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How to Overcome With Limitations of Slow Sand Filteration System

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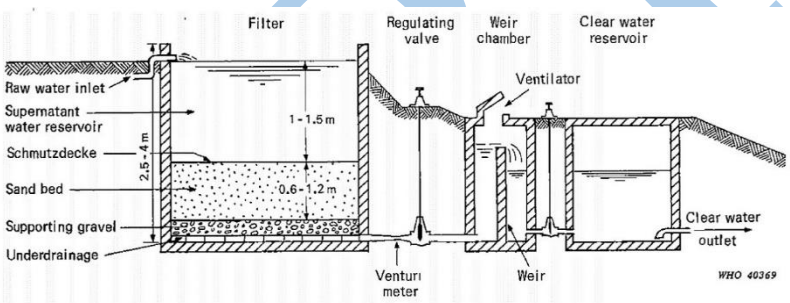
ABSTRACT

Slow Sand Filtration has been accepted as a suitable mechanism for converting pathogenic content water to drinking water. As the slow sand filtration system is not the economic system nor the straightforward operation to work and continue, but more capable undergoing suitable conditions. Slow sand filter can be effective for water purification. Slow Sand Filter is to successfully pull out the turbidity, pathogenic organisms and bacteria with the help of biological and physical operations in a single pace. It is a powerful technique for curing pathogenic water. By 18th century, the conception of purification of water has been across by board. In 1804, the first municipal filter was proposed by a possessor of bleachery, named John Gibb from Scotland by using gravel and sand. In 1827, the first slow sand filter was invented by a civil engineer named Robert Thom from Scotland. Slow sand filtration system has two faces, its strength (i.e., easy to install, long lifespan, bacteria removal, etc.) as well as limitation. This review paper is a summarize part of the limitations, as we would not only discuss about limitations of Slow Sand Filtration, but also the steps to overcome with those limitations which includes - acceptability of raw water, poor removal of colloidal, and high cleaning downtime.

Key words: Slow sand filter, Colloidal removal, Downtime, Acceptability, Filter roughing, Filter mat.



INTRODUCTION

The enhancement of water quality is firmly correlated with the relationship between man and environment. Water is the spirit of life and need of pure drinkable water is very high a human being. So, supply of pure drinkable water is very important for the development of humanity and the world. Slow sand filtration system is a process used for purification of unfiltered water from hundreds of years. This filtration process is convenient for the small communities, rural communities. Slow sand filter does not require a much attention nor a higher degree of skill for its operation.

For water treatment, there are two main types of sand filters – **Rapid sand filter** and **slow sand filter**. These both filtration system processes differently at different criteria. Slow sand filtration is an operation in which unfiltered water is passed through a fine granular bed of sand, which is basically called as filter bed which helps in removing the impurities of water. To attain potable water at the end of filtration process, the unfiltered water is carried out through screening and sedimentation process, which helps in removing of bacteria and turbidity from water. Slow sand filter removes a large percentage of bacteria, impurities and turbidity which results to the low rate of filtration and its high economical cost.

The first use of sand filtration is carried out in 1804 for purifying water by a bleachery from Scotland, named John Gibb. Followed by this, in 1827 a civil engineer, named Robert Thom

(Known as inventor of slow sand filter) from Scotland, installed an experimental slow sand filtration system. In refining this filtration

method, an engineer James Simpson installed slow sand filter in 1829 for a company called Chelsea Waterworks Company, situated in London for more than 11 million peoples. Slow sand filters are broadly used in European countries more than United States where there are approximately 27 Slow sand filters which provide supply to a small community (less than 10,000 people) and which are more working from more than 50 years.

The slow sand filters are cleaned by using surface scrapping method in which the top filter media is removed about 1.5 to 3 cm. Then the top surface of filter media is racked, roughened, and cleaned with clean water. In addition to this, L Huisman, a prof. of Civil Engineering, and W.E Wood, Former Chief of water supply, WHO recommended the accomplishment of re-sanding by the method of trenching. According to them, trenching helps in avoiding the deposit in the lower part of the filter bed.

