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AFFORDABLE WATER SUPPLY AND SANITATION

An appropriate iron removal technology

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EXCESSIVE IRON IN groundwater became a major setback for the continuation of the hand pump well programme of the FINNIDA assisted water Project in Kandy during mid eighties. As a result of very high user sensitivity a considerable rejection levels of Hand pumps were observed. Since then few types of Iron removal plants (IRPS) employing different technologies were installed and tried out in the field between 1985-1987. During the testing "FINNIDA Circular" IRP type employing the treatment philosophy of biological iron removal showed promising results to bring down the iron content to an acceptable level to the user group. The main limitation in this model was seen as failure of maintenance, in the absence of a centralized repairing team. Based on the experience gained in testing, "FINNIDA Square" IRP was developed. Field testing was continued subsequently since 1988.

The main design consideration in this development had been community adaptability of the cleaning process with special features such as simplicity in construction, operation and maintenance. Also utilization of material and skills at village level were optimized. Field trials carried out for longer years has proved "FINNIDA Square Type" IRP as an appropriate technological option for iron removal at community level.

Background

In Kandy District a total of 2500 hand pump wells had been completed by Kandy District Water Supply and Sanitation Project under FINNIDA assistance. High rejection rates of the hand pump well programme by the recipient community was observed in mid eighties. This was due to high user sensitivity as a result of excessive iron content in water. There were two categories of causes for the problem namely:

a) Occurrence of iron due to corrosion of below ground component of the hand pump well in aggressive ground water.
b) Occurrence of iron in ground water.

The iron problem due to corrosion was solved by changing the below ground components of the hand pumps with new non-corrosive parts. And the problem due to occurrence of iron in ground water had to be dealt with an appropriate treatment technology at hand pump level. Few types of Iron removal plants were installed and tested in order to solve this problem. Some limitations were observed in the application of these technological options. Therefore R&D work continued in order to establish a more appropriate Iron removal technology manageable at community level for the future sustenance of the hand pump well programme.

Experience on previous field trials (1985-1987)

Following types of Iron removal plants had been installed at different locations and performance was monitored accordingly.

a) FINNIDA Dual Unit Type
b) FINNIDA Circular Type
c) UNICEF Type

Different type of filter media such as charcoal, cement coated polystyrene balls leca particles were utilized in the upward filter for both Dual unit type and the circular type employing biological iron removal as the main operation philosophy. Out of these iron removal plants FINNIDA circular type has shown promising results bringing down the iron levels to the required standards.

However the main limitation observed in this model was the difficulty of frequent cleaning as the cover slab was too heavy and difficult to handle safely. Therefore many installations were dependent on the centralized maintenance unit, making maintenance expensive and cumbersome. The cement coated polystyrene balls used as a substitute for the imported "leca" pebbles used in the upward filter did not appear either to be durable in the long run or could be replaceable practically at the village level.

Development of a more appropriate IRP

"Finnida square type" IRP had been designed as a treatment unit meeting VLOM requirements based on the above experience in the iron removal. The water from the Hand pump wells was allowed to enter 700mm long 75mm diameter PVC pipes where the aeration will take place due to turbulence caused as a result of vanes provided.

The aeration process had the added advantage where the water column in the aeration pipe had a fluctuation of 300mm height over every discharge making aeration more effective.

Another PVC pipe of 50mm dia. with circular ports staggered at 60mm spacing was connected to the 75mm pipe to evenly distribute the water in the filter. Granite chips 10-25mm size was utilized as the filter media in the upward filter known as the Hopper chamber.

The main feature in this treatment unit is allowing a growth of thriving band of iron bacteria in the upper layers of granite chips. The pH condition at the Hopper chamber becomes favourable for both microbiological oxidation as well as conversion of ferrous bicarbonates to ferric hydroxides. Also the accumulated ferric hydroxide flocs aggravates growth of iron bacteria. The enlarging cross section of the Hopper chamber allows for gradual decrease of velocities in the upward flow which will reduce the risk of flushing away of bacteria, which might reduce the bacteriological action.

The water from the upward filter is allowed to spill slowly over wider spilling perimeter of the Hopper chamber, evenly distributing the water to the 150mm thick sand filter. The sand filter bed acts as a strainer since the small suspended solids are retained at the top of the layer. The filtered water is collected through perforated pipes at the bottom of the filter and collected at the outlet pipe. The overall retention time of the whole unit seems to be in the order of 5-8 minutes.

Cleaning operation

Special emphasis was placed in the whole design to ease and simplify the cleaning process at village level. It is estimated that a frequent cleaning process could be very easily carried out by two women within a period of 30-45 minutes. The cover slab consists of three cast segments of concrete lids weighing only 10kg each which is easily liftable with handles provided.

The blocked hopper chamber with iron bacteria flocs could be washed out by opening outlet provided after filling the chamber with water and raking the granite chips. The cleaning of the sand filter was simplified with the provision of a commercially available non-woven fabric where the filtered materials blocking the filter operation could be taken out. In general, use of the fabric had increased the filter run length and also has decreased the ripening period for the "Schmutzdecke" after a cleaning process.

Construction

Simplicity in construction is one of the major advantages of the Design. This consists of a concrete base slab, a Hopper chamber (concrete) a Brick outer chamber wall and pre-cast concrete cover slabs. Since the formwork and the layout is a standard one the works could be handled very satisfactorily employing intermediate level Technicians or skilled labourers, with very little training.

The type of work available does not need any special equipment and could be completed at village level without having a centralized precast unit, as in the case of FINNIDA circular type.

The per capita cost of construction of such a unit could be completed at a very low cost of US$0.4. (Table 1)

Figure 1. FINNIDA square type iron removal plant - (Construction cost - Us $40).

Table 1. Bill of Quantities for FINNIDA Square Type IRP

Item	Qty
Material	
20mm Aggregates	0.65cum.
6mm Aggregates	0.42 cum.
Sand	1.00 cum.
Mis. steel Rods	22 kg
Bricks	200 Nos
Piping	5m
Labour	
Skilled labour	4 days
Labour	4 days

Graph 1. Variation of removal efficiency with the inlet loading.

Monitoring of iron removal plants

Sixty hand pump wells reported to have excessive iron in groundwater have been installed with both circular and square types over the last six years. This consists of 23 FINNIDA circular types installed in 1987-1988 and 37 FINNIDA square type installed since 1988.

The maintenance of these units had been completely handed over to the community. Intervention of the centralized maintenance unit had been completely stopped over the last six years limiting the project role to monitoring function only.

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The detailed survey carried out on all the sixty wells had revealed that out of the 23 nos. of circular type, 37 Nos of square type IRPS 13 and 32 Nos respectively are in working order. The reason for the failures of the 13 Nos. of circular types IRPS are due to difficulties in frequent cleaning. On the other hand the balance survived in the operation are plants with low inlet loading which does not require frequent cleaning. The reasons given as causes of failures of five numbers of square type filters are unsuitable siting and lower yielding of hand pump wells which are purely not dependent on iron removal technology.

The results of iron removal efficiency monitored over the last five years shows that the efficiency of the unit increases with increase of iron content of the inlet loading (Graph 1).

However, the following limitations are observed and needs further design development.

a) Insect breeding under the concrete cover slab due to negligence of the consumers
b) Damages caused on the edges of the cover slab due to frequent handling.

Conclusion

The FINNIDA square iron removal plant was found to be highly efficient in iron removal among taste sensitive communities. The technology of this unit seems to be more acceptable and adaptable at village level.

References

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