CENTRE OF SCIENCE FOR VILLAGES, DATTAPUR-WARDHA

Low cost Arogya Water Filter

Introduction

In collaboration with TATA Consultancy Services Ltd., Pune CSV has introduced a low cost water filter made from rice husk ash for villagers. The filter is very cheap and can be fabricated at the village level by the women folk, with very little investment. The filter is very hygienic and kills about 98% bacterial in the water and keeps it free from fluorides and arsenic. Village women have now come out with a Programme of constructing nearly 500 filters and they have already started working on the same...

Filter Description: The filter developed by TRDDC uses rice husk ash, pebbles and a binder for the fabrication of the filter bed. Various types of containers can be used for housing the bed. These can be plastic buckets, plastic pipes or even earthen pots. The choice depends upon requirement and affordability. The filter can be produced either in a factory setting by a village entrepreneur or can be made in a 'do-it-yourself' mode.

Characteristics of Filtered Water:

The TRDDC filters have been tested with water from three different sources (with widely varying levels of contamination) for pH, turbidity and bacterial count. In all cases, the filtered water from the TRDDC filters was found to be equivalent to or better than the tap water supplied by the public water-work departments in cities. The turbidity of canal water decreased from 12 to 0.5 (NTU) and bacterial trapping was generally 93-99%. A filtration rate of approximately 2-3 litter/hour is possible in normal sizes. However the rates can vary depending upon design and size.

Filter Life:

The life of the filter bed material varies from 6 to 8 months depending on the type of influent. Once the filtration rate decreases to less than the desired rates, the filtered material can be discarded and fresh material can be filled into the same container for reuse.

Fabrication of Filter Element : The fabrication of the filter bed (cartridge comprises of three main process:

- Preparation of treatment of rice husk ash
- Container preparation
- Casting of filter bed

Each process of the fabrication procedure is discussed in detail.

Material

Rice Husk: Rice husk can be procured from near by rice mills.

Rice Husk Ash: Rice husk ash can be collected from brick kilns where rice husk is used as fuel. The rice husk ash should be collected from the inner section of the kiln. Make sure that the ash you are collecting is pure and is of rice husk only. The other sources are boiler ash (where rice husk is used as fuel for boiler) and heap burning of rice husk.

Pebbles: Pebbles can be collected from riverbanks or obtained from construction material supplier. The size should be – 10mm.

Granite stone (aggregates), Cement and Sand: This material can be obtained from the building material vendor.

Tools and Accessories : The tools and accessories required for the preparation and pre-treatment of RHA are listed in Table.

Stainless Steel Mesh : Stainless steel mesh of 1mm, 3mm, 5mm and 10mm is required for fabricating Sieves. Size of mesh required for fabrication of Sieves is 3' x 3' (feet). All the four sides of the mesh are fitted with wooden plates for support. These sieves are made to classify sand and pebbles in desired sizes.

Sieving Mesh: For sieving of RHA, a sieve of 420 micron (# 37 mesh) size were fabricated. For the fabrication of sieve, standard 37 number mesh available in the market was used. The sieves were made from the 40 litres size plastic tub available in the market. The bottom part of tub and 36-mesh sieve were cut in proper size. Then the mesh is sealed to the cut tub. The fabricated sieves were used to classify to the RHA in 420 micron size.

Weighing balance : The capacity of the weighing balance is 10 Kg. The weight box contains standard weights of 2, 10.5,0.2 01 Kg. etc.

Mechanical mixer / Tapi : It is commercially available mixer used for concrete mixing. The size of mixer is 5/3 cubic feet. The capacity of the mixer is 150 kg. Tapi is a small mixing tool for hand mixing.
Poking tool : The poking tool is made up of stainless steel rod, which is used to poke the material for uniform packing.

Ramming tool : Ramming tool is fabricated using mild steel. The ramming tool is made up of two parts, as shown in figure. The total weight of tool is 3 Kg.

