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New initiative

A simple chemical free arsenic removal method for community water supply - A case study from West Bengal, India

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This work presents the chemical free arsenic removal method from groundwater and its successful implementation in West Bengal for community water supply.

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A B S T R A C T

This report describes a simple chemical free method that was successfully used by a team of European and Indian scientists (www.qub.ac.uk/tipot) to remove arsenic (As) from groundwater in a village in West Bengal, India. Six such plants are now in operation and are being used to supply water to the local population (www.insituarsenic.org). The study was conducted in Kasimpore, a village in North 24 Parganas District, approximately 25 km from Kolkata. In all cases, total As in treated water was less than the WHO guideline value of 10 mg/L. The plant produces no sludge and the operation cost is 1.0 US$ per day for producing 2000 L of potable water.

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1. Introduction

This report describes a simple chemical free method that was successfully used by a team of European and Indian scientists (www.qub.ac.uk/tipot) to remove arsenic (As) from groundwater in a village in West Bengal, India. Six such plants are now in operation and are being used to supply water to the local population (www. insituarsenic.org). The study was conducted in Kasimpore, a village in North 24 Parganas District, approximately 25 km from Kolkata. The total area of the village is 5.0 km, and the average annual income of the villagers is US$350/annum. The main source of water for the village is shallow wells and tube wells. Kasimpore was chosen as the model village in our study since our preliminary study revealed that 70% of the tube wells in this village had arsenic concentrations above 50.0 mg/L as compared to the WHO guideline value of 10 mg/L. The area of study belongs to the lower Gangetic plains of India, where arsenic contamination has reached an alarming level. According to one estimate, nearly 100 million rural people are affected by exposure to As in food chain and drinking water in Asia (Carbonell-Barrachina et al., 2009).

2. Brief description of the technology

Subterranean groundwater treatment is based on the principle of oxidation and filtration processes of conventional surface treatment plants for removal of Fe and Mn from water. In this case, underground aquifer is used as a natural biochemical reactor and adsorber, that removes As along with Fe and Mn at an elevated redox value of groundwater, when dissolved oxygen concentration is raised above 4 mg/L. Water is pumped from the underground aquifer using a submersible pump. About 15–20% of this water is returned to the aquifer at the same depth under gravity after aeration while the remainder is supplied as arsenic free water to the consumers.

A schematic layout of the plant is illustrated in Fig. 1. Ordinary plastic shower heads were used to increase the dissolved oxygen (DO) level in water up to 6 mg L^{-1} by spraying it in a plastic tank before returning it to the aquifer in a certain operating sequence comprising delivery, intermission (rest) and infiltration (Fig. 2). The basic layout of an in-situ treatment plant

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consists of an oxidation station containing a spray nozzle or water jet air pump, a storage tank and pipelines for delivery from the aquifer and for enrichment in the aquifer. The plant components were sourced from local DIY shops and were installed by local plumbers and electricians. A well with a depth of approximately 37 m was constructed and the well-head was sealed. Only the necessary pipes for delivery, infiltration and a device for aeration and de- aeration of the well go through the well-head in order to allow pressure infiltration. The device for aeration and de-aeration was constructed in a way that no water flows out during infiltration/ pressure infiltration.

During the groundwater delivery, primarily Fe(II) is adsorbed to the surface of the soil grains, while oxygen rich water oxidises Fe(II) deposits into insoluble ferric hydroxide that remove arsenic as co-precipitation product. The oxidation processes are accelerated by the autocatalytic effect of the oxidation products and by the autotrophic microorganisms. Ferrous oxide could serve as an energy source for iron oxidising bacteria. The process is explained in Fig. 3. The method is very effective in reducing the concentration of As below 10 μg L^{-1}. The main advantage of this process is that there is no sludge handling cost. The pictures of the site before and after installation are shown in Fig. 4.

3. Conclusions

Employing this technology, the team has installed six plants in West Bengal, India, for supplying potable water to rural commu- nities using locally available components (www.insituarsenic.org). In all cases, total As in water samples was less than the WHO guideline value of 10 μg L^{-1}. The plant produces no sludge and the operation cost is 1.0 US$ per day for producing 2000 L of potable water.

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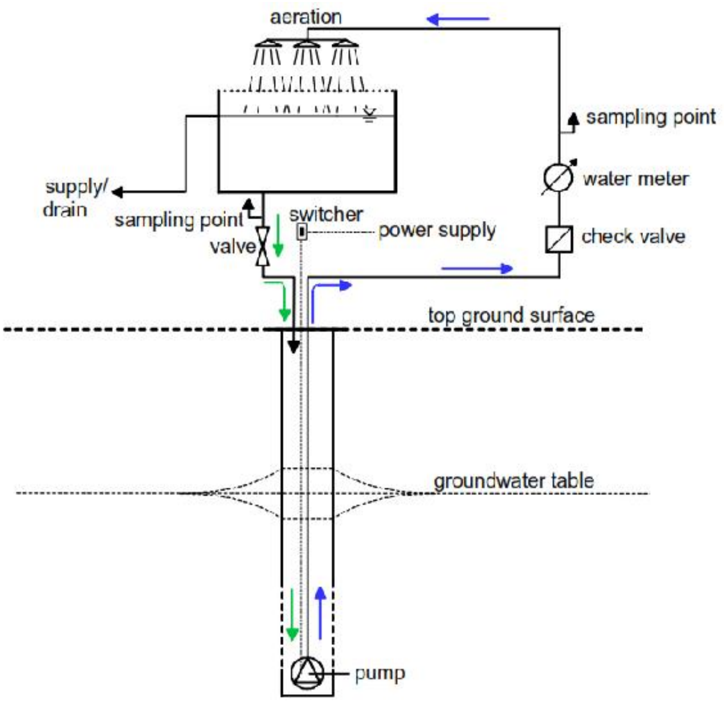

