ETI - Environmental Technology Initiative
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What is a trickling filter?

A trickling filter (TF) is a wastewater treatment system that biodegrades organic matter and can also be used to achieve nitrification. The wastewater trickles through a circular bed of coarse stones or plastic material. A rotating distributor (a rotating pipe with several holes across it) evenly distributes the wastewater from above the bed. The microorganisms in the wastewater attach themselves to the bed (also known as the filter media), which is covered with bacteria. The bacteria break down the organic waste and remove pollutants from the wastewater.

When excess nutrients became a concern, it became necessary to adapt "conventional" sewage treatment systems to meet the increased oxygen demand placed on receiving waters by high ammonia nitrogen concentrations in wastewater effluents. TFs and other attached-growth processes proved to be well-suited for the removal of ammonia nitrogen by oxidizing it to nitrate nitrogen (nitrification).

What is nitrification?

Nitrogen exists in many forms in the environment and can enter aquatic systems from either natural or human-generated sources. Some of the primary direct sources or transport mechanisms of nitrogen from sewage are listed below:

- Untreated sewage-direct discharge
- Publically owned treatment works (POTW) effluent-direct discharge, land application
- POTW waste solids-direct discharge, land application
- Septic tanks and leach fields-ground-water movement

Nitrification/denitrification is the process of converting nitrogen into a form in which it can ultimately be removed. In the first step of this process, influent ammonia nitrogen is oxidized to nitrate nitrogen. At this point, the nitrogen has merely changed forms and has not yet been removed from the wastewater. In the second step, denitrification, nitrate nitrogen is converted into nitrogen gas that vents to the atmosphere naturally.

The two general types of TF nitrification configurations are single-stage and two- (or separate-) stage.

- *Single-stage:* Carbon oxidation and nitrification take place in a single TF unit.
- *Two- (separate-) stage:* Reduction of organic material occurs in the first treatment stage, and nitrification occurs in the second stage.

Although numerous types and combinations of treatment units exist, in general, a single-stage TF has to remove organic material in the upper portion of the unit and provide nitrifying bacteria for nitrification in the lower part.
Since the influent is necessarily of high organic strength (i.e., receiving primary treatment only), it has to be applied at a rate low enough to achieve both organic removal and nitrification sufficient for required effluent quality. A two-stage system allows for greater process flexibility since each stage can be operated independently and the flow regime can be varied to achieve the best results.

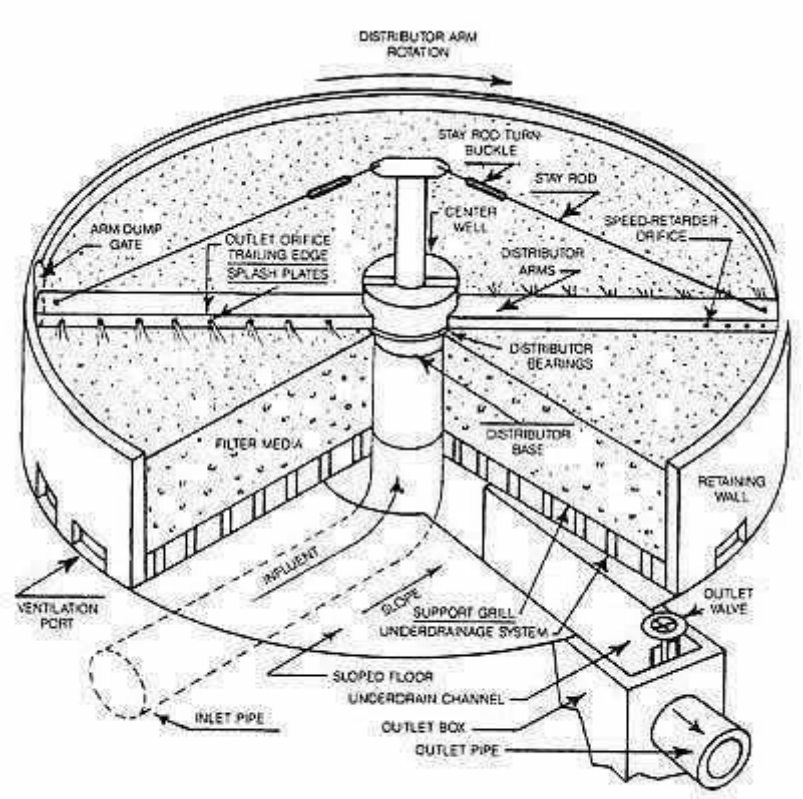

Figure 1: Schematic of a Trickling Filter

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What are the advantages and disadvantages of using TFs?

Advantages

- Simple, reliable process that is suitable in areas where large tracts of land are not available for a treatment system
- May qualify for equivalent secondary discharge standards
- Effective in treating high concentrations of organic material depending on the type of media used
- Appropriate for small- to medium-sized communities and onsite systems
- High degree of performance reliability
- Ability to handle and recover from shock loads
- Durability of process elements
- Relatively low power requirements
- Level of skill and technical expertise needed to manage and operate the system is moderate

Disadvantages

- Additional treatment may be needed to meet strict discharge standards
- Generates sludge that must be treated and disposed of
- Regular operator attention needed
- Relatively high incidence of clogging
- Relatively low loadings required depending on the media
- Limited flexibility and control in comparison with activated sludge processes
- Potential for vector and odor problems

What determines the performance of a TF?

The nitrification process is sensitive to how much oxygen is available, the level of organic loading, ammonia nitrogen concentration, media type and configuration, hydraulics of the TF, temperature, and pH.

Are TFs easy to operate and maintain?

Although TFs are generally trouble-free processes, there is still potential for operational problems. Common operating problems can be caused by increased growth of biofilm (sludge buildup), changes in wastewater characteristics, improper design, or equipment failures.
Listed below are some common problems that occur in TFs followed by possible causes:

- *Disagreeable odors from filter:* Too much organic load that causes insufficient oxygen for bacteria to thrive on; not enough ventilation
- *Ponding on filter media:* Excessive biological growth
- *Filter flies:* Not enough moisture on filter media; poor housekeeping
- *Icing:* Low wastewater temperature
- *Rotating distributor slows down or stops:* Not enough wastewater flow to cause the distributor to turn; clogged arms or orifices; clogged distributor arm vent pipe; distributor arms not level; distributor rods hitting media

All of the equipment must be tested and calibrated according to manufacturer's instructions. A routine operation and maintenance schedule should be developed and followed for any TF system. It is also important for a TF to be pilot tested before installation to ensure that it will meet the site's permit requirements for discharged wastewater.

How do I stay informed about TF technology?

For more information on TFs 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.nsfc.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.

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