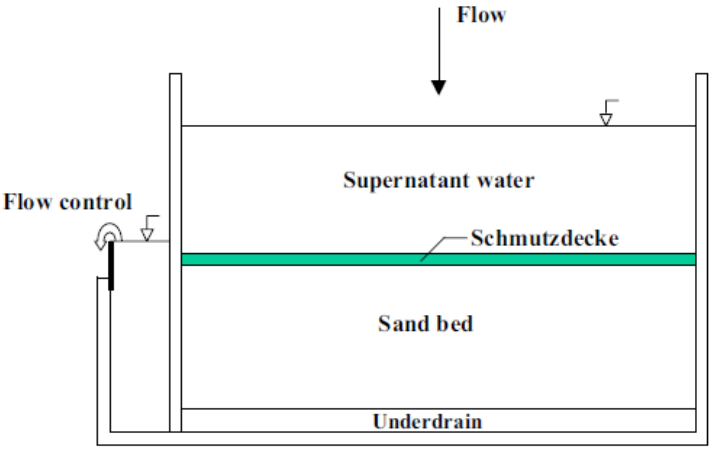
The slow sand filtration system has both faces of strength and limitation. As this filtration system removes most of the pathogenic organisms, turbidity but in other hand the rate of filtration is very low and the construction is economically costly. This also helps in removal of ammonia, but not effective in virus removal. It also contributes in reduction of protozoa and bacteria as well as it is easy to operate and requires less

maintenance. But on other hand, filtration system can clog due to fine dust present in water which is too small to remove.

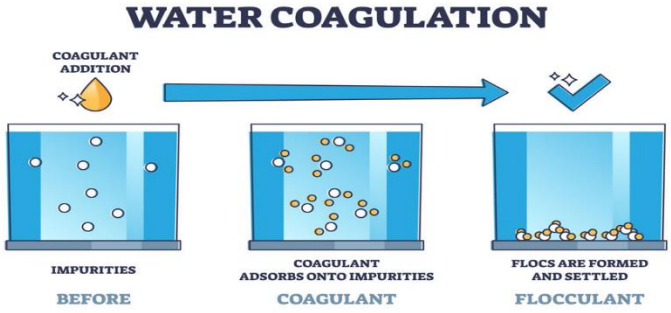
Apart from this, we will be briefly discussing about other limitations and the procedure to overcome with those limitations like acceptability of raw water with the help of a method known as filter roughing, the obstruction of poor removal of colloidal materials can be treated by using non-hazardous coagulants and many more.

MATERIAL REQUIRED

1. **Filter Media:** Filter media is basically containing the clean river sand layer of 90-110 cm thickness with having the effective size of sand (D_{10}) to be about 0.25-0.35 mm, and also with the uniformity coefficient (C_u) to be about 3-5.



2. **Enclosed Tank:** A water-tight rectangular tank constructed by brick masonry or stone masonry or concrete. The depth of tank depends upon the rate of filtration with a bed slope.
3. **Base Material:** Base material provides support to the filter media, which contains gravel of 30-75 cm thickness, which is laid in layers where each layer is of 15 cm thick.
4. **Under-drainage System:** Under-drainage system fulfils multi-purpose by providing the support to the filter medium while storing the water and transfers the cleaned water to the reservoir.
5. **Regulating Valve:** Regulating Valve is a mechanical device used in regulate temperature, pressure, flow rate, and many other parameters.
6. **Filter Mat:** Filter mats are basically made up of glass fibre, glass wool, cellulose fibre by using a process named, conventional wet-laying process. The main objective behind using this is to remove contaminated particles present in water.
7. **Coagulants:** A coagulant is a chemical that is used to remove suspended solids from unfiltered water. Aluminum chloride, polyaluminium chloride (PACl) & aluminum chlorohydrate (ACH), ferric sulfate, ferric chloride, aluminum sulfate.



LITERATURE REVIEW

Table-1: Limitations and the process to overcome them

Limitations to be overcome	Method to overcome the limitations
1. Raw water acceptability	Introduce filter roughing process
2. Poor removal of colloidal	Provide Coagulants (Non-hazardous)
3. High cleaning Downtime	Install filter mats

1. **Introducing Filter Roughing to overcome with acceptability of raw water:** Filter roughing is a pre-treatment technique used in slow sand filter. The basic components used in filter roughing are filter box which is divided into two or three compartments, gravel bed in decreasing size layer for each compartment of filter box. The direction of flow in filter roughing can be either vertical or horizontal **(fig.3)**. Where horizontal roughing is considered to have greater silt storage capacity. Size of gravel material, length of filter, and filtration rate are the principal parameters for roughing filter design. The size varies from 20-2 mm of graded gravel in the sequence of coarse, medium and fine compartmental packs. Roughing filters have achieved significant reductions in raw water turbidity, bacteria, apparent colour, and algal content.

