RESPONDING TO THE PROBLEM OF IRON IN GROUND WATER

INTRODUCTION

This brief presents information about research done by ATC on Iron Removal Plants (IRP). The objective of the study was to develop a strategy for iron removal from ground water sources. The research was conducted in two phases: the first study was a baseline to determine the functionality and experience of users in using the existing installed IRPs. The second study was designed to address the challenges identified by making improvements to a selected IRP design.

The information contained in this brief is intended to inform the reader about the findings from the above studies and further provide vital information on the construction, operation and maintenance of an IRP.

Occurrence of iron in water

High iron content in water has an unpleasant taste to and adverse effects on clothes and food. Iron is introduced in water resources through dissolution of the parent rock minerals and also through corrosion of riser pipes in corrosive water. Whatever the cause maybe, one sure outcome is that the resulting water is not desirable for use and unless the content can be reduced to acceptable levels the water sources are usually abandoned. Drinking water is should have maximum iron content of 0. 3mg/l (WHO) but in some cases values as high as 34mg/l have been observed. The Ministry of Water and Environment had been grappling with this problem for more than 15 years. This led to the introduction of IRPs at some affected sources. The principle behind these designs is that the dissolved iron in the water can be precipitated through aeration and then eliminated by sand filtration. In addition galvanized iron riser mains are replaced with to eliminate the effect of corrosive waters which contribute to the iron problem in some areas.

These plants worked well for some time. Some were abandoned. In some places like Rakai, the authorities opted for rainwater harvesting in places with high iron content in the ground water although IRPs were first piloted there. Lack of proper operation and maintenance and knowhow and skills were a major problem unearthed by the field study.

Background to the research by ATC

The baseline study carried out in early 2013 identified a number of blockages affecting the use and scaling up of IRPs. These include:

- Acquisition of filter media
- Lack of knowledge & skills about the proper maintenance of the system
- Vermin intrusion
- Reduced flow rates in the plants
- Lack of documentation of the performance of the filters over time
- Some poor designs implemented by organizations with a limited understanding about the proper design of IRPs
- Lack of expertise about IRPs at the district level to support the communities.

The second study established that coarse sand that is sieved can work effectively as a filter material and that the flow rate can be increased by using sand filter with 2mm as the smallest grain size.
The study showed that iron removal efficiency was at 95% for up to 10 mg/l of iron in the raw water. However this fell to less than 77% for water with higher iron content.

Chemistry behind IRP functionality

Iron exists in water as dissolved ferrous (iron II) iron compounds such as ferrous sulphate and ferrous chloride. The formation of ferric ions is achieved through oxidation of ferrous ions by introducing an oxidizing agent. Although, there are many chemical oxidizing agents such as potassium permanganate, these are costly. The cheapest oxidizing agent is oxygen gas which is readily available in air. Thus, the introduction of air into raw water with ferrous irons will initiate a chemical reaction where ferric ions are formed and being insoluble will precipitate and can therefore be eliminated through mechanical filtration.

Iron removal plants

This is a simple chamber constructed to allow sufficient oxygen into water such that ferric iron precipitates are formed. These are then filtered out using a sand filter media.

How do they work?

The chamber is constructed at the outlet of a water source with high iron content such as a borehole and the spout is modified to distribute the water through a perforated pipe. Aeration is further enhanced by using aerator plates (perforated aluminium sheets). When the water comes into contact with oxygen the ferrous iron dissolved in the water will get oxidized by air that flows through vents on the sides of the chamber.

Testing of Prototype at ATC

The ATC constructed an IRP on its premises and built a 1,000l tank adjacent to it. This design was based on Eng. Ahmed Ssentumbwe's improvement of the Silsoe design. Rainwater was then pumped into the tank and iron II sulphate at different doses was artificially introduced into the tank and the water pumped through the IRP to determine its efficacy. The study showed that up to 8 mg/l of water, the iron content was reduced to levels acceptable for drinking water by WHO. However for an initial iron content of 26 mg/l, the residual iron in the treated water was 5.93mg/l which is significantly higher than the WHO guideline.

Installation costs

The total cost of installing an IRP is about 1.3 million Uganda shillings.

Recommendations

- IRP development should incorporate sensitization of users, caretakers and hand pump mechanics about the proper maintenance of the IRP.
- Training of the users should include sourcing, preparation and installation of filter media in the IRP to ensure the filter media can be replaced when required.
- New training should be offered to DWOs, HPMs and users in areas where IRPs have already been installed
- District authorities should adopt this design of the IRP where the iron content is not more than 10 mg/l
- Further research is needed to develop an IRP design for iron contents greater than 10 mg/l
- Water quality analysis is critical to ensure that the source of the iron problem is the ground water rather than corrosion of the pipes. Where it is corrosion of the pipes, replacement with plastic pipes and not an IRP would be the solution.

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