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Wastewater Treatment by Peat Filters

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This is the fifth in a series of articles on alternative wastewater treatment systems in Minnesota. Portions of this article were taken from Volume 10, Number 1, Winter 1996 issue of Small Flows, a publication of the National Small Flows Clearinghouse.

Peat is defined as the organic remains of plants that have accumulated in places where decay has been retarded by excessively wet conditions. It takes approximately 100 to 500 years to produce 12 inches of peat, depending on the plant species and environmental conditions. The three most common types of peat are, moss peat (i.e. *Sphagnum*), reed-sedge peat, and peat humus. It is estimated that Minnesota contains roughly 7.5 million acres of peatlands, and only 2,000 acres are used to harvest peat, largely for horticultural peat.

The use of peat for filtering wastewater was first used in Virginia, Minnesota in the 1970's at a USDA Forest Service campground in the Chippewa National Forest. The use of a peat over sand filter to treat secondary effluent at the USDA Forest Service campground has operated successfully for over 20 years. In Maine, peat filters systems were developed in the 1980's and have been an approved system during the last few years. Peat filters housed in containers or modules were also developed in the 1980's by two companies, an Irish peat company and a Canadian peat company.

Figure 1. Aerial view of the peat filters at the NERCC research/demonstration site.

More recently, peat filters are being tested in Minnesota at a test site near Duluth (Figure 1) at the Northeast Regional Correction Center (NERCC) as part of a statewide initiative to test alternative treatment systems. At NERCC, in-ground peat filters were constructed in 1995, while the

modular-type peat filters were installed in 1998.

Peat Filter Characteristics

A typical peat filter system uses either a lined excavation or a pre-fabricated container, an under-drain system composed of a few inches of gravel, 24-36 inches of peat, distribution piping (the distribution network) that delivers wastewater to the peat filter, and additional peat to cover and insulate the filter. The peat used in the filter can differ in composition from air-dried Sphagnum moss to coarse peat screenings with cotton grass (*eriophorum*), or varying mixtures of the two. It should however be noted, that a certain mix of cotton grass/Sphagnum is protected by patents in this field, in which the Irish company Bord Na Móna is the sole proprietor.

Wastewater is dosed to the distribution network in the peat filter by a pump located in a tank that is regulated by a timer. This network is designed to distribute the wastewater by either gravity or by pressure distribution. The distribution network is installed near the top of the peat media, which evenly disperses effluent near the top of the filter at timed intervals, for example, once every 2 hours. The distribution system is covered with an additional 6-12 inches of peat to control odor and to insulate the system during the winter months.

Figure 2. Construction of an in-ground single-pass peat filter at NERCC.

As the septic tank effluent leaves the distribution system, it percolates by gravity down through the peat medium, which provides a home to a variety of microorganisms that decompose the wastewater. The wastewater is also wicked laterally, thereby utilizing a much larger surface area. Physical characteristics of the peat, such as its large surface area, high water holding capacity, and high porosity are unique to peat, and are what make it an excellent medium for treatment.

Peat filters treat the wastewater through a combination of physical, chemical and biological interactions within the peat media. In order for the treatment process to be successful, oxygen must be present in the peat filter, as is the case with other treatment systems. The physical treatment processes consist of filtration and absorption, while chemical interactions occur by

adsorption and ion exchange. Biological treatment processes consist of a large numbers of different organisms that use the wastewater as a source of food and energy. The peat itself provides an excellent environment for many different kinds of aerobic (require oxygen) and anaerobic (do not require oxygen) bacteria. In addition, high numbers of fungal organisms and higher life forms (protozoa, rotifers, insects, annelid worms) have been found within the media.

Figure 3. Placement of the pressure distribution network in a peat filter at NERCC.

Figure 4. A view of two identical in-ground peat filters each sized for a single family home at NERCC.

Containerized Peat Filters

Difficult site situations, including limited area, shallow ground water, high bedrock, and poor soils (i.e. clay) often pose a challenge when it comes to wastewater treatment. The versatility of containerized peat filters may offer a solution to these problems in some locations. Containerized peat filters come in the form of pre-cast polyethylene modules that can be placed above ground or at varying depths below the surface. These units come partially or fully assembled, and are installed and hooked-up by qualified and licensed contractors. Other than slight variations in their peat media and method of distribution, essentially they work in the same way.

Figure 5. An aboveground view of modular peat filters showing the distribution network, peat over the network, and the cover being placed over the module.

The containers for the peat filters can be completely enclosed or have perforated bottoms. Units that are enclosed at the bottom have an under-drain system (as described above), and require the construction of a separate subsurface water dispersal system, which could include shallow trenches, drip irrigation, at-grade system, or modified mound. Containers with perforated/flow-through bottoms are typically set on a gravel bed of varying thickness, depending on the soil characteristics at the site. The peat filter effluent exits the container and is then dispersed in the soils below the unit. Use of this second type of container is entirely dependent on adequate soils/soil depths under the peat filter and local health department approval.

