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## Fabrication & Testing of Rapid Sand Filter Equipment

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Sand has been used to purify water for over a thousand years; and it still remains the dependable methods of making water fit for drinking. The idea of water sand filtration can be seen when water taken from sandy river beds is generally pure, because it has percolated through the sand grains where harmful bacteria are removed.

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# Fabrication & Testing of Rapid Sand Filter Equipment

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**Abstract** - Water is described as a universal solvent which is the most abundant and useful compound that nature has provided. Two main sources of water are: surface and underground water. Among the many essential elements for the existence of human beings, animal and plants, water is rated as one of the most important elements for human living. Man can survive for weeks without food but a few days without water.

Sand has been used to purify water for over a thousand years; and it still remains the dependable methods of making water fit for drinking. The idea of water sand filtration can be seen when water taken from sandy river beds is generally pure, because it has percolated through the sand grains where harmful bacteria are removed.

As a result of high demand for quality and clean water by the society, various means to meet this demand have been constructed. Though, many of these means are not easily accessible by some communities, due to unavailability, high cost, or complexity of usage. This has led to the design and construction of water filters which can be accessible by all communities. Data obtained from our laboratory results clearly shows that an appreciable degree of treatment had taken place when the designed filter was used. In this paper we describe the fabrication rapid sand filtration equipment by using glass boxes, sand, activated carbon, mesh, coagulant etc. and also tested the raw water & treated water by using WHO standard analytical procedures.

## I. INTRODUCTION

Unsafe drinking water, along with poor sanitation and hygiene, accounts for nearly 10% of the total burden of disease worldwide. This includes an estimated 4 billion cases of diarrhea disease annually, causing 1.8 million deaths, mostly among children under 5 years of age. By affecting normal consumption of foods and reducing the adsorption of nutrients, diarrheal diseases are also an important cause of malnutrition, which can lead to impaired cognitive development and physical growth, reduced resistance

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to infection, and potentially, long-term gastrointestinal disorders. Contaminated water is also an important contributor to other potentially waterborne diseases, including hepatitis A and E, cholera, typhoid, and poliomyelitis.

## II. LITERATURE REVIEW

The kind of treatment water needs strongly depends upon the composition and quality of the water. Water treatment contains two process steps: physical removal of solid particles, mainly minerals and organic matter and chemical disinfection; killing or deactivating micro organisms in water.

Since water contains no calories and can serve as an appetite suppressant and helps the body metabolize stored fat, it may possibly be one of the most significant factors in losing weight. In his book, titled "The Snowbird Diet" Dr. Donald Robertson says the body will not function properly without enough water and discusses the importance of drinking plenty of water for permanent weight loss: "Drinking enough water is the best treatment for fluid retention; the overweight person needs more water than the thin one; water helps to maintain proper muscle tone; water can help relieve constipation; drinking water is essential to weight loss." Water is a key component in determining the quality of our lives. Today, people are concerned about the quality of the water they drink. Although water covers more than 70% of the Earth, only 1% of the Earth's water is available as a source of drinking. Yet, our society continues to contaminate this precious resource. Water is known as a natural solvent. Before it reaches the consumer's tap, it comes into contact with many different substances, including organic and inorganic matter, chemicals, and other contaminants. Many public water systems treat water with chlorine to destroy disease-producing contaminants that may be present in the water. Although disinfection is an important step in the treatment of potable water, the taste and odor of chlorine is objectionable. And, the disinfectants that are used to prevent disease can create byproducts which may pose significant health risks. Today, drinking water treatment at the point-of-use is no longer a luxury, it is a necessity! Consumers are taking matters into their own hands and are now determining the quality of the water they and their families will drink by installing a drinking water system that will give them clean, refreshing, and healthier water.

In our country most of the people are drinking non potable water. By consumption of this water leads to human health problems.

a) *Types of filters*

i. *Slow sand filter*

Slow sand filters are used in water purification for treating raw water to produce a potable product. They are typically 1 to 2 meters' deep, can be rectangular or cylindrical in cross section and are used primarily to treat surface water. The length and breadth of the tanks are determined by the flow rate desired by the filters, which typically have a loading rate of 0.1 to 0.2 meter per hour (or cubic meter per square meter per hour). Slow sand filters now are also being tested for pathogen control of nutrient solutions in hydroponic systems

