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STUDY OF FILTRATION PROCESS IN WATER TREATMENT

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Abstract
Filtration is any of various mechanical, physical or biological operations that separate solids from fluids by adding a medium through which only the fluid can pass. The fluid that passes through is called the filtrate. In physical filters over size solids in the fluid are retained and in biological filters particulates are trapped and ingested and metabolites are retained and removed. However, the separation is not complete; solids will be contaminated with some fluid and filtrate will contain fine particles. Filtration occurs both in nature and in engineered systems; there are biological, geological, and industrial forms. For example, in animals (including humans), renal filtration removes wastes from the blood, and in water treatment and sewage treatment, undesirable constituents are removed by absorption into a biological film grown on or in the filter medium, as in slow sand filtration.
Index Terms: *trapped, ingested, biological etc.*

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1. INTRODUCTION

Water to be supplied for public use must be potable i.e., satisfactory for drinking purposes from the standpoint of its chemical, physical and biological characteristics. Drinking water should, preferably, be obtained from a source free from pollution. The raw water normally available from surface water sources is, however, not directly suitable for drinking purposes. The objective of water treatment is to produce safe and potable drinking water. Some of the common treatment processes used in the past include Plain sedimentation, Slow Sand filtration, Rapid Sand filtration with Coagulation-flocculation units as essential pre-treatment units. Pressure filters and Diatomaceous filters have been used though very rarely. Roughing filters are used, under certain circumstances, as pre-treatment units for the conventional filters. The treatment processes may need pre-treatment like pre-chlorination and aeration prior to conventional treatment. The pre-treatment processes comprising of Coagulation and Flocculation have been discussed under the main title of Rapid Sand filters in this chapter. Detailed discussion on all such aspects as well as recommended unit operations, is given in the Manual on Water Supply and Treatment (1999Edition) Ministry of Urban Development.

2. BACKGROUND

High-quality water is defined as water that contains no pathogenic organisms and is free from biological forms that may be aesthetically objectionable. It is clear and colorless, and has no objectionable taste or odor. It does not contain concentrations of chemicals that may be physiologically harmful, aesthetically objectionable, or economically damaging. It also is not corrosive, nor does it leave excessive or undesirable deposits on water-conveying structures, including pipes, tanks, and plumbing fixtures.

Criteria used to evaluate the safety of drinking water are continually reassessed as new constituents are identified and health effects research advances. Regulatory agencies are developing standards and recommendations for contaminant levels in drinking water. Concurrently, the water supply industry is developing new and improved operation and treatment techniques to respond to the changing criteria. Drinking water quality criteria must consider all factors that affect the quality of water, the public health significance of the constituents, and the available technology to treat water.

The factors must recognize the practical aspects of design and operation and the capital cost of meeting the quality criteria. Establishing appropriate criteria, therefore, requires the combined efforts of regulatory agencies, consumers, and the water supply industry, society's ever changing needs. Therefore, protection and enhancement of available surface water and groundwater supplies should be a North American priority to facilitate the effectiveness of economical production of safe, adequate, and Water.

3.SLOW SAND FILTER

Slow sand filtration is a simple and reliable process. They are relatively inexpensive to build, but do require highly skilled operators. The process percolates untreated water slowly through a bed of porous sand, with the influent water introduced over the surface of the filter, and then drained from the bottom.

3.1 PROCESS

Slow Sand filtration was the first type of porous media filtration used in water treatment. This process is known for its simplicity and efficiency.

During the initial operational period of slow sand filters, the separation of organic matter and other solids generates a layer of biological matter on the surface of the filter media.

3.2 FILTER CONTROLS

1. Deliver raw water into the supernatant reservoir,
2. Removes cum and floating matter,
3. Drain off supernatant water prior to filter cleaning,
4. Lower water level in the bed,
5. Control the rate of filtration and adjust it as bed resistance increases,
6. Ensure that negative pressures cannot occur within the bed (the weir is the device usually used for this purpose),
7. Convey filtered water to the filter water tank,
8. Run filtered water to waste or to the inlet side of other filters during the ripening process,
9. Fill sand bed from below with filtered water (from other filters) after cleaning.

3.3 OPERATION

The operation of the filter is determined by the filtration rate, which is controlled at the effluent outlet. Inflow, which may be by gravity from a constant level reservoir, or by a pump, is adjusted so that the head of water in the supernatant reservoir remains constant at all times. Excessive raw water delivery will cause overflow through the scum outlets, while a reduction in the rate of inflow will cause the level in the supernatant water reservoir to drop; either condition should alert the operator to a defect in the mechanism controlling the supply of raw water.

The filtration rate is controlled by a single regulating valve on the effluent delivery. At the beginning of the filter run this will be partially closed, the additional resistance thereby provided being equal to that which will later build up within the filter bed. Day by day as the run continues this valve must be checked and opened fractionally to compensate for the choking of the filter and to maintain a constant filtration rate. In the early part of the filter run the daily build up of resistance will be almost imperceptible, calling for very little valve adjustment.