2. **Providing coagulant for better removal of colloidal:** As suspended particles cannot be completely

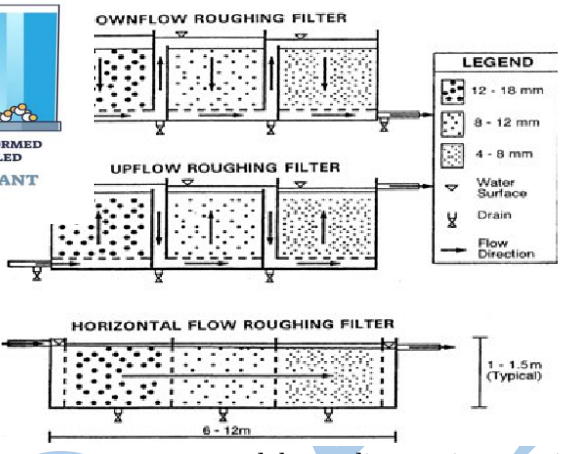


Figure 3- Filter roughing for different flows.

removed by sedimentation or simple settling. The large and heavy particles will readily to settle down but in case of smaller and lighter particles the settlement is very low or they do not settle. Those small and lighter particles are basically called as colloidal particles, the sedimentation step is taken to another stage by adding some chemicals known as coagulant. Coagulants are added to the water to bring the non-settling particles together into larger, heavier masses of solids called floc. Coagulants are made up of positively charged molecules, which help to provide effective neutralization of water. During this process, the coagulant has to be quickly added to the water and mixed in water. When the water is coagulated, it is often filtered through an ultrafiltration or microfiltration membrane, or a medium filter, to get rid of the settled particles **(fig.4)**. Water can also be moved into a settling tank, in which the heavy particles will sink to the bottom, where they can then be removed easily. Coagulants can be used for removal of colloidal particles are: Aluminum chloride, polyaluminium chloride (PACl) & aluminum chlorohydrate (ACH), ferric sulfate, ferric chloride. Most common coagulant used for water treatment is Aluminum sulfate. Aluminum sulfate is additionally referred to as Alum.

3. **Installing Filter mats to reduce the cleaning downtime of filter:** The performance of slow sand filters can be improved by the use of a layer of nonwoven, synthetic fabric to the filter surface, known as filter mat **(fig.5)**. The main objective of installing filter mat to sand surface of slow sand filtration system is to concentrate the suspended matter removal process within the fabric layer. Because of greater porosity and specific area, non-woven fabrics offers more efficient filtration medium than sand. The main reason behind the usage of this non-woven synthetic fibric in filtration system includes – a filter cleaning arrangement and especially, the longer filter run-time which is due to the lower rate of head loss development, which basically means the reduction in routine cleaning

downtime of the slow sand filtration system. The only problem with filter mat installation on top of slow sand filter are associate with removal and cleaning of fabric.

CONCLUSION

As slow sand filter had consistently demonstrated its effectiveness in the stage of purifying raw/unfiltered waters. However, every system needs to be upgraded to its extents, over time to perform better and provide the satisfactory result.

All the limitation and overcome statements or modification for slow sand filtration process is to enhance the treatment performance as well as operation of the slow sand filter which includes the raw water acceptability, rate of removal of colloidal particles, and reducing the cleaning downtime of the slow sand filtration system.

Where filter roughing, makes the slow sand filtration system to overcome with the acceptability of raw water entering into the filtration system. This is done by providing compartments for filter box. The roughing can be of horizontal or vertical.

The second limitation is resolved by providing the coagulants in the raw water which contains the colloidal particles, which are the main reason of clogging in filtration system. And this is overcome by mixing coagulant into the water to settle the particles and removed simply through sedimentation process.

The last problem which is faced is the cleaning downtime, which is very high in slow sand filters. Which is resolved by installing filter mat, which helps in avoiding the maximum impurities to enter I the filter which is why the routine cleaning can be delayed and simultaneously, the cleaning downtime is also reduced for the slow sand filtration system.

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