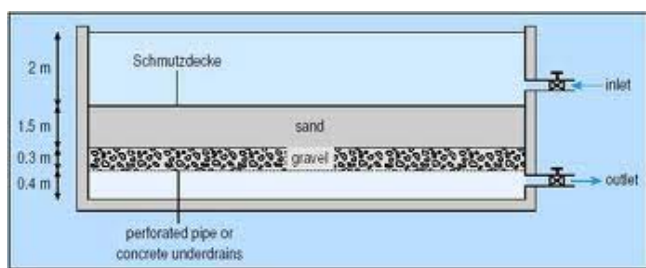


Fig. 1 : slow sand filters

1. Water from the North Santiam is put on slow sand filters.
2. Algae, protozoa, and small invertebrates that live in the slow sand filter remove biological contaminants such as Cryptosporidium. The surface of the slow sand filter is where most of the contaminant removal occurs.
3. Straining of dirt and clay particles occurs at the surface of the filter as well as further down through the sand and gravel.
4. After water passes through the slow sand filter, chlorine is added for disinfection, and soda ash is added for corrosion control.

**Advantages**

There are several advantages of slow sand filtration over other methods of water disinfection:

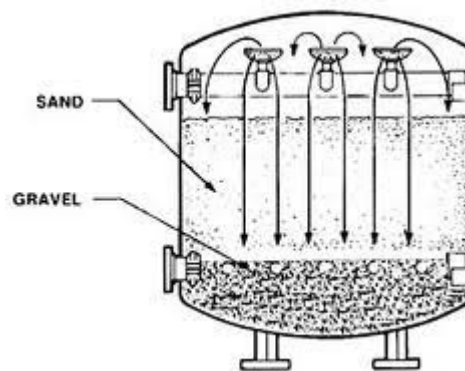
- It is a low energy consuming process
- It has great adaptability in components and applications maintenance is minimal
- Systems can be built and installed by laymen
- Costs of building and running significantly lower than other disinfection methods

**Disadvantages**

- Due to the low filtration rate, slow sand filters require extensive land area for a large municipal system.
- Many municipal systems in the U.S. initially used slow sand filters, but as cities have grown they

subsequently installed rapid sand filters, due to increased demand for drinking water.

ii. *Rapid sand gravity filter*



The **rapid sand filter** or **rapid gravity filter** is a type of filter used in water purification and is commonly used in municipal drinking water facilities as part of a multiple-stage treatment system.

Rapid sand filters use relatively coarse sand and other granular media to remove particles and impurities that have been trapped in a flock through the use of flocculation chemicals--typically salts of aluminium or iron. Water and flock flows through the filter medium under gravity or under pumped pressure and the flocculated material is trapped in the sand matrix.

Mixing, flocculation and sedimentation processes are typical treatment stages that precede filtration. Chemical additives, such as coagulants, are often used in conjunction with the filtration system

**Advantages**

- Much higher flow rate than a slow sand filter; about 150 to 200 million gallons of water per acre per day
- Requires relatively small land area
- Less sensitive to changes in raw water quality, e.g. turbidity
- Requires less quantity of sand

**Disadvantages**

- Requires greater maintenance than a slow sand filter. For this reason, it is not usually classed as an "appropriate technology," as the term is applied in less-developed countries.
- Generally ineffective against taste and odor problems.
- Produces large volumes of sludge for disposal.
- Skilled supervision is essential.
- Cost of maintenance is higher. It cannot remove bacteria.

III. EXPERIMENTAL

a) *Fabrication of rapid sand filter*

The equipment consists of three boxes having side 25 cm of cube. The First glass box and second



glass box consists of 3 cm thickness fiber box. In that fiber box contains double layer cloth mesh; on it 2 cm thickness of sand layer is placed. On the sand layer aluminum mesh is kept, 0.5 cm thickness of Gravel is placed on the aluminum mesh and Activated carbon of 0.5 cm is kept on it, 5 gm of aluminum oxide crystals are placed on activated carbon.

Third glass box is used to store water. From third glass box a booster pump is connected for collecting the water.

*b) Working of rapid sand filter (RSF)*

The collected water is allowed in the top glass box of the system. The water passes through aluminum oxide and activated carbon. Then this water reacts with activated carbon which is negatively charged, by this oxidation will be done.

After this the water passes through gravel where large particles will be filtered then water will pass through aluminum mesh and then to sand membrane here small size particles will be filtered, then water will pass through the cotton cloth meshes here very small size particles are filtered from the water .