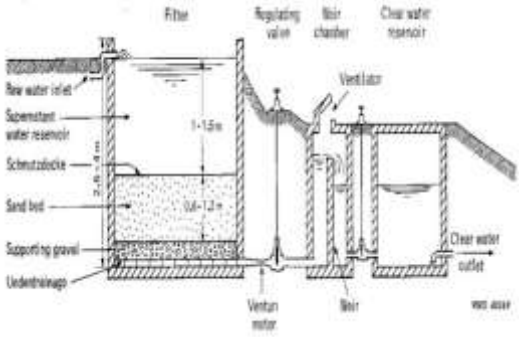


Fig1. Slow sand filter

3.4 CONTROL OF ALGAL GROWTH

Excessive algal growth may cause trouble in the operation of open filters. Pre-treatment by micro strainers is one method of removing the algae contained in the raw water.

3.5 WATER QUALITY

Samples of raw and treated water will be taken at regular intervals for analysis. In a large water works with its own laboratory, sampling will almost certainly be carried out daily, since the effluent analysis constitutes the only certain check that the filter is operating satisfactorily and the raw water analysis provides what is possibly the only indication of a change in quality that might adversely affect the efficiency of treatment. In case of small plants with no laboratory facilities, an attempt should be made to conduct sampling on regular basis. Field testing equipment may be used to measure water quality.

3.6 FILTER CLEANING

While the filter is in operation, a stage comes when the bed resistance increases so much that the regulating valve has to be fully opened and it is the right time to plan the cleaning of the filter bed since any further resistance is bound to reduce the filtration rate. Resistance accelerates rapidly as the time for cleaning approaches. Indicators may be installed showing the inlet and outlet heads, from which the head loss can be regularly checked; this gives a clear picture of the progress of choking and the imminence of the end of the run. Without any measurement of the head loss the only true indicator of buildup of resistance is the degree of opening of the regulating valve, though the experienced operator may be able to recognize preliminary visual warnings in the condition of the filter bed surface. A slight deterioration in the effluent quality may be a reason for the need for cleaning.

4. RAPID SANDFILTER

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.

4.1 PURPOSE

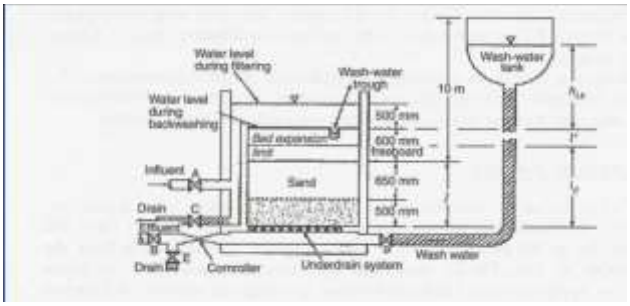
The purpose of coagulation and flocculation is to

remove particulate impurities, especially non settleable solids (particularly colloids) and colour from the water being treated. Non-settleable particles in water are removed by the use of coagulating chemicals.

4.2WORKING OF RAPID SAND FILTER

Rapid sand filters use relatively coarse sand and other granular media to remove particle sand impurities that have been trapped in a flock through the use of flocculation chemicals typically alum. The unfiltered water flows through the filter medium under gravity or under pumped pressure and the floc 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. The two types of rapid sand filter are the gravity type and pressure type. A disinfection system (typically using chlorine or ozone) is commonly used following filtration. Rapid sand filtration has very little effect on taste and smell and dissolved impurities of drinking water, unless activated carbon is included in the filter medium.

Rapid sand filters must be cleaned frequently, often several times a day, by back washing, which involves reversing the direction of the water and adding compressed air. During back washing, the bed is fluidized and care must be taken not to wash away the media.



The byproduct of backwashing is sludge which is either tankered away or is run to waste if the composition is within the tolerable limits. These tanks are known as 'Dirty wash water tanks'.

4.3 FLOCCULATION BASIN-OPERATION

The objective of a flocculation basin is to produce a settled water of low turbidity which in turn will allow reasonably long filter runs. Following points should be considered during the operation of the flocculation basins.

4.4 Dosing of the coagulant at a spot of maximum turbulence

Rapid mix of coagulant at a spot of maximum turbulence, followed by tapered flocculation In three compartmentalized units allows a maximum of mixing, (reduced short circuiting) followed by a period of agglomeration intended to build larger fast settling flock particles. The velocity gradient is gradually reduced from the first to the third unit. The concepts of velocity Gradient and tapered flocculation have been discussed in the Manual of Water supply and Treatment.

4.5 Interaction and sedimentation process

The processes of coagulation and flocculation are required to precondition or prepare non-settleable particles present in the raw water for removal by sedimentation and filtration. Small particles (particularly colloids), without proper coagulation and flocculation are too light to settle out and will not be large enough to be trapped during filtration process. Since the purpose of coagulation–flocculation is to produce particle removal, the effectiveness of the sedimentation and filtration processes, as well as overall performance, depends upon successful coagulation- flocculation.

5. CONCLUSION

Slow sand filtration is a simple and reliable process. The process percolates untreated water slowly through a bed of porous sand, with the influent water introduced over the surface of the filter, and then drained from the bottom.

A well-operated rapid sand filter reduces turbidity regarding the removal of most other contaminants, the rapid sand filter are ineffective. If combined with adequate pre-treatment measure sand final disinfection, rapid sand filtration usually produces safe drinking water.

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