

Investigation of Heavy Metals Including Arsenic (As) Concentration in Underground Water of Agra City using Arsenic Hydride System by Atomic Absorption Spectrometer and also Application of Geo-Spatial Technology

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Abstract

Water Plays a significant role in our life. It serves the purpose of various Human activities such as irrigation, electricity, generation, industrial production etc. Water requirement in Uttar Pradesh is continually on the rise. In India ground water is being used as raw or untreated water for 85% of the public Supply of water varies widely from region to region and country to country. The prime requirement for sustainable development of a region is its water quality especially underground water. To check groundwater and sort out the contaminated region is economically very significant for the development of the area...Currently the potable water woes are global problem. This paper focuses on the ground water contamination of Agra city. It was selected for its importance as a popular tourist destination worldwide. The large number of tourists coming here use its water, therefore it is imperative that its water quality be monitored regularly. The present study is of mid-monsoon season 2018. For these 15 samples were collected using handheld GPS from randomly selected stations from different wards having easy access for regular sampling. The drinking water in Agra city is assessed for the following 8 parameters namely, pH, conductance, total dissolved solids (TDS) and heavy metals like Cu, Cr, Zn, Pb and As. and it is found that the concentration of various parameters is not within the permissible limit of water quality prescribed by WHO and CPCB. A GIS database of the measured spatial and water quality data is developed using QGIS3.2 and ground water quality maps are also prepared which will be helpful in monitoring the ground water quality of the status of the study area.

Keywords: GIS database, arsenic, water quality map

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Introduction

Groundwater is a major source of freshwater in some parts of the world to meet daily needs, including agriculture. Groundwater is one-third of the world's population's dependence on drinking water. Most of the world is experiencing significant water pollution due to the involvement of various toxins, minerals, and heavy metals, either naturally or through the chaotic growth of human development. Arsenic is the most important and deadly of these metals. Groundwater pollution by heavy metals is a form of groundwater pollution and is often caused by high concentrations of heavy metals that occur naturally in deeper aquifers. This is a notable issue as it uses deep wells to supply the Ganges Delta, causing severe "arsenic" infections for many. According to a 2007 survey, more than 137 million people in more than 70 countries in Bangladesh could be affected by arsenic poisoning. Arsenic contamination of porewater is found in many countries around the world, including the United States. Roughly 20 significant episodes of porewater heap contamination were accounted for, of which of these four significant occurrences happened in Asia. The Gonadwana coal seam at the Rajmahal site in East India encountered the Bihar mica site (0.08% 0.12%) in East India. Proterozoi-Vindhyan district (0.26% As) in central India in the Son River gold basin in eastern India, As is contaminated by an average of 2.8%. The isolated sulphide culture in eastern

Himalayan is 0.8%. Anthropogenic sources Agricultural wood preservatives Industrial source numbers Treatment Acid mine drainage, fossil fuel combustion, etc. Represents a source of arteriosclerosis.



Pollution raised due to Arsenic is a type of groundwater pollution, just because of high flow of arsenic naturally in deeper aquifer. The fresher regions are believed to be Assam, Arunachal Pradesh, Bihar, Manipur, Meghalaya, Nagaland and the United States. And Tripura ... Arsenic in Terai, Nepal is also contaminated. A 1980 toxicological study shows that in some areas of West Bengal, arsenic was present in groundwater above the permissible limit of 0.05. The presence of arsenic is considered to be one of the dangerous factors in the environment, and exposure to arsenic causes the presence of serious health problems such as cardiovascular, nerve, blood, kidney, and respiratory problems. increase. High concentrations of arsenic in drinking water are an inorganic form that damages the skin, liver, lungs and other organs in some parts of the world. Underwater arsenic is becoming a major problem in the flood plains of Ganga, Megna and Brahmaputra. In the Ganges Delta, the impacted wells are regularly in excess of 20 meters and under 100 meters down. Groundwater close to the surface generally invests less energy in the dirt and may have assimilated lower centralizations of arsenic. Water further than 100 m is presented to a lot more seasoned residue that are as of now drained of arsenic. This point got global consideration in 1995. This review, led in Bangladesh, examined great many water tests, as well as hair, nail and pee tests. In the Ganges Delta, the impacted wells are commonly in excess of 20 meters and under 100 meters down. Groundwater close to the surface generally invests less energy in the dirt and may have assimilated lower centralizations of arsenic. Water further than 100 m is presented to a lot more seasoned silt that are now exhausted of arsenic.

