



Septic Tank Systems for Large Flow Applications

An Online Continuing Education Course for Engineers

Course Number: EN-2002

Credit: 2 Hours / 2 PDH / 2 CPD

Septic Tank Systems for Large Flow Applications

DESCRIPTION

A septic tank system is a traditional wastewater treatment technology utilizing treatment in a tank system followed by soil absorption. The system operates on gravity and has been used in residential areas for decades. A modification to the traditional system is an enlargement to accommodate many homes and/or commercial discharges. This is accomplished with individual septic tanks followed by a community collection and subsurface disposal system, or a community collection system followed by a single treatment system. Commercial establishments, such as restaurants, nursing homes, hospitals and other public use areas do not generally use septic tank systems due to oil and grease, odor, and flow issues.

The primary device in treatment is a septic tank enclosed in a watertight container that collects and provides primary treatment of wastewater by separating solids from the wastewater. The tank removes solids by holding wastewater in the tank and allowing settleable solids to settle to the bottom of the tank while floatable solids (oil and grease) rise to the top. In large commercial systems, a separate oil/grease removal system is applied to the commercial waste before introduction to the septic tank. The tank

should hold the wastewater for at least 24 hours to allow enough time for the solids to settle.

Some solids are removed from the water and stored in the tank while some are digested. Up to 50 percent of solids retained in the tank decompose while the remainder accumulate as sludge at the tank bottom and must be removed periodically by pumping the tank.

Three main types of septic tanks are used for wastewater treatment:

- Concrete.
- Fiberglass.
- Polyethylene/plastic.

All tanks must be watertight because groundwater entering the system can saturate the soil absorption field, resulting in a failed system. Furthermore, in instances where septic tanks precede a secondary treatment process, excess groundwater may inundate the downstream process, causing it to perform poorly.

From the septic tank, the clarified wastewater passes through the tank outlet and enters the soil absorption field. The

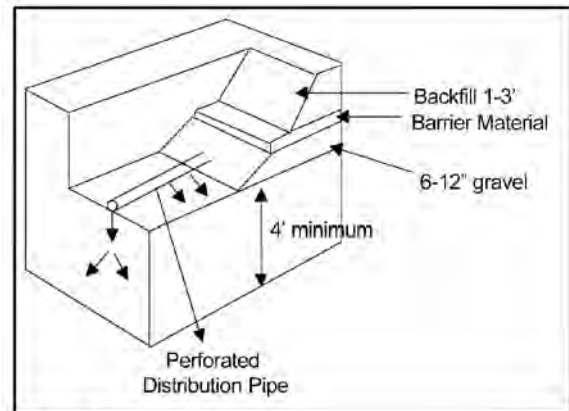
most common outlet is a tee fitting connected to the pipe leading to the soil absorption field. The top of the tee retains floatable solids (scum, oil, and grease) that might otherwise clog the absorption field. An effluent filter can be placed in the outlet tee for additional filtering of wastewater. The effluent filter removes additional solids, keeping them from clogging the absorption field and causing premature failure. Effluent filters must be cleaned regularly. For more information on effluent filters, see APPENDIX A.

Soil Absorption Field

The soil absorption field provides final treatment and distribution of the wastewater. A conventional system consists of perforated pipes surrounded by media such as gravel, chipped tires, or other material, covered with geotextile fabric and loamy soil. This system relies heavily on the soil to treat wastewater, where microorganisms help remove organic matter, solids, and nutrients from the water.

As effluent continually flows into the soil, the microbes eating the components of the wastewater form a biological mat. The mat slows the movement of the water through the soil and helps keep the area below the mat from becoming saturated. The water must travel into unsaturated soil so microbes there and in the mat can feed on the waste and nutrients in the effluent. The grass

covering the soil absorption system also uses the nutrients and water to grow.



Source: Robillard and Martin, 2000

FIGURE 1. SECTION OF TRENCH SOIL ABSORPTION SYSTEM

Treatment

Used properly, the septic tank and soil absorption system works well, reducing two parameters commonly used to measure pollution: (1) biochemical oxygen demand, which is lowered by more than 65 percent; and (2) total suspended solids, which are cut by more than 70 percent. Oil and grease are typically reduced by 70 to 80 percent (EPA 1980).

Using a septic tank to pretreat sewage from commercial sources also makes other secondary treatment systems more effective. The effluent from the septic tank is consistent, easy to convey, and easily treated by either aerobic (with free oxygen) or anaerobic (without free oxygen) processes.

Common Modifications

Septic tanks for large flow systems may be followed by traditional soil absorption systems or by one of several alternate technologies such as constructed wetlands or slow sand filtration. Pressure sewers and small diameter gravity sewers may also be used as alternate collection systems for transport of effluent to central treatment facilities. This course focuses on the traditional septic tank system applied to commercial waste and multiple sources, using subsurface infiltration for wastewater disposal.

