



Recirculating Sand Filters

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What is a recirculating sand filter?

A recirculating sand filter (RSF) system is a modified version of the old-fashioned, single-pass open sand filter. It was designed to alleviate the odor problems associated with dosing partially treated wastewater over a sand filter. The noxious odors were eliminated through recirculation, which increases the oxygen content in the treated wastewater that is sprayed over the filter bed.

RSFs are a viable addition/alternative to conventional methods of treatment when soil conditions are not conducive to proper treatment/disposal of the wastewater through percolative beds/trenches. Sand filters can be

Historically, sand filter systems have been in use for more than a century. However, the RSF concept was introduced in the late 1960s and early 1970s by public health engineers from Illinois who were experimenting with sand filter designs. RSF systems commonly serve mobile home parks, rural schools, small municipalities, and other generators of small wastewater flows.

The three basic components of an RSF system are a septic tank(s) (or an aerobic unit), a recirculation tank, and an open sand filter. (See Figure 1.)

Wastewater first receives primary treatment in a septic tank or other pretreatment unit. The pretreated wastewater flows into a recirculation tank along with a portion of the wastewater that has already been through the sand filter. This dilutes the incoming wastewater from the pretreatment tank. A pump chamber conveys the wastewater mixture to the sand filter, where it is evenly distributed over the top of the filter bed made up of carefully graded media. As the wastewater flows through the sand filter, treatment is accomplished by the microorganisms attached to the filter media.

As the wastewater moves downward through the filter media,

it absorbs oxygen in the pore spaces between the media particles. This oxygen eliminates the odor associated with the wastewater. The treated wastewater is collected in underdrains at the bottom of the sand filter, and then a portion is discharged for further treatment or disposal, while another portion is recycled back into the recirculation tank.

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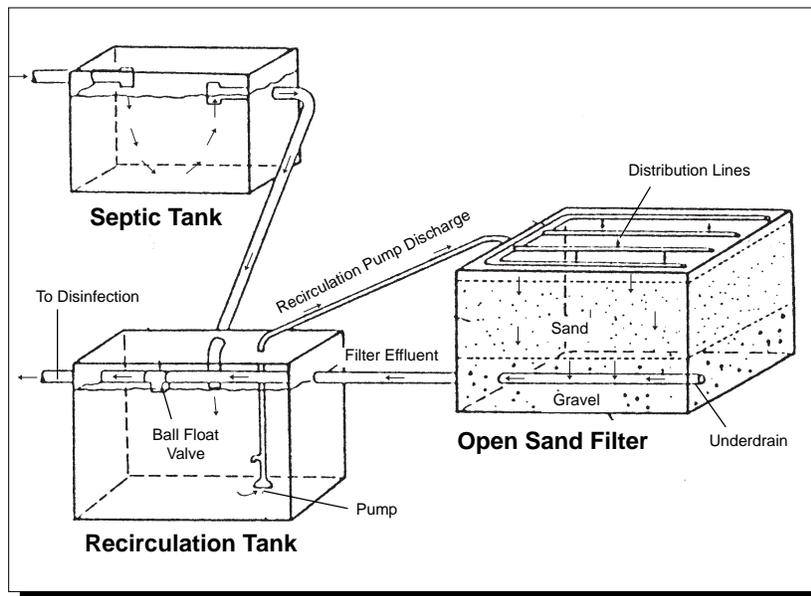


Figure 1: Typical Recirculating Sand Filter System

Adapted from: Hines and Favreau (1974) with permission

used on sites that have shallow soil cover, percolation rates that are too slow or too fast, or high groundwater. Because they require less land area than intermittent (single-pass) sand filters and do not require highly trained operators, RSFs are often used to treat wastewater collected from clustered residences and small communities.

This fact sheet was developed by Clement Solomon, Peter Casey, Colleen Mackne, and Andrew Lake.

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What are the advantages and disadvantages of using RSFs?

Advantages

- RSFs provide a very good effluent quality with over 95% removal of organic material and total suspended solids.
- The treatment capacity can be expanded through modular design.
- RSFs are effective in applications with high levels of organic content.
- RSFs are easily accessible for monitoring and do not require a lot of skill to maintain.
- A significant reduction in the nitrogen level is achieved.
- If sand is not feasible, other suitable media could be substituted that may be found locally.
- No chemicals are required.
- Less land area is required (1/5 of the land area of a single-pass sand filter) for RSFs than for single-pass sand filters.