In 1995, this topic received international attention. This study, conducted in Bangladesh, analyzed a huge amount of water sample's and `hair, nail`s, and urinary samples. The WHO-defined acceptable level for the maximum concentration of arsenic in drinking aqua is 0.01 mg / l. The Bangladeshi government standard is five times higher, and 0.05 mg / L is considered safe. World Health Organization has defined concerned territories at risk? Arsenic concentrations in groundwater above 0.05 mg / L have been reported in 7 of the 20 districts of West Bengal. The overall citizens of seven districts exceeds 34` million, with more than 1 million using water containing arsenic (0.05 mg / L or more). According to a 1998 British Geological Survey of shallow pipe wells in 61 of the 64 districts of Bangladesh, 46% of the samples exceeded 0.01 mg / L and 27% exceeded 0.050 mg / L. Combined with the estimated population of 1999, the number of people exposed to arsenic concentrations above 0.05 mg / l was 2835 million, and the number of people exposed to above 0.01 mg / l was 466, Estimated to be 5.7 million scams (BGS, 2000). In Bangladesh, arsenic levels in tubular wells have been tested, but wells with arsenic levels above what are considered safe levels are painted red to warn residents that they cannot drink water. Indian state Bihar, porewater

in more than dozens of districts was detected adulterated with levels of arsenic` above 0.05` mg / L. Such territories are near major rivers such as the Ganga and Gandakrivers. The greatest public health threat from As comes from contaminated groundwater. Inorganic arsenic is naturally present in high concentrations in groundwater in many countries, including Argentina, Bangladesh, Chile, China, India, Mexico, and the United States. Water is a wellspring of openness. Fish, stripped meat, meat, poultry, dairy items, and grains can likewise be wellsprings of arsenic, however openness to these food varieties is for the most part a lot higher than openness from sullied groundwater. There are not many. In fish, arsenic is tracked down essentially in its less harmful natural structure.

