

Aerobic Treatment Unit

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An aerobic treatment unit (ATU) pretreats wastewater by adding air to break down organic matter, reduce pathogens, and transform nutrients. Compared to conventional septic tanks, ATUs break down organic matter more efficiently, achieve quicker decomposition of organic solids, and reduce the concentration of pathogens in the wastewater.

More than 20 brands of ATUs are available, but efficiency varies widely. A properly operating ATU should produce high-quality effluent with less than 30 mg/liter BOD (biochemical oxygen demand, a measure of the organic matter), 25 mg/liter TSS (total suspended solids), and 10,000 cfu/100mL fecal coliform bacteria, an indicator of pathogens and viruses.

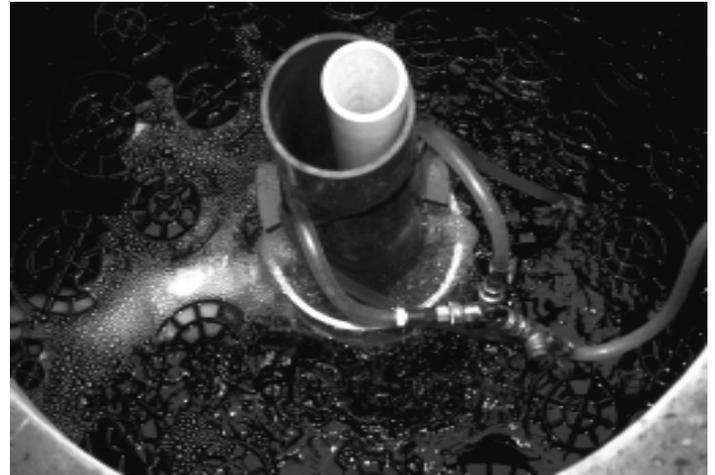


Figure 1. Aeration in an ATU breaks down organic matter.

Aerobic Treatment Application

Since wastewater leaves an ATU as high-quality effluent, the soil in the trench or mound soil treatment system may be better able to accept it, and the system should last longer. Because ATUs produce cleaner wastewater, they are useful in sites with “disturbed” (compacted, cut, or filled) soil, and in environmentally sensitive areas such as those near lakes in shallow bedrock areas, aquifer recharge areas, and wellhead protection areas. Pretreatment may allow a reduction in the three-foot separation requirement between the soil treatment system and the limiting soil layer. Researchers are testing this hypothesis.

ATU systems may also be successfully retrofitted into drainfields that have failed because of excessive organic loading from lack of maintenance.

How Do Aerobic Treatment Units Work?

By bubbling compressed air through liquid effluent in a tank, ATUs create a highly oxygenated (aerobic) environment for bacteria, which uses the organic matter as an energy source. In another stage bacteria and solids settle out of the wastewater and the cleaner effluent is distributed to a soil treatment system.

ATUs are more complicated than septic tanks. In a septic tank, solids are constantly separating from liquid. As individual bacterial cells grow, they sink to the bottom, along with less decomposed solids, to form a layer of sludge. Floating materials, such as fats and toilet paper, form a scum layer at the top of the tank.

IN PARTNERSHIP ...

In an ATU, the bubbler agitates the water so solids cannot settle out, and floating materials stay mixed in the liquid. Well-designed ATUs allow time and space for settling, while providing oxygen to the bacteria and mixing the bacteria and its food source (sewage). Any settled bacteria must be returned to the aerobic portion of the tank for mixing and treatment.

There are three basic ATU operation styles: suspended growth, fixed-film reactor, and sequencing batch reactor. All three types usually have a septic tank (sometimes called a trash tank) ahead of them that removes the large solids and provides some protection to the ATU.

A **suspended-growth tank** has a main treatment chamber where bacteria are free-floating and air is bubbled through the liquid. The second chamber where the solids settle out is separated from the main tank by a wall or baffle. The two chambers are connected at the bottom or by a pump, and settled bacteria from the second chamber are brought back into the main treatment chamber. This return and mixing is critical for proper operation. Treated effluent from the second chamber is piped to the soil treatment system (Figure 2). Though simple, the system is likely to have problems with bulking (the formation of chains or colonies of bacteria that don't settle or sink to the bottom as they should). Bulking is caused by changes in wastewater strength or quantity. When too much water/wastewater is added to the system, the bacteria can run out of food or become overloaded. Bulked bacteria remain suspended in the liquid and can clog the outflow.

A **fixed-film reactor** has bacteria growing on a specific surface medium and air is provided to that part of the tank. The bacteria can grow on any surface including fabric, plastic, styrofoam, and gravel. Decomposition is limited to this area, and settling occurs in a second chamber. This design is expensive, but the effluent is of consistently high quality, and bulking is uncommon. There is no need for a return mechanism because the bacteria stay on the film (Figure 3).

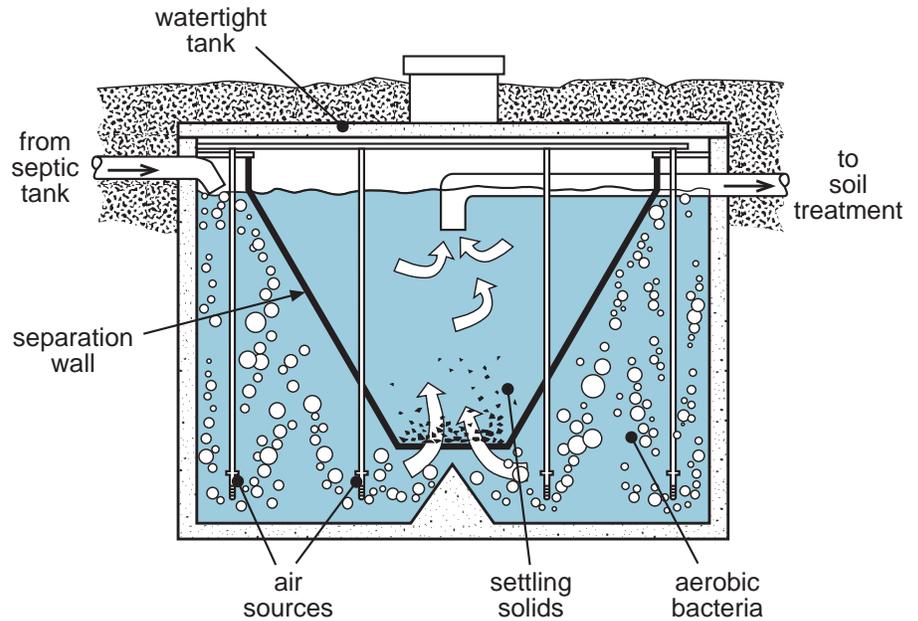


Figure 2. Suspended-growth ATU