Disadvantages

- If appropriate media are not available locally, costs could be higher.
- Weekly maintenance is required for the media, pumps, and controls.
- Design must address extremely cold temperatures.

What determines the performance of an RSF?

The performance of an RSF depends on how biodegradable the wastewater is, the design of the filter, and the environmental conditions within the filter.

Other factors that affect the performance of RSFs are the degree the wastewater was pretreated prior to going through the sand filter, the size and depth of the media, the hydraulic loading rate, and the method and frequency that the wastewater is “dosed” over the filter bed.

Sand filters remove contaminants in wastewater through physical, chemical, and biological processes. Although the physical and chemical processes play an important role in the removal of many particles, the biological processes play the most important role since bacteria thrive in sand filters.

Are RSFs easy to operate and maintain?

RSFs require routine maintenance, although the complexity of maintenance is generally minimal.

The surface of the sand bed should be kept weed free. Pumps and controls should be checked periodically, and the septic tank(s) should be checked for sludge and scum buildup and pumped as needed. The recirculation pump will eventually need to be replaced, and a duplicate recirculation pump should be available for backup.

What is the cost of an RSF?

The cost of RSFs depends on the labor, materials, site, capacity of the system, and characteristics of the wastewater. Operating costs are low. For example, capital costs typically range from \$3 to \$10 per treated gallon, and O&M for the RSF serving the community of Elkton, Oregon, (135 septic tanks), requires 25 to 30 hours per month and costs less than \$5,000. That includes \$780 for electricity.

One of the most significant factors that affects the cost of sand filters is media cost. Therefore, using locally available materials for the media is the most cost-effective option.

According to two RSF contractors/installers, the capital costs (land not included) for an RSF with black beauty sand media treating 5,000 gallons of wastewater per day (gpd) would cost about \$68,600, while an RSF treating 5,000 gpd and using sand media would cost approximately \$36,000. It should be noted, however, that these are typical costs, and actual costs will vary from site to site and among different designs.

How do I stay informed about RSF technology?

For more information on recirculating sand filters or a list of other fact sheets, contact the National Small Flows Clearinghouse (NSFC) at West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064. Phone: (800) 624-8301 or (304) 293-4191. Fax: (304) 293-3161. World Wide Web site: <http://www.nsfv.wvu.edu>.

The NSFC provides free and low-cost informational services and products to help homeowners and small communities address their wastewater needs. Also, information about manufacturers, consultants, regulations, and facilities can be obtained from the NSFC's databases.

References

- Anderson, D. L.; R. L. Siegrist; and R. J. Otis. 1985. “Technology Assessment of Intermittent Sand Filters.” U.S. Environmental Protection Agency (EPA). Municipal Environmental Research Laboratory. Cincinnati, Ohio.
- Ball, J. L. and G. D. Denn. 1997. “Design of Recirculating Sand Filters Using a Standardized Methodology.” Site Characterization and Design of Onsite Septic Systems. American Society for Testing Materials. Fredericksburg, Virginia
- Crites, R. and G. Tchobanoglous. 1998. *Small and Decentralized Wastewater Management Systems*. The McGraw-Hill Companies. New York, New York.
- Hines, M. and R. E. Favreau. Dec. 9–10, 1974. “Recirculating Sand Filter: An Alternative to Traditional Sewage Absorption Systems.” Proceedings of the National Home Sewage Disposal Symposium. pp. 130–136. Chicago, Illinois.
- Hines, M. Sept. 29–Oct. 1, 1975. “The Recirculating Sand Filter: A New Answer for an Old Problem.” Proceedings of the Illinois Private Sewage Disposal Symposium. pp. 68–78. Champaign, Illinois.
- Martin, E. J. and E. T. Martin. 1991. *Technologies for Small Water and Wastewater Systems*. Environmental Engineering Series. pp. 285–291. Van Nostrand Reinhold (acquired by John Wiley & Sons, Inc.). New York, New York.
- U.S. Environmental Protection Agency. 1980. *Design Manual: Onsite Wastewater Treatment and Disposal Systems*. EPA Office of Water. EPA Office of Research & Development. Cincinnati, Ohio. EPA 625/1-80-012.

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