Others : All other items used in the fabrication process are listed in Table

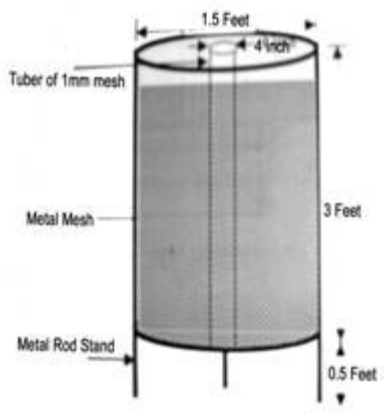
Table list of accessories required for the fabrication process.

Item	Quantity
Tube in basket burner (2 x 3)	1
Sieves with 1, 3, 5 and 10mm, mesh (3' x 3')	1 each
Sieve 420 micron (37 mesh, Size 12 inch)	1
Weighing Machine (10 Kg capacity	1
Tubs (100 litre)	2
Bucket (25 litre)	2
Ramming Tool (2.5 Kg.)	1
Mixing tool (Tapi)/mechanical mixer	1
	2

Filter Fabrication Process : The procedure for fabricating filter bed is summarized in figure 3. The fabrication process is divided into three main processes.

- Pre-treatment of ash
- Classification of sand and pebbles
- Container preparation
- Casting process

Burning of Rice husk : Burning of rice husk is done in Table-in-Basket (TIB) burner. The tube and basket is fabricated using 1mm mild steel mesh. The size of basket is 1.5 feet in diameter and 3 feet in height. Inside basket a tube of 4 inches of diameter is placed as shown in Figure 2. The basket was kept on a mild steel stand. The total capacity of the basket is 200 litres and it takes around 25 kgs of rice husk, which is dumped into the basket and then fired from the bottom and inside tube. The husk burns slowly and takes 12 hours to be completely burnt. Once the ash is formed let it cool to normal temperature. The weight of ash obtained from burning 25 kgs of rick husk is around 8 kgs. Then store the dry ash in dry plastic containers.



Pre-treatment of ash

Rice husk ash (RHA) is prepared by burning rice husk. Burning of rice husk can be done in two ways by using Tube in basket burner and basket burner (heap burning).

Pre-treatment of Rice Husk Ash (RHA) involves

1. Sieving Process
2. Acid Treatment
3. Drying Process

Schematic of Tube-in-Basket (TIB) burner for burning rice husk

Sieving process : Take 500 grams of RHA in a 37 mesh (-420 micron) sieve. RHA is a brittle, soft and light material. Crush the ash with hands and shake the sieve. The time taken to sieve 500 grams of ash is 15 minutes. The percent loss of ash in sieving process is 10%. Repeat the above procedure. The classified ash is stored in dry containers.

Acid treatment : Take 6 kgs of -420 micron size ash in a 100 litre capacity container. Add 50 litres water to it. Add 250 ml of concentrated HCl, measure the pH. Keep the ash soaked in water overnight. Drain the water slowly and wash the ash with water 1-2 times. Dry the ash in the open for 2 days. After drying store the ash in dry container.

Classification of sand and pebbles : The pebbles or granite aggregates are sieved through 10 mm mesh in 3'x3' size sieve. The -10 mm fraction is sieved over the 5 mm mesh. The size – 10mm +5 mm is then washed with water, dried and stored in dry and clean containers. Similar sand is sieved in two sizes, one is -3mm + 1mm size. Both the fractions are washed thoroughly with water, then dried and stored in dry containers.

Fabrication Process Steps for RHA filter Element.

Container preparation : The dimensions of the container used for bed casting are top diameter of 23 cm, bottom diameter of 19 cm and height 8 cm. The holes were made in the container by piercing a hot nail through it. The number of holes made in the container is fixed to 100-120 numbers. Take the nylon mesh (any specification). Cut two meshes of 22cm and 18-cm diameter. Place the nylon mesh in the filter bed container over the perforations made in it.

Preparation of filter bed : The preparation of filter bed consists of two processes, mixing the material and then casting.

Making the slurry for filter bed making

Weighing Take required quantity of RHA, OPC & Pebbles. The table 2 shows the amount to be taken for a single filter. Similarly, weigh the required quantity of material for a batch of 10, in similar proportions.

