Design of Filter for Fluoride and Bacteria Removal

INREM foundation has designed a domestic water filter which is now been used by project beneficiaries of Jhabua district. This filter has been produced within the program for Fluorosis mitigation supported by the Sir Dorabji Tata Trust. The water filter does not require electricity. It removes high fluoride from water and brings it down to concentration much below 1 mg/l. Apart from that it also removes bacterial contaminants to some extent.

The filter consists of an exterior casing currently made as earthen pot, filtration material known as Activated Alumina (AA), a micro-filter, Zero-B and other smaller parts. The final product on location is shown in Figure 1 and the schematic design diagram is in Figure 2.

1. Exterior Casing

   The earthen pot exterior has a capacity of 15 litres. A requirement for efficient fluoride removal is that the contact time of raw water with the filtration material is at least 20 minutes. In order that this is maintained, it is necessary that the water column is as long as possible. In our case, we have designed a water column of length 24 cm. Traditional pots are more round in shape broader base and would be less suited for this purpose. Hence one would need a more elongated or taller shape as we have made.

   The earthen pot exteriors are now prepared by potters located in Meghnagar town of Jhabua district who have been trained by INREM for this purpose.

2. Micro-filter

   Roughly, the raw high-Fluoride water has to be in contact for about 20 minutes with AA. Given our design, this comes to about 10 litres/hour of flow. Keep a factor of safety, we have designed a micro-filter which can release water at a rate of 8 litres/hour. This micro-filter has been designed by INREM and mould has been prepared by Brahma Industries, Ahmedabad.

   The schematic diagram of micro-filter is shown in Figure 3. There are two main design aspects of this micro-filter:

   a) To disallow AA particles of size 0.4 mm to 1.2 mm into the micro-filter. Taking into account small probability of tinier particles, we have kept this slit size at 0.2 mm.
   b) Secondly, the orifice diameter of the micro-filter is kept such that the filter-flow at around 8 litres /hour. After experiments, this was arrived to between 1-1.5 mm. We have kept this orifice diameter at 1 mm size.
   c) Thirdly, in between the slits the hood is made downward angular to avoid deposition of AA at the slits during the flow of water. This will not block the flow of water from the micro filter.

3. Fluoride Removal

We are utilizing high grade Activated Alumina (AA) for Fluoride removal. Currently this material is manufactured by Siddhartha Industries, Surat. The quantity of AA in a filter will depend on (i) fluoride content in water, (ii) adsorbing capacity of AA, and (iii) how much quantity of water to be filtered in a specified time period.

That is, if A = Adsorption Capacity in mg/kg of AA

M = Quantity of AA in kg

C = Concentration of fluoride in mg/litre

D = Daily water use in litre/day

Then, N = A*M/C*D, where N is the number of days that AA will work properly.

For the average Fluoride levels that we encounter in Jhabua (4 mg/l – 8 mg/l) and replacement time for AA as 5-6 months, we have set the amount of AA within the filter as 3 kgs. After N number of days, i.e. 5-6 months, either same AA can be regenerated using Caustic soda and Sulphuric acid, or a new pack of 3-kg AA can replaced. The procedure for regeneration is documented in text and video/photo form by INREM in a separate documentation.

4. Bacteria removal

Since we find that bacterial contamination is prevalent even for water from handpumps, there is need for bacteria removal filter. Also, there is a possibility of a bacterial bio-film getting formed (layered) on AA crystals or granules. So we need to pre-filter the raw water for bacterial content. For this purpose, we are using Zero-B Surakhsha resin filter manufactured by Ion Exchange, Mumbai. We are fitting it at the bottom of a funnel mouth which is placed on top of the upper compartment of the filter. Using Zero-B does not remove bacterial loading completely. Other options for such bacterial removal will slow down the filtration process even more and make it infeasible for users, so we are currently using this technology. But our search for an alternative continues.

5. Other parts

Apart from the above, we have an iron tripod stand (if required) for the filter, a perforated plastic lid cover for the upper layer of AA granules inside the earthen container to allow uniform spread of input raw water over AA bed and a funnel for Zero-B at the top.

The following table summarizes the above:

Sr no.	Part name	No. of units	Made by
1	Earthen pot	1	Potters in Meghnagar, Jhabua
2	Activated Alumina	3 kgs (we recommend 2 such sets at the beginning)	Supplied by Siddhartha Industries, Surat
3	Micro-filter	1	INREM Foundation
4	Bacteria removal resin filter	1	Ion Exchange, Mumbai

Figure 1: Final product of INREM's filter on location in Jhabua

Figure 2: Schematic design diagram of INREM's filter

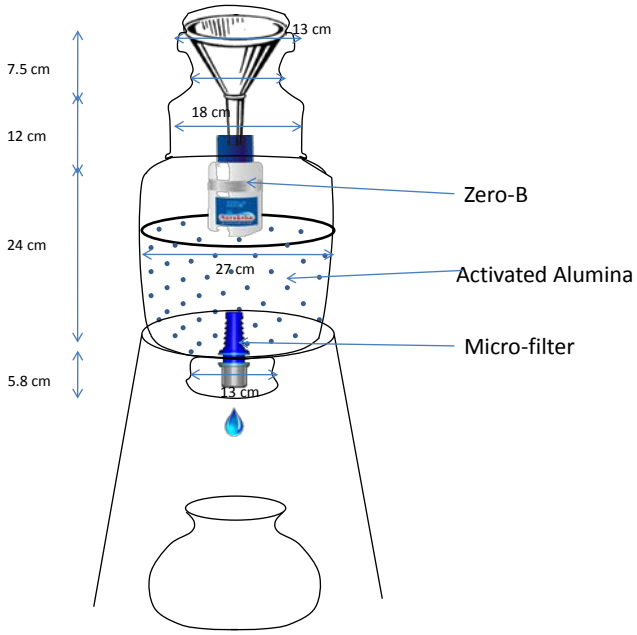

Figure 3: Schematic Design Diagram of micro-filter