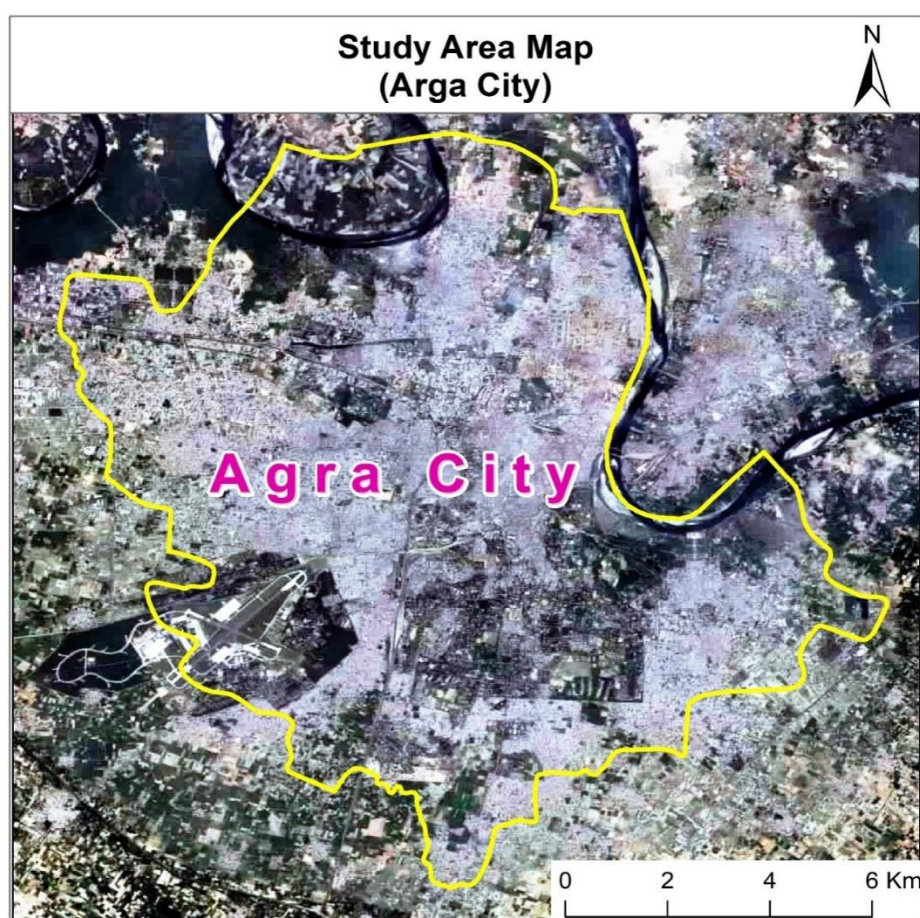
Industrial Processes

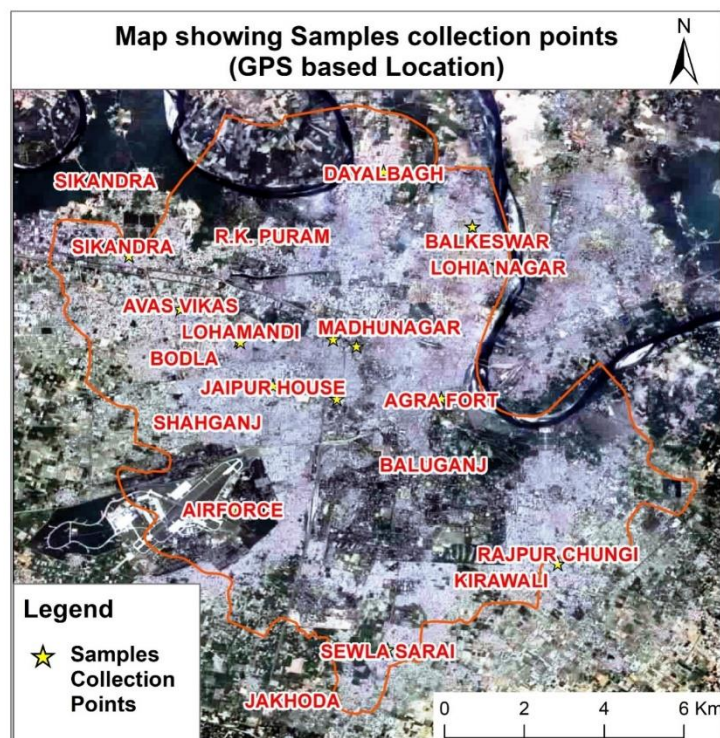
Arsenic is economically utilized as an alloying specialist in the handling of, for instance, glass, colors, filaments, paper, metal cements, wood additives and aluminum. Arsenic is additionally utilized in cowhide tanning and is likewise utilized in restricted range in pesticides, feed added substances and drugs. Arsenic responds with zinc in an acidic medium to frame AsH_3 . This gas is absorbed in glass wool soaked with lead acetate and then treated with silver diethyl-dithiocarbonate dissolved in pyridine, when a red complex is formed. This reaction forms the basis of colorimetric determination of arsenic.

Experimental

Sample Collection.

Water samples from various sites of Agra city are collected. The chosen sites are Kamla Nagar, Madhu Nagar, AvasVikas Colony, LohaMandi, Kheria, St. John,s College Campus, Sikandra , Shamshabad, Fatehpursikri, RajpurChungi, Jaipur House, Kirawli, Tundla, Bodla, Agra fort , Sheetla and Awalkheda





As Study of Toxic Heavy Metals

The evaluation become achieved the use of the Atomic Absorption Spectrometer (AANALYST100).