Table 2 Quantity of material required for fabricating one filter element

Material	Quantity	
	For 1 filter	For 10 filters
RHA (-420 micron, acid treated)	470 gms	4.7 kg.
OPC Cement	30 gms	300 grams
Pebbles or Aggregates (passing 10 mm mesh)	3 Kg.	30 Kg.
Water	1200 ml.	12 litres

Mixing

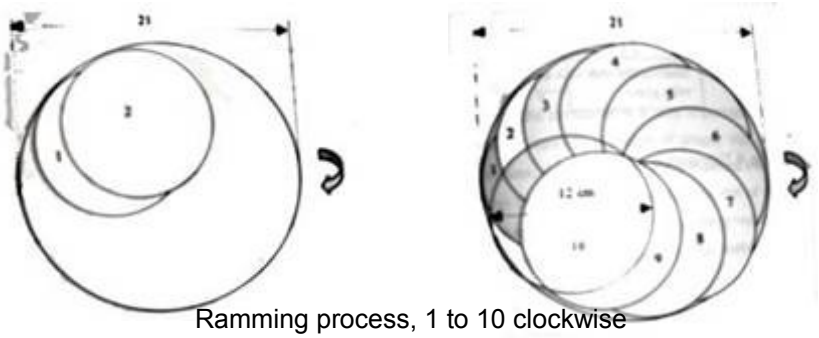
Take the weighed quantity of pebble put them in the mechanical mixer/mixing container, add 300 ml of water and mix thoroughly (mechanical / hand mixing) so that the pebbles are wetted by water. Then add cement to the mixer and mix it thoroughly for a minute. After mixing add ash and water in it and again mix thoroughly. Again add water gradually with continuous mixing. Then mix it for 3 minutes. The same procedure is followed for mechanical mixing. The order of adding material and mixing time should remain fixed. This being a crucial step determining subsequent filter performance, the order of mixing has to be maintained.

Fabricating the filter element:

Casting: The above mixture is poured into the filter bed container. Slight poking with a metal rod is done while the mixer is being poured into the container.

Poking : After casting, take the weight of the container and material. The weight should be 4.2 to 4.3 kg. The poking was done using steel rod 40 times, all round the bed.

Ramming : The ramming process is the crucial step. The ramming was done using recommended ramming tool. The ramming process is shown in figure 5. In each cycle 9 rams were done in clockwise direction and one at the centre, hence a total of 10 rams was done per cycle. Ramming is done for 3 complete cycles. The excess water squeezes its way out through the bottom while the filter mixture starts to set. Then keep the bed for 24 hours for bed mix to set.



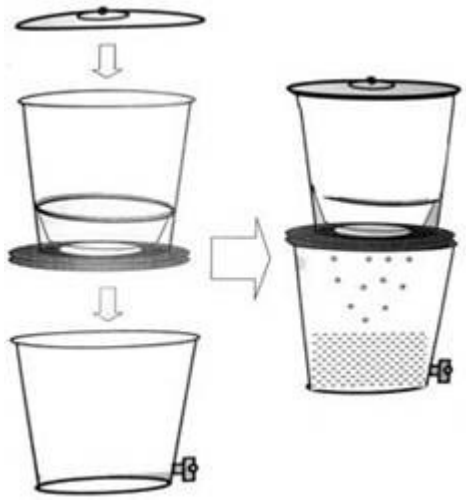
Ramming process, 1 to 10 clockwise

Sealing the top of the bed : After the setting of the filter bed is over, about 200 grams of sand is placed on top of the filter bed to prevent RHA particles from floating while water is being poured. Place a perforated plastic plate on the blade. Prepare a sealant mixture of sand and cement in 1:1 ratio. Seal the top plate to the container with sand – cement mix.

Curing: Then the filter bed is covered with wet cloth and cured for 21 days by sprinkling water over it every day.

Preparation of outside containers: The filter assembly is made up of two containers. The top container is cut from the bottom using cutting plate of proper size. The cutting plate is heated and then pressed to the bottom part of the container to get a hole of that size.

The bottom container, in which filter water was collected, was fixed with a tap cock. The tap was fixed in the container by punching a hole in the container.



Fixing of bed in the container : Fixing the bed to the container is a very important step. The bed has to be properly fixed inside the container. The gasket of proper size was fixed over the bed and the bed with gasket was slowly and vertically inserted into the container. Once it was properly placed then the bed was pressed at

the rim of the bed container to fix the bed tightly. The leakage test has done by putting water into the gap between outside container and the bed over the gasket. The leakage was checked by visual observation.

