Single-Pass Sand Filters

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A single-pass sand filter system pretreats septic tank effluent by filtering it through sand before sending it to a soil treatment system. Various sand filter types and designs have been extensively tested and used in the United States. Other wastewater treatment filters use peat, pea gravel, crushed glass, or other experimental media, but sand is the best understood and the most predictable.

Treatment mechanisms in a sand filter include physical filtering of solids, ion exchange (alteration of compounds by binding and releasing their components), and decomposition of organic waste by soil-dwelling bacteria. A properly operating sand filter should produce high-quality effluent with less than 10 mg/liter BOD (biological oxygen demand, a measure of organic material), less than 10 mg/liter TSS (total suspended solids), and less than 200 cfu/100 ml fecal coliform bacteria, an indicator of viruses and pathogens.

Figure 1. Single-pass sand filter

Figure 2. Low-rate sand filter being installed

Sand Filters Application

Since wastewater leaves a sand filter system as high-quality effluent, the soil in the trench or mound soil treatment system may be better able to accept it, and the system should last longer. Because sand filters produce cleaner wastewater, they are useful for sites that have been compacted, cut, or filled; and for environmentally sensitive areas like those near lakes, in shallow bedrock areas, aquifer recharge areas, and wellhead protection areas. Pretreatment may allow a reduction in the three-foot separation required between the soil treatment system and the limiting soil layer. Researchers in several states, including Minnesota, are testing reduced separation distances in soil treatment systems receiving wastewater pretreated in a sand filter.

Sand filter systems may also be successfully retrofitted into drainfields that have failed because of excessive organic loading from lack of maintenance.

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How Do Sand Filters Work?

Sewage flows from the house into one or several septic tanks, depending upon the size of the house and local requirements. Effluent from the septic tank(s) flows into a pump or lift tank. A pump introduces the effluent at the top of the watertight sand filter, using pressure distribution to apply the wastewater evenly to the filter surface to maximize treatment. A timer is used to dose the entire surface of the filter intermittently with wastewater. This draws oxygen from the atmosphere through the sand medium and its attached microbial community. The effluent is treated by physical, chemical, and biological processes. Suspended solids are removed by mechanical straining due to enhanced contact and sedimentation. Treatment occurs through the bacteria that colonize in the sand grains. Microorganisms use the organic matter and nutrients in the effluent for growth and reproduction.

Designing Sand Filter Systems

The two main types of sand filters differ in the rate at which wastewater is introduced into the system. Loading rates determine the amount of maintenance needed and how long the system will last. A single-pass filter with a high loading rate needs regular cleaning (every two to three months) of the sand surface to prevent clogging.

In high-rate sand filters, effluent is applied at rates of 1.6 to 5 gallons per day per square foot. This application rate means the surface of the filter must be easy to access. That is why high-rate sand filters (Figure 3) are more common in warmer climates where they can be left open or have a lid that is easily removed.

Low-rate sand filters are the most common designs in Minnesota. Effluent from the pump tank is applied at rates of 0.8–1.5 gallons per day per square foot. Sizing criteria used for low-rate sand filters are similar to those for rock beds in mound soil treatment systems. These systems are covered with 6 inches of loamy topsoil and vegetation to provide insulation during the winter (Figure 4).

To determine the design size of the filter, the volume of wastewater flow from the residence is divided by the loading rate. The length to width ratio is not as critical as providing a system that distributes wastewater evenly across the filter surface at regular intervals. Timed dosing and a two-foot spacing of inlet pipes are recommended. In Minnesota, to be considered a standard pressure distribution system, anywhere from 2-to 5-foot spacing is allowed. Perforations in the laterals can be $^{3}/_{16}$ inch to $^{1}/_{4}$ inch in diameter. While laterals with $^{1}/_{4}$ inch perforations require a larger pump, smaller perforations are subject to plugging.

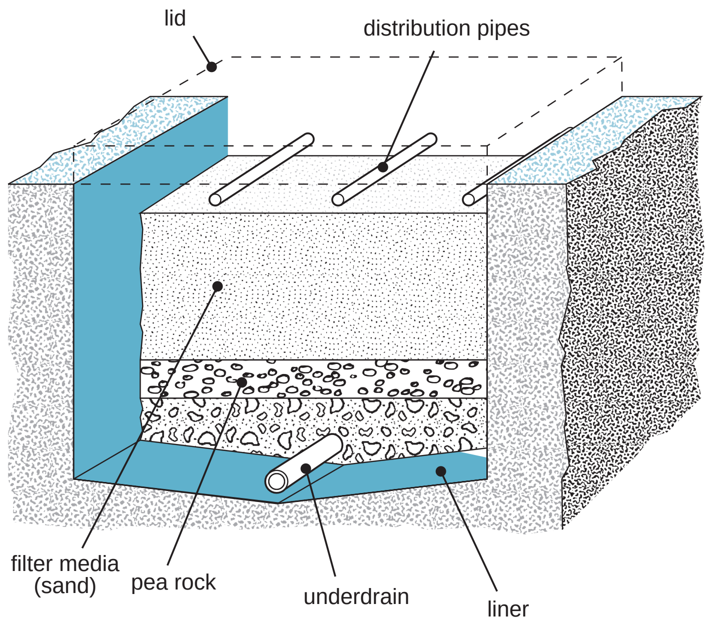

Figure 3. High-rate sand filter

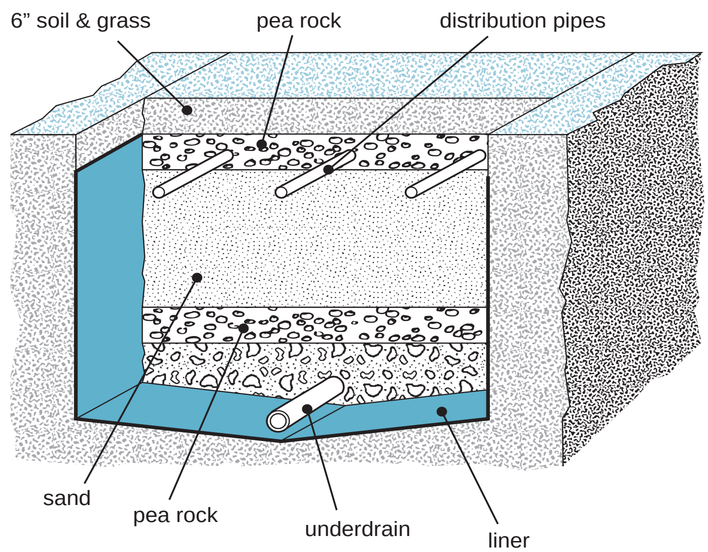

Figure 4. Low-rate (0.8–1.5 gpd/sq. ft.) sand filter

Placement

Site flexibility is probably the biggest advantage of a sand filter system. Because the filter is watertight and uses media for treatment, the soil where it is constructed is not as important as the ability of the media in the filter to transfer oxygen. Without enough oxygen, bacterial action will be compromised. The system should be constructed to keep surface water from entering the filter.

Outflow drainage from the filter is provided by a four-inch pipe surrounded by pea rock. Depth of outflow should be one foot to 18 inches below the bottom of the sand. The effluent must drain freely out of the sand, since filter saturation reduces treatment effectiveness.

Final Disposal of Wastewater

Effluent discharged from this system will be very clean, but must still be applied to the soil for final treatment. The design of this part of the system is still being tested and sizing requirements are being developed. Effluent leaving the sand filter is sent to a soil treatment system. The effluent is so “clean,” a biomat layer does not form the way it does in soil treatment systems receiving effluent from septic tanks. A pressure distribution network is needed to apply effluent evenly throughout the system. Options for the soil treatment system include trenches, mounds, and drip distribution. Figure 5 shows a sand filter system with pressurized trenches for even effluent application throughout the soil treatment system.

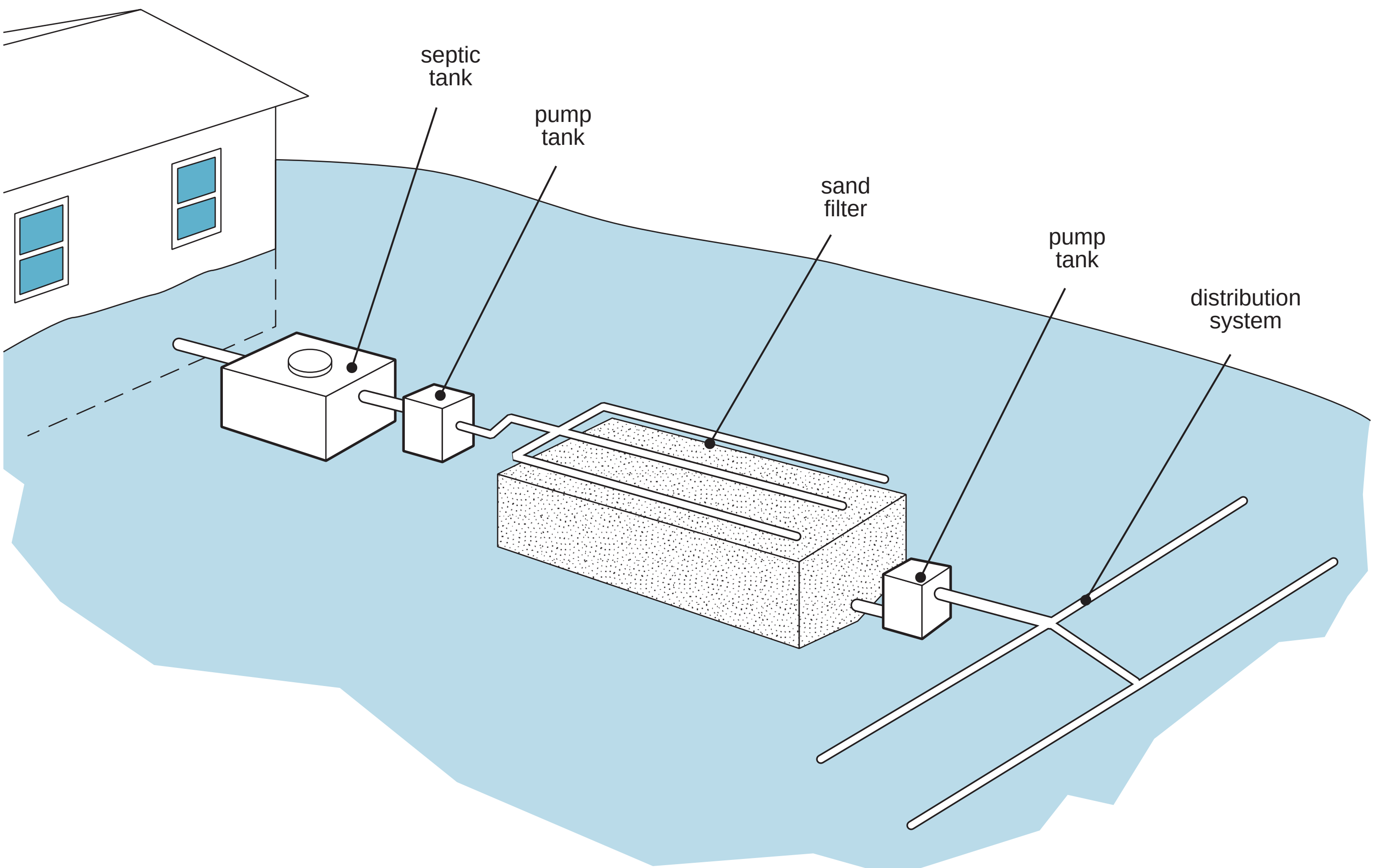

Figure 5. Sand filter system with pressurized trenches

Operation and Maintenance

All the routine operation and maintenance practices suggested for any onsite treatment system apply to sand filters (See *Septic System Owner's Guide*, PC-06583, for details.) Sand filters require more maintenance than a conventional septic-tank-drainfield system. A maintenance contract is strongly recommended.

At high loading rates (2 to 6 gal./sq. ft.), the sand must be replaced every 2–5 years. At lower loading rates, the system will operate properly for a longer time. If higher loading rates are necessary, recirculating the waste is an attractive alternative to the single-pass design. (See *Recirculating Media Filter*, FO-07670, for more information.)

Maintenance includes inspecting all components and cleaning and repairing when needed. Visual inspection of the effluent is required and often a laboratory analysis is necessary. A flow meter and timer should be installed and periodically checked to ensure the right amount of effluent is being applied to the system.

Daily running costs for a sand filter are based on the operation of a small submersible pump, and average less than a dollar per month for an individual home. Overall operational costs of \$200–\$500 per year includes cleaning tanks, repairs, maintenance, and electricity.

Summary

Single-pass sand filters are an effective way to treat wastewater in an onsite application. The sand filter system has been used for more than 30 years across the United States and there is significant design, treatment, and maintenance experience with these systems. Sand filter systems are very reliable in treatment of BOD, TSS, and fecal coliform. The system protects the final soil treatment area because failure will occur in the sand filter before the soil treatment system is significantly affected. Single-pass sand filters require more area that recirculating filters and are not a good choice for small lots.

Visit our Web site at www.bae.umn.edu/septic/ for additional information.

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