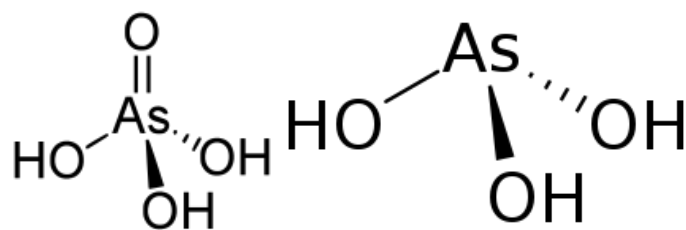
Analysis of poisonous heavy metals calls for the preparations` of popular steel answers (5 popular answers of 0.01, 0.1, 1, 10 and 100ppm concentrations) of metals which include Cr, Ni, Cu, Pb had been organized for tool calibration. After tool standardization water pattern is aspirated into flame after adjusting the very last burner positions till flame is much like that earlier than aspiration of the solvent.

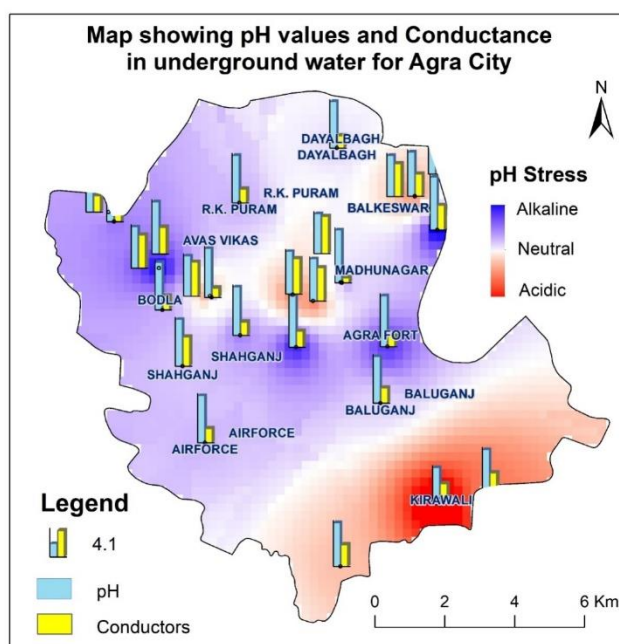
- Arsenic is analysed with the aid of using arsenic hydride system (AsHS)
- Water samples that to be analyzed wishes to be digested with conc. HNO₃ earlier than introducing it to the nebulizer (Atomiser).

Digested water pattern while aspirated into the flame offers the imply fee of concentrations of respective steel withinside the pattern.

Result and Discussion

Arsenate [As (III)] is most toxic form of As and causes acute toxicity, form of As such as “As (III)” and “As (v)” leads to chronic toxicity. These two forms of As are highly toxic. Arsenic-contaminated water usually contains arsenic acid and arsenic acid or its derivatives. These compounds are extracted from the underlying rocks surrounding the aquifer. Arsenic acid tends to be present in neutral water as ions [HAsO₄]²⁻ and [H₂AsO₄]⁻, but arsenic acid is not ionized. Arsenic acid (H₃AsO₄), arsenic acid (H₃AsO₃) and their derivatives are usually found in arsenic-contaminated groundwater.





Colour

- The colour change of the water is due to the presence of Tannins, Fe, Cu, Mn.
- The unit for colour change is Hazen and the permissible colour change limit is 5 hazen-25 Hazen due to the adverse colour change acceptance decrease.
- Colour change treatment can be brought about by filtration, distillation, reverse osmosis, ozonisation.

Total Dissolved Solids (TDS)

- Limestone waste, septic system landfills, nature of soil, hazardous waste landfills, dissolved minerals, Fe & Mn are sources of dissolved solids.
- The allowed permissible limit For TDS is 500mg/l to 200mg/l high TDS may lead to silty deposits, sediment, cloudy coloured water.
- Various methods like reverse osmosis, distillation, deionization by ion exchanger can be adopted to treat water with high TDS content.

Iron (Fe)

- Iron pipes in water distribution systems can lead to high content of iron in drinking water due to leaching.
- Content of iron in water should be between the permissible limits which is 0.3-1.0 mg/l.
- As a result of high presence of iron in water, the taste of water may change adversely oxidizing filter, green and mechanical filter are commonly used for treating the water with high iron content.

