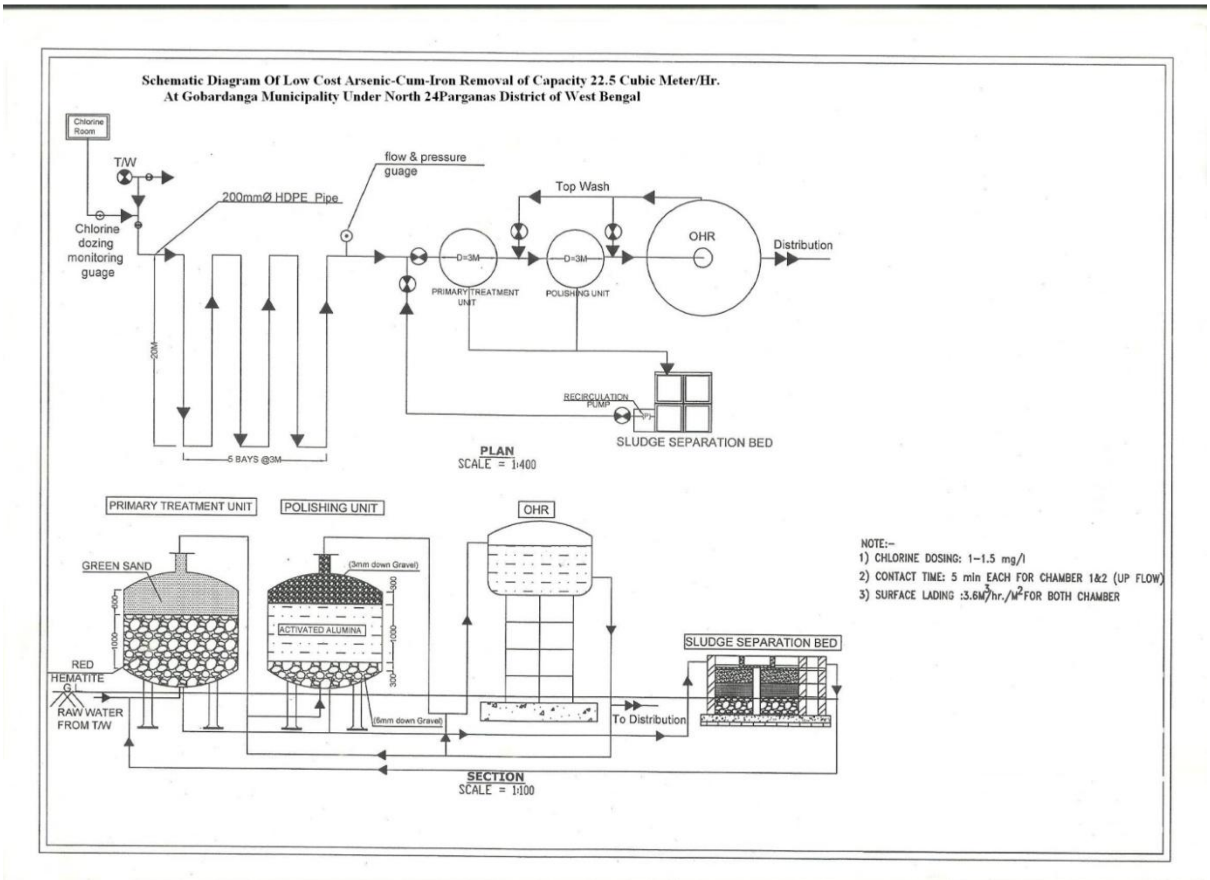
(Design of a Low-cost Treatment Plant)

For the benefit of the inhabitants of the locality, a ground water based low cost water treatment plant was designed and built up at Gobardanga, one of the arsenic affected municipalities in the district. The ground water lifted from the aquifer through the borehole (TW) is first chlorinated by means of an electro-chlorinator and a chlorine dosing monitoring gauge that insures proper chlorination. The average dose of chlorine is maintained between 1.0 to 1.5 mg L^{-1} of water.

The chlorinated water is then allowed to pass through an oxidation unit which is actually a zig-zag (underground) high density polyethylene pipeline having a total length of 120 m and an internal diameter of 200 mm.

From the experimental results it becomes apparent that about 30.43 to 39.17 % of arsenic and 26.23 to 46.15 % of iron are removed during the movement of water through this passage. Due to chlorination, entire arsenite present in the water is oxidized into arsenate in this channel, and at the same time, entire ferrous iron is also oxidized to the ferric state and a part of them are co-precipitated.

The arsenite free water is then allowed to pass against the gravity through a primary unit consisting of a layer of red hematite (placed at the bottom of the unit) and a layer of green sand over the hematite layer (as shown in the diagram). The contact time of water with this adsorbent bed is approximately 5 minutes. Experimental results indicate that this unit removes 58.19 to 63.02 % of arsenic and 61.09 to 63.94 % of iron during this period through adsorption. This partly treated water is then transferred and fed into the final unit or polishing unit that contains an activated alumina layer enclosed between two layers of gravels of different sizes (as mentioned in the diagram). This unit effectively removes arsenic and iron and the result witnesses that 95 to 99.14 % of arsenic and 81 to 91.17 % of iron are removed in this unit to make the water potable. The contact time in this unit is also 5 minutes and the water is allowed to flow in this unit is also against the gravity. The surface loading in both primary treatment and polishing units is 13.6 $m^3 h^{-1} m^{-2}$. Finally, the clarified water is pumped into an overhead clear water reservoir and from this storage system, the water is allowed to reach the distribution system to supply to the beneficiaries. The yield is approximately 22.5 m^3 of clarified drinking water per hour.



CONCLUSION

Frequent awareness camps on the affected areas by the NGOs, Providing employment on alternative (micro, small and medium)cottage industry initiative, Frequent organizing health camps and home visits in the affected areas Spreading awareness for the acceptability of the affected member, Free medicines circulation, More deep ground water provide, Shallow groundwater (well switching), Dug well water ,Surface water from ponds and Rainwater harvesting. Public Consciousness, Industrial Co-operation and Legislative Control can mitigate the problem,Effluent treatment plan, Restoration plan and rehabilitative means of finding affordable treatment policy and mitigation policies,Natural and anthropogenic resources and research have been done in present study ,Governmental, Donor, Financial, Technical and Logistic assistance are essential to reduce aresenicosis.

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Interacted and guided by

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