Subsurface Infiltration

Subsurface wastewater infiltration systems (SWISs) are subgrade land application systems most commonly applied in unsewered areas by individual residences, commercial establishments, mobile home parks, and campgrounds (EPA, 1992). The soil infiltration surfaces are exposed in buried excavations that are generally filled with porous media. The media maintain the structure of the excavation, allows the free flow of pretreated wastewater to the infiltrative surfaces, and provides storage of wastewater during times of higher flows. The wastewater enters the soil where treatment is provided by filtration, adsorption, and biologically mediated reactions which consume or transform various pollutants. Ultimately, the

wastewater treated in the SWIS enters and flows with the local groundwater.

Various SWIS designs have been developed for various site and soil conditions encountered. The designs differ primarily in where the filter surface is placed. The surface may be exposed within the natural soil profile (conventional or alternative technology) or at or above the surface of the natural soil (at-grade or mound systems). The elevation of the filter surface is critical to provide an adequate depth of unsaturated soil between the filter surface and a limiting condition (e.g. bedrock or groundwater) to treat wastewater applied.

The geometry of the filter surface also varies, with long, narrow filter surfaces (trenches) much preferred. Wide filter surfaces (beds) and deep filter surfaces (pits and deep trenches) do not perform as well, although they require less area.

Subsurface infiltration systems are capable of high levels of treatment for most domestic wastewater pollutants. Under suitable site conditions, they provide nearly total removal of biodegradable organics, suspended solids, phosphorus, heavy metals, and virus and fecal indicators.

The fate of toxic organics and metals is not as well documented, but limited studies suggest that many of these constituents do not travel far from the system. Nitrogen is the most significant wastewater parameter

not readily removed by the soil. Nitrate concentrations above the drinking water standard of 10 mg-N/L are commonly found in groundwater immediately below SWISs (EPA 1992), but these concentrations fall with distance down-gradient of the SWIS.

APPLICABILITY

Community Establishments

Septic tanks are usually the first component of an on-site system and are the most widely used on-site wastewater treatment option in the United States. Currently, about 25 percent of new homes in the United States use septic tanks for treatment prior to disposal of home wastewater.

Septic tanks for single family homes are generally purchased as “off the shelf” items, which means that they are ready for installation and based on a standard flow. The wastewater characteristics used to design septic tanks are generally those for a typical residence.

Commercial Establishments

For many commercial establishments, the wastewater-generating sources are sufficiently similar to the wastewater-generating sources in a residential dwelling. For other establishments, however, the wastewater characteristics may be considerably different from those of typical residential wastewater.

Commercial establishments can take advantage of a centralized system if the flows and capacities are sufficient and adequate pretreatment is available. Wastewater must be pretreated prior to being discharged to a soil absorption system. Wastewater is most commonly pretreated by an on-site septic tank when a soil absorption system is used for treatment/disposal. In areas where soil and groundwater conditions are favorable for wastewater disposal and land costs are low, a community soil absorption system is usually the most cost effective wastewater treatment/disposal option for flows below 35,000 gallons per day. Careful application of the effluent to the soil absorption system ensures uniform application of effluent over the filtration surface. Distribution laterals should be provided with cleanouts for access and flushing. Ponding monitors should be installed in trench areas to allow observation of liquid level in trenches.

Subsurface Infiltration

In some instances, it is desirable to bury the absorption system. Buried systems, known as subsurface wastewater infiltration systems (SWISs), are advantageous because the land above a SWIS may be used as green space or park land, and because they provide groundwater recharge. Subsurface infiltration systems are well suited for treatment of small wastewater flows. Small SWISs, commonly called *septic tank systems*, are traditionally used in unsewered

areas by individual residences, commercial establishments, mobile home parks, and campgrounds. Since the late 1970s, larger SWISs have been increasingly used by clusters of homes and small communities where wastewater flows are less than 25,000 gpd. They are a proven technology, but require specific site conditions to be successfully implemented. SWISs are often preferred over on-site mechanical treatment facilities because they provide better performance with less maintenance requirements, lower costs, and less visual impact on the community.

DESIGN CRITERIA

Pretreatment of Commercial Septic Tanks

The most serious problem encountered with commercial septic systems has been the clogging and grease due to poor maintenance. Suspended material is more of a problem where a disposal field is to be used to dispose of septic tank effluent without further treatment. Recognizing that poor septic tank maintenance is common, some regulatory agencies require the addition of a large septic or other solids separation unit before collected septic tank effluent can be disposed of in subsurface disposal fields. The use of oil and grease traps reduces the

discharge of TSS and oil and grease significantly. The presence of oil and grease in effluents from septic tanks servicing restaurants has led to the failure of downstream treatment processes such as intermittent and recirculating sand filters. As a consequence of these problems, pretreatment is recommended.

In centralized treatment plants, coarse screening, grit removal, oil and grease separation, equalization, and TSS

Oil and Grease Removal

Restaurants, laundromats, and other commercial establishments may discharge large amounts of oils and greases to the soil when they enter a septic tank. Oils and greases tend to accumulate on the soil surface in a soil absorption system, exceeding its capacity. Oils and greases are particularly troublesome because of their persistence and low rate of biodegradation. To avoid problems in decentralized wastewater treatment and disposal systems, the effluent oil and grease concentration should be reduced to less than about 30 mg/L before it is introduced to the soil absorption system (Crites and Tchobanoglous 1998).

The problems associated with the removal of oils and greases become more complex with

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

Close this window and click "Add to cart" on the product page.