Manganese (Mn)

- The permissible limit for manganese in water should be 1.0mg/l- 1.03mg/l.
- The major sources for manganese are landfills, deposits in rock and soil.
- Brackish colour and bitter taste is usually observed when water contains high manganese content.
- This can be treated using ion exchange, chlorination method, oxidizing filter, or green sand mechanical filters.

Nitrate (NO₃)

- Methemoglobinemia or blue baby syndrome is the major disease caused due to high nitrate content in drinking water.
- The permissible limit for nitrate is 45mg/l-100mg/l. livestock facilities, septic system, fertilizers, house water, wastewater are the major sources for nitrate in water.

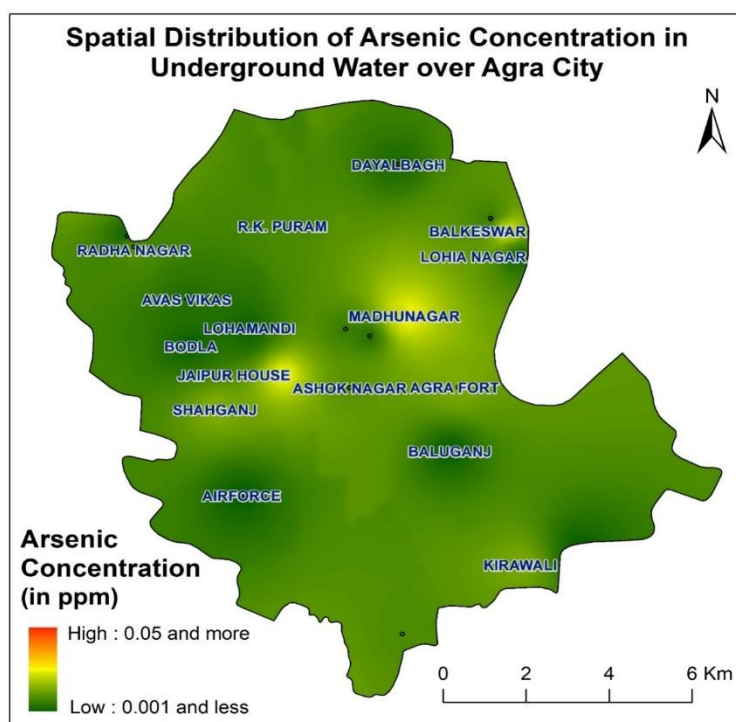
- Distillation, reverse osmosis, ion exchange techniques are used for water treatment

Fluoride (F)

- Fluoride content in water is permitted to 1.0 mg/l-1.5mg/l.
- Discharge of industrial waste in water sources leads to high fluoride content in water.
- Brownish discoloration of teeth and bone damage is the major health effect seen due to high fluoride content.
- Activated alumina, distillation, reverse osmosis, and ion exchange techniques are usually adopted for treatment.

Arsenic (As)

- Irresponsible waste disposal or improper product storage of glass and electronic are major sources of arsenic in water.
- Besides these pesticides, mining rocks also add arsenic to water.
- Weight loss, Skin and nervous toxicity is seen when its concentration exceeds permissible limit of 0.05 mg/l. Value of arsenic in analysed water samples ranges from 0.001 mg/l at bodla to 0.003 mg/l at Nunhai industrial area.
- For treatment of water with high arsenic content methods which can be used are activated alumina, filtration, reverse osmosis, distillation, chemical precipitation and lime



Chromium (Cr)

- Major sources of chromium are septic system. Permissible limit for Cr metal is 0.05mg/l.
- Amount of chromium above than permissible limit leads to skin irritation nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system, accumulates in the spleen, bones, kidney and liver. It can be treated using reverse osmosis and distillation.

The level of Cr in analyzed water samples range from 0.02mg/l at avas vikas-2.20mg/l at nunhai industrial area.

Copper (Cu)

- Leaching from copper waste pipes and tubing, algae treatment industrial and mining waste adds copper metal to natural sources.
- The prescribed permissible limit for Cu is 0.05mg/l-1.5mg/l.