Then the water flows through the holes of first glass box and fell into the second glass box. Here the same process will be repeated as in the first glass box. Then the water flows from second glass box and fell into the third glass box. From third glass box the water is pumped by the booster pump and that water is collected and tested.

Also Reverse osmosis membrane (RO), (in which large molecules and ions are removed from solution by applying pressure to the solution) is also used for testing the water. The water passed through the RO membrane is collected and tested.

A taste chamber is used to add taste to water. The collected water is analyzed by using WHO standard analytical procedures.

The all connections are done with the help of 1 cm diameter pipes between boxes and Booster pump, RO membrane, taste cartridge etc.

*c) Testing method, results & disscution*

The raw water is passed through i) RSF ii) RO & iii) Both RSF & RO and tested.

The fig 3.3.1 shows Rapid sand filter, Fig 3.3.2 shows Reverse Osmosis and Fig. 3.3.3 shows Rapid sand filter with RO.



*Fig 3.3.1 : Rapid sand filter.*



*Fig 3.3.2 : Reverse Osmosis.*



*Fig. 3.3.3 : Rapid sand filter with RO.*

The raw water (RW) and the treated water (TW) are analyzed for water quality parameters and results are shown in below table 3.3.1 & table3.3.2.

From the results in table 3.3.1 the Electrical conductivity, TDS, Total Solids, Turbidity, Hardness, Alkalinity & Residual chlorine are within the limits

specified by IS standards for the water treated by the system without RO membrane when compared to raw water. But DO decreases below the limit specified by IS system.

Also the water quality parameters of the water treated by RO alone are not within the limits.

Table 3.3.1 : Results of RO and RSF

Further analysis is carried to find the effect of RSF with RO membrane. The results are shown in Table 3.3.2.

S.NO	NAME	pH	EC (Mho/cm)	TDS (mg/l)	TS (mg/l)	TURBIDITY (mg/l)	DO (mg/l)	HARDNESS (mg/l)	ALKALINITY (mg/l)	RESIDUAL CHLORINE	F <sup>-</sup>
1	RW	8.3	2.340	2983	3627	16.4	7.78	1123	892	1.26	1.42
	TW	7.6	1.450	1206	1482	8.9	2.59	469	426	0.63	1.12
2	RW	8.4	2.560	3057	3780	16.9	7.84	1149	889	1.32	1.54
	TW	7.5	1.490	1233	1398	9.1	3.2	473	420	0.71	1.24
3	RW	7.5	1.848	1242	9.2	9.2	3.2	940	1023	1.1	0.42
	TW	7.1	0.973	623	716	4.3	2.4	390	420	0.52	0.36
4	RW	7.9	1.676	1642	1863	11.2	4.9	862	966	0.9	0.96
	TW	7.2	0.826	934	1076	6.4	3.6	374	426	0.56	0.72
5	RW	7.6	1.167	1250	1592	10.9	4.2	796	874	0.86	0.96
	TW	6.8	0.742	649	864	5.2	2.9	387	399	0.52	0.76

From the results in table 3.3.2, the Electrical conductivity, TDS, Total Solids, Turbidity, Hardness, Alkalinity & Residual chlorine are within the limits

specified by IS standards for the water treated by the system when compared to raw water. But DO decreases below the limit specified by ISO system.

Table 3.3.2 : Results of RO & RSF combined

S.no	Name	PH	EC	TDS	TS	Turbidity	Do	Hardness	Alkalinit	Residua Chlorine	F <sup>-</sup>
1	RW	8.2	2.3	3106	3492	16	7.6	1110	882	1.2	1.4
2	RO	8.0	2.1	2634	2752	14.2	6.8	739	690	0.89	1.34
3	RSF with RO	7.7	1.6	1849	1923	9.5	3.9	540	512	0.63	1.2

According to results from table 3.3.1 the values of Treated Water with RO is reduced to 15-20% and the Treated Water without RO is reduced to 30- 40%. And by using both the values reduced to 50-60% from table 3.3.2.

#### IV. CONCLUSIONS

The following conclusions can be made from this research. The Rapid sand filtration method is the most suitable among several treatment processes, locally available materials were used in the construction, the depth and capacity of filter bed were increased which made it to be more efficient to an appreciable

degree. In conclusion, despite the fact that water gotten from the tap has undergone some treatments, it still needs to be filtered for it to be safe for drinking. An efficient filter tank having more capacity using rapid sand filtration method with inclusion of activated charcoal and the filter bed length increased have been produced.

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