Fig. 1. A simple one well system.

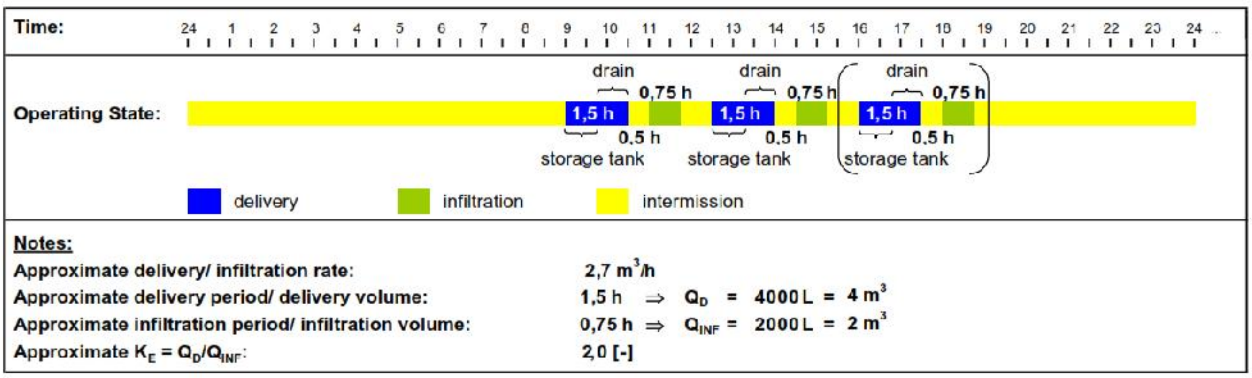

Fig. 2. Sequence of operation in terms of delivery, infiltration and transmission.

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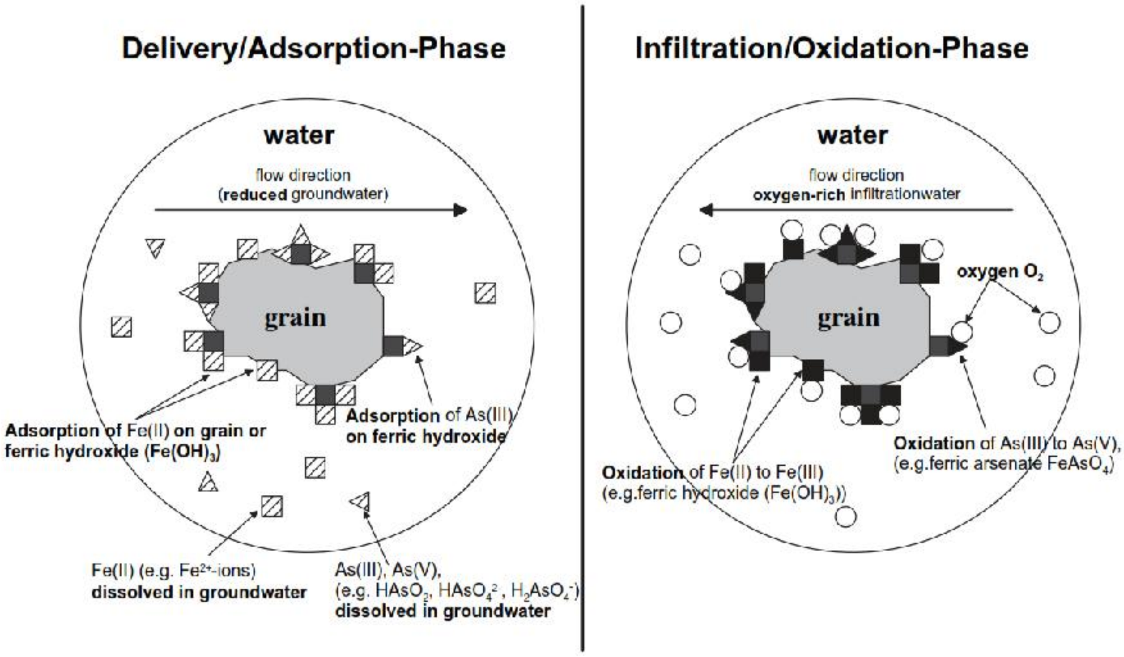

Fig. 3. Chemical processes taking place during delivery and infiltration.

Fig. 4. A view of the site before and after installation of the treatment plant.