In our analysis, the value to Cu ranges from 0.023 at kamlanagar to 0.302 at st. john's campus.

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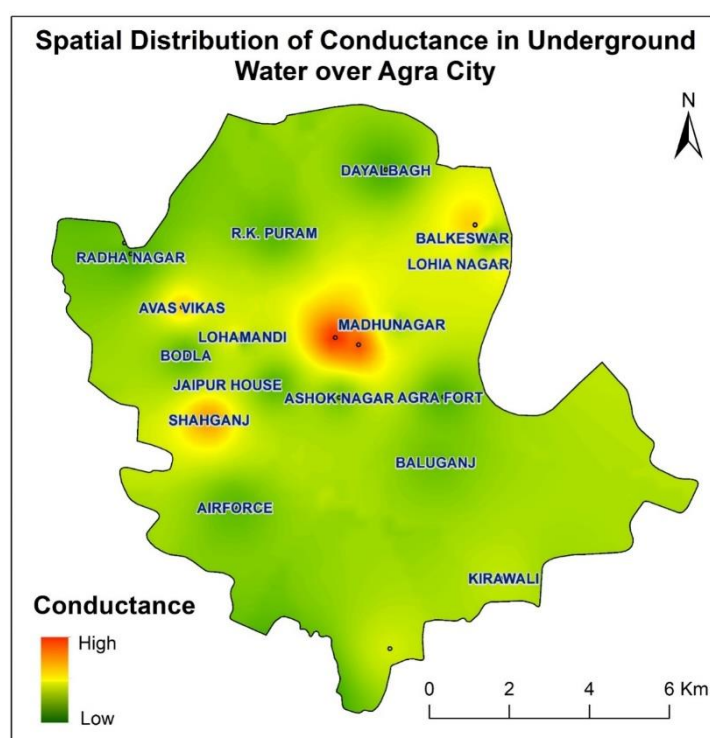
Copper (Cu)

- Leaching from copper waste pipes and tubing, “algae” treatment, Industrial waste adds copper metal to natural sources.
- The prescribed permissible limit for Cu is 0.05mg/l-1.5mg/l.
- In our analysis, Cu ranges from 0.023 in Kamla Nagar to 0.302 in St. John's Campus. High Cu content can cause problems such as anaemia, indigestion, chronic diseases to liver and kidney which leads to damage, gastro-intestinal irritation, bitterness and metallic taste, and turquoise stains on sanitary ware.

It can be treated by reverse osmosis and distillation.

Lead (Pb)

- Major sources of lead are “Paint”, “diesel fuel combustion pipes” and “solder”, “discarded batteries”, “leaded” and gasoline products.
- The permissible limit for lead in natural resources is 0.05mg/l.
- High lead content in water reduces mental capacity (mental retardation), interference with kidney and neurological functions hearing loss, blood disorders, hypertension, death at high levels. In the analysed water samples amount of lead ranges from 0.0002mg/l at avasvikas to 0.007mg/l at lohamandi area.
- Ion exchange, Activated, Carbon, reverse, osmosis, distillation are few techniques that can be used for treating water with
- In the analysed water samples amount of lead ranges from 0.0002mg/l at avasvikas to 0.007mg/l at lohamandi area.
- Ion exchange, Activated, Carbon, reverse, osmosis, distillation are few techniques that can be used for treating water with



Small-Scale Water Treatment

- The Sono Arsenic Filter is simpler and cheaper to remove arsenic, using three jugs with cast iron shavings and sand in the first jug and activated charcoal made from wood and sand in the second jug.
- Large number of these frameworks have been utilized and have been found to keep going for a really long time while staying away from the harmful material treatment issues inborn in customary arsenic expulsion plant's.
- Although new, this filter is not certified by hygiene standards such as "NSF", "ANSI", "WQA" and consider the disposal of toxic waste like other iron removal processes.
- In the US, a tiny "point of use" treatment unit "under the sink" is used to remove arsenic from drinking water.
- The most common type of home care "reverse-osmosis" technology. "Ion-exchange" and "activated alumina" have been studied, and rarely used.
- In areas where the potable water is provided by filtering the water extracted from the underground aquifer. Chaff-based filters have been reported to reduce the arsenic content of water to 3 microgram/litre.