Testing of filter bed: Testing of fabricated bed is done by filtration rate measurement. The average filtration rate of filter bed should be around 2 to 3.5 litres/hour. This test is the quality check for fabricated filter bed. If filtration rate is out of 2-3.5 litre/hour range, filter bed should be discarded.

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Detailed Report of Arogya Water Filter (NEERI, Nagpur)

Abstracted from the dissertation work for M.Sc. Degree by Miss Ashvini J. Kamble under the guidance of Dr.(Mrs. Shanta Satyanarayan, Ex. Deputy Director, NEERI, Nagpur and Co-guide Dr.P.R.Chaudhari

Bacteriological Quality Examination of Water Samples.

Types of medium	Medium	Bacterial species	Amount of Growth		Appearance of growth
			BF	AF	
Simple	Nutrient agar	E. coli	30	0	Colonies appear as smooth moist grayish white easily emulsifiable in saline
	MacConkey agar	E. coli	41	0	3 nm circular pink entire elevated opaque mucoid
Differential	Cosin-methylene blue agar	E. coli	48	0	3 nm circular dark black centered entire elevated opaque mucoid & with metallic green sheen.
	Endo agar	E. coli	11	0	3 nm circular deep red with metallic sheen entire elevated opaque mucoid.
Enriched	Blood agar	Streptococus	39	0	α -Hemolytic streptococci colonies are surrounded by zone of partial haemolysis
			25	0	β -Hemolytic streptococci colonies are surrounded by clear zone of haemolysis

F : Filtration; A : After, B : Before

Salient Features of Existing Arogya Water Filter which has been used in the present studies:

Sr.No.	Important Features	Arogya Water Filter	Water Boiling	UV inline purifier	Candle filter
1	Harmful bacteria removal	√	30-40 Min. boiling is essential	√	X
2	Better taste	√	X	√	X
3	Turbidity Removal	√	X	√	X
4	Odour removal	√	X	√	X
5	Expensive gas is not needed	√	√	√	√
6	No Electricity	√	√	X	√
7	Continuous free flow water is not needed	√	√	X	√
8	No need of plumbing	√	√	X	√
9	No need of highly expensive maintenance	√	√	X	√
10	Low cost	√	X	X	√

Studies have confirmed the efficiency of the filter with respect to microbial removal. This filter could remove many associated problems apart from microorganisms. This will help the rural masses to drink safe water, which will inturn reduce the gastro intestinal diseases.

Our main objective should be to provide safe drinking water at cheaper rate. Polluted water can be treated to safe drinking levels using highly sophisticated techniques but it will be beyond the reach of the poor masses. Due to this reasons we are unable to control the diseases. Cheaper and full proof technology with in poor peoples reach is the need of the hour.

The great yeomen service in this direction is the fabrication of low cost indigenously prepared filter by **Centre of Science for Villages, (CSV), Dattapur, Wardha.**

This filter apart from removing microbial contamination also removes heavy metals, fluoride and hardness from he water samples.

Removal of heavy metals is also of urgent need. Heavy metal like Arsenic is very deadly to humans, cattle and also to the plants. This filter can be used in areas where presence of Arsenic metal is very prevalent in ground water samples. At least drinking water needed, can be filtered through this filter to remove the arsenic metal. At least ingestion of direct arsenic can be prevented. Detail studies on heavy metals including arsenic and fluoride removal has also been carried out and results have been discussed elsewhere.

Finally it can be concluded based on the detail experimental work that the low cost filter fabricated at Centre of Science for Villages (**CSV**), Dattapur, Wardha **is very effective.**

This filter has universal application in places where heavy metals like Arsenic, and fluoride, hardness and microbial contamination are prevalent. The present filter is very effective in removing the above contaminants.

It is the most cost effective, sustainable and eco-friendly filter. It needs propaganda/ publicity to make it popular in rural areas. Being cheaper rural masses should be forced to use the filter for filtering their drinking waters. Indirectly its use will bring down the diseases and make the life of people more healthy.

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