The companies that manufacture and sell containerized peat filters generally require a maintenance agreement. Although these systems require minimal maintenance, they must be periodically checked. This maintenance agreement may be performed directly by the company or indirectly through a licensed qualified contractor, and may include a variety of services including routine maintenance, performance evaluations, and peat media replacement after so many years of operation.

Re-circulating Peat Filters

Peat filters can be operated as either a single-pass peat filter or as a re-circulating peat filter, similar to the technology developed for sand filters. The overall performance of peat filters has been well documented by numerous studies, which have shown that peat filters perform an excellent job at removing organic matter (Biochemical Oxygen Demand or BOD), solids (total suspended solids or TSS), and pathogens (using the indicator organisms fecal Coliform bacteria).

Substantial amounts of nutrients can be removed from wastewater using peat filters. However, nitrogen removal can be enhanced by re-circulating effluent back from the peat filter to mix with septic tank effluent. To re-circulate a system, a tank is needed for the mixing of septic tank effluent and the peat filter effluent. Wastewater from the septic tank flows by gravity to the re-circulation

tank. Wastewater from this tank is time-dosed to the peat filter. The wastewater moves slowly through the peat, and the treated effluent exits the bottom of the peat filter, where the flow is split using a simple device called a flow-splitter. A portion of the effluent is directed back to the re-circulation tank where it mixes with septic tank effluent, and is dosed onto the peat filter again. The remaining effluent by-passes the re-circulation tank and goes directly to the soil for final treatment and dispersal.

Performance in Minnesota

The in-ground, single-pass peat filters have been operating at NERCC since January 1996. In the summer of 1997, the gravity distribution network and gravel were replaced with a pressure distribution network and coarse peat after hydraulic problems occurred. Despite this setback, the performance of the peat filters has been consistently good in the removal of organic matter or BOD (>90% removal), total suspended solids (>90% removal), and fecal Coliform bacteria (>99.99% removal). They also performed moderately well in removing nutrients, including phosphorus (23-61% removal), and total nitrogen (22-67% removal). Because peat is such a good insulating material, there have been no problems with freezing of the units during the first three winters of use.

Two containerized peat filters were installed at NERCC in June 1998. One of the systems is operated with a proprietary Irish peat used by the company, while the second system uses a Bord Na Móna specified propriety Minnesota peat. The systems can be used as either a re-circulating peat filter or a single-pass peat filter. Test data from the first nine months, operating as a re-circulating peat filter, indicate the filters are performing well, using both the Irish peat and the Minnesota peat.

Figure 6. Two sets of modular peat filters (each set sized for a 3-bedroom home) testing the Irish peat in one set of modulesand a Minnesota peat in the other modules.

Operation and Maintenance

Although most peat filters require minimal maintenance, a qualified professional must perform this service. Routine maintenance typically includes flow monitoring, septic tank pumping, and cleaning effluent screens in septic tanks. It is recommended that pressure distribution networks may need to be flushed periodically. Electrical components, such as pumps and timers, need to be checked and serviced according to manufacturer recommendations. All septic systems, including those that use peat filters, need to be maintained on a regular basis to function properly.

Figure 7. Routine maintenance of peat filter systems is needed to ensure that they are working properly and to prevent pre-mature failure of the system.

The containerized peat filters may be sold with a maintenance agreement, and could include regular scheduled maintenance performed by the company or a certified licensed contractor. Maintenance agreements are different depending on the manufacturer. Manufacturers of containerized filters recommend that the peat media may need to be replaced with fresh peat every 8-15 years, depending on use.

Peat Filter Cost

Exact costs for peat filter construction, operation and maintenance depend on site conditions, filter design, water use, and local costs for materials, trucking and labor. The cost for a septic tank, pump tank and controls, and a system to disperse peat filter effluent into the natural soil, need to be factored in when evaluating the overall cost of a system. Depending on geographical location, the cost of constructing a peat filter may be more or less economical than a mound or sand filter, due to the costs and trucking of the filtering media. A good contractor should be able to lay out possible options with approximate costs, when deciding which type of onsite wastewater treatment system is best for your particular needs.

Figure 8. A peat filter module coupled with an "at-grade" soil dispersal system is used to treat septic tank effluent and disperse it into the natural soil on this lakeshore lot.

Although not a lengthy history to date, peat is increasingly being used for alternative wastewater treatment purposes in North America. It only makes sense that because of the availability and abundance of peat in Minnesota, coupled with an excellent record of performance, that the popularity of peat filters will grow in the future.

For additional information about peat filters, you can contact the Minnesota Extension Service, the Natural Resources Research Institute-UMD at 800-234-0054, or the National Small Flows Clearinghouse at 800-624-8301.

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