Large-Scale Water Treatment

- Supply water or drinking water to homes by utilities should be treated as per primary health standards, especially in the United States.
- Certain regulations are required for large treatment plants to eliminate arsenic from aqua supplies.
- The efficacy of each technique relies on the chemistry of the specific supply of water.
- Watery arsenic science is perplexing and can influence the pace of expulsion that can be accomplished in any cycle
- A few huge utilities with various water wells ought to just be delivered from wells or ground sources that satisfy "arsenic" guidelines. Different administrations, particularly little ones with few wells, might not have an accessible water supply that fulfills arsenic guidelines.
- Flocculation or Coagulation/filtration eliminates arsenic by coprecipitation and adsorption with iron coagulants.
- Alumcoagulation/filtration is as of now utilized in an administration to eliminate dangled solids and can be modify to eliminate arsenic.
- Constant issues with such purifier frameworks are that it is very easy to clog. The usual gets stuck within a 2-to-3-month period.
- Arsenic-contaminated sludge is disposed of by concrete stabilization, but there is no guarantee that it will not be removed in the upcoming time.
- "Iron-oxide adsorption" purify the water using a granular media carrying "ferric-oxide".
- "Ferric-oxide" has a outrageous proclivity for captivating disintegrated metals like "arsenic".
- Disposal of sludge is a problem, especially with iron oxide media. The iron oxide medium eventually becomes saturated and needs to be replaced.

Activated alumina effectively removes arsenic.

- Two Asian countries "India" and "Bangladesh" have been eliminating both "As (III) and (V)" from porewater for quite a long time utilizing actuated alumina segments associated with shallow cylindrical wells.
- Through the efforts of a water committee elected in the area that collects local water taxes to fund operations and maintenance. Long-term column performance was possible.
- Use to eliminate unwanted higher levels of "fluoride".
- Conventional anion exchange resins are appropriate for eliminating As (V), however not As (III), or "arsenic-trioxide" without a net charge.
- Powerful long haul particle exchange evacuation of arsenic for section upkeep requires a prepared administrator.
- Switch assimilation and "electro-dialysis" can eliminate arsenic with a "net-ionic" charge. (Arsenic oxide "As₂O₃" is a typical type of arsenic in porewater that breaks up however has null charge.)

- Right now, a few administrations utilize one of these techniques., Reduces the aggregate sum of broken up solids and works on the taste.

The issue with the two techniques is that high salt wastewater, called brackish water or concentrate, is delivered and should be discarded.

Subterranean Arsenic Removal (Sar) Technology

Underground arsenic evacuation (SAR) permits circulated air through groundwater to be gotten back to the spring to make an oxidation zone where the adsorption cycle can catch “iron” as well “arsenic” on soil molecules. Oxidation zones made via carbonated water improve the action of arsenic`-oxidizing` micro-organisms that can oxidize arsenic from +3` to `+5 “SAR-Technology”.

- Since the iron and arsenic compounds are inactivated in the aquifer itself, no chemicals are used and almost no sludge is produced during the operational phase.
- As a result, the disposal of toxic waste and the risk of its future organization are prevented. It also has a very long life, like a long-lived pipe well that pumps water from a shallow aquifer.
- Six such SAR facilities, funded by the World Bank and built by the Ramakrishna Vivekananda Mission, are operating in West Bengal.
- Each facility produces more than 3,000 liters of arsenic and iron-free water daily and supplies them to rural areas.
- A team of European and Indian engineers led by Bhaskar Sen Gupta of Queen's University Belfast built the first urban water purifying process depends on “SAR technology” for TiPOT 2004 in Kasimpore near Kolkata.
- SAR Technology received IChemEUK's 2010 Dhirubhai Ambani Award for Chemical Innovation.
- Large SAR facilities are currently installed in the United States, Malaysia, Cambodia and Vietnam

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