United States
Environmental Protection
Agency

Decentralized Systems Technology Fact Sheet

Septic Tank Polishing

DESCRIPTION

Polishing systems are used to improve the quality of septic tank system effluent. Effluent polishing may be necessary due to site constraints, regulations, or other limiting factors. One of the most common technologies used to polish septic tank effluent is the sand filter. Because sand filters can be designed in various configurations, they are highly flexible and can be adapted to many different types of sites, making them ideal for use in different community settings. The three types of sand filters typically used for septic tank polishing include buried, intermittent, and recirculating sand filters.

Treatment of effluent by sand filter systems involves physical, chemical, and biological processes. Suspended solids are removed principally by mechanical straining and sedimentation. Action by bacteria that colonize sand grains further enhances the removal of suspended solids. The removal of biological oxygen demand (BOD) and the conversion of ammonia to nitrate (nitrification) is performed under aerobic conditions by microorganisms present in the sand bed. The conversion of nitrate to nitrogen gas (denitrification) is routinely performed by anaerobic bacteria that exist in the anaerobic zones near the bottom of the filter and in anaerobic tanks, resulting in a significant (up to 45 percent) loss of nitrogen. Specific constituents are removed by sorption, both chemical and physical. Intermittent application and venting of the underdrains helps to maintain aerobic conditions in the filter, which helps achieve a high performance level.

DESIGN CRITERIA

Buried sand filters are typically installed with underdrains in 30 cm (1 ft) of coarse gravel, covered with 60-90 cm of sand. Liquid enters through a perforated pipe in another foot of gravel, and covered with at least 15 cm (6 in) of topsoil. **Intermittent** sand filters are divided into two or more units that are alternately loaded and rested. Wastewater is applied over a bed of sand 60 to 90 cm (2 to 3 ft) deep. The sand should have an effective size of 0.2 to 0.6 mm, with a uniformity coefficient less than 4.0. The filtrate is collected by underdrains contained in a bottom layer of gravel. The sand remains aerobic and serves as a biological filter, removing suspended solids (SS) and dissolved organics. Because of smaller sand size and higher loading rates, these units must be accessible for periodic servicing. The **recirculating** filter system consists of a septic tank and a recirculation tank that contains a timer-controlled sump pump for dosing onto a sand filter. The filter bed contains 90 cm (3 ft) of coarse sand and 30 cm (1 ft) or less of gravel surrounding the underdrain system. In this case, the sand should have an effective size of 0.6 to 1.5 mm with less than a 2.5 uniformity coefficient. A recirculation ratio of 4:1 (recycled filter effluent to forward flow) is recommended. If tank effluent requires disinfection, common methods used in on-site systems include tablet chlorination, iodine crystals, or ultraviolet irradiation. Designers must be careful when specifying sand - minimum dust content is essential.

Although sand is the most common media, alternative polishing media exist, including foam and geotextile fabric, which produce high quality effluents. These media are pre-fabricated, allowing performance to be unaffected by the grading of the sand. However, stringent fecal coliform effluent requirements may require sand filter polishing in addition to textile filtering.

Buried sand filters are generally constructed in two sections that are dosed separately from a tank with alternating siphons. Above ground sand filters (intermittent or recirculating) can be installed in areas where subsurface construction is impossible. Dosing tanks with pumps or siphons feed these filters. The filters may be open or covered, but must be accessible for cleaning. Covering and insulation are recommended for intermittent and recirculating filters to minimize freezing in cold weather and potential health risks and nuisances in warm weather.

Typical recommended loading rates from sand filter systems are 30 to 60 L/m^2 d (0.75 to 1.5 gal/ft^2 d) for buried sand filters; 200 L/m^2 d (5 gal/ft^2 d) for intermittent sand filters; and 120 L/m^2 d (3 gal/ft^2 d) for recirculating sand filters (based on forward flow alone).

ADVANTAGES AND DISADVANTAGES

Advantages

Sand filters are relatively inexpensive, have low energy requirements, and are highly flexible. They can be used on sites with shallow soil cover, high groundwater, and unsuitable permeability. Sand filters do not require highly skilled operators because the process is stable and no chemicals are required during operations. Filters generally produce high quality effluents.

Disadvantages

Land availability may limit the application of polishing systems. Furthermore, the amount of head required by the filters typically exceeds 90 cm (3 ft). As a consequence, pumping may be required if elevation differentials are inadequate. Odors from anaerobic portions of open, single pass filters used to treat septic tank effluent may be a problem if not installed correctly, and ongoing maintenance is necessary for the media, pumps, and controls. Power is required for pumping and some disinfection units. State or federal discharge permits are required, accompanied by periodic sampling and monitoring.

PERFORMANCE

Table 1 provides details of typical improvements in effluent quality with intermittent sand filtration of lagoon effluent.

OPERATION AND MAINTENANCE

Sand filters require relatively little operational control and maintenance. Primary servicing tasks include filter surface maintenance, dosing equipment, and monitoring of influent and effluent. With continued use, sand filter surfaces will become clogged with organic biomass and solids, and when operating infiltration rates fall below the hydraulic loading rate, permanent ponding of the filter surface will occur, indicating that the filter should be taken off-line for rest or sand removal and

TABLE 1 TREATMENT PERFORMANCE OF ON-SITE SEPTIC TANK AND SAND FILTER

Parameter	Raw Waste	Septic Tank Effluent	Intermittent Sand Filter Effluent
BOD, mg/L	210 - 530	140 - 200	< 10
SS, mg/L	237 - 600	50 - 90	< 10
Total nitrogen, mg/L	35 - 80	25 - 60	--
Ammonia-nitrogen, mg/L	7 - 40	20 - 60	< 0.5
Nitrate-nitrogen, mg/L	< 1	< 1	25
Total phosphorus, mg/L	10 - 27	10 - 30	--
Fecal coliforms (# / 100 mL)	10^6 - 10^{10}	10^3 - 10^6	10^2 - 10^4
Viruses (# / 100 mL)	Unknown	10^5 - 10^7	--

Source: Adapted from Tchobanoglous and Burton, 1991.

replacement. Inaccessible buried filters are designed to operate without maintenance for their design life. Filters exposed to sunlight may develop algae mats, which can be controlled by shading the surface. Disinfection is required prior to discharge in community systems, but disinfectant quantity requirements are low due to the high quality of the effluent from the sand filter.

Weeding should be performed at the surface of above-ground filters to prevent unwanted vegetative growth. In cold climates, the filter should be insulated and the distribution lines must be drained to prevent standing water and to prevent freezing.

Although it is a common maintenance practice, surface tilling is not recommended for slow sand filtering systems. This process moves clogged zones to the bottom of the tilled zone which may exacerbate surface ponding problems.

COSTS

Filter costs depend on many factors including soil type, cost of land, site topography, groundwater level, and cost of filter media. These site and system specific factors should be examined and incorporated when preparing a polishing filter cost estimate.

Construction Costs

Under typical, favorable soil conditions, the cost to install a polishing filter system is greater than the costs of a conventional gravel pipe drainfield. Nonetheless, while drainage pipe costs are lower, the drainfield footprint may be up to two times larger than that of a conventional gravel drainfield. Typical costs for a single pass sand recirculating filter system range between $7,000 and $15,000, including the septic tank and soil adsorption field. System design by an engineer, if required, will be an additional cost. If the existing site is inadequate for a new drainfield or if the existing field is no longer serviceable, removal and disposal costs should be considered.

Operation and Maintenance Costs

Operation and maintenance costs for sand filtration filter systems are minimal. Key costs associated with proper functioning of drainfield systems include septic tank cleaning, which ranges between $400 to $1,500 per cleaning.

REFERENCES

Other EPA Fact Sheets can be found at the following web address:

http://www.epa.gov/owm/mtb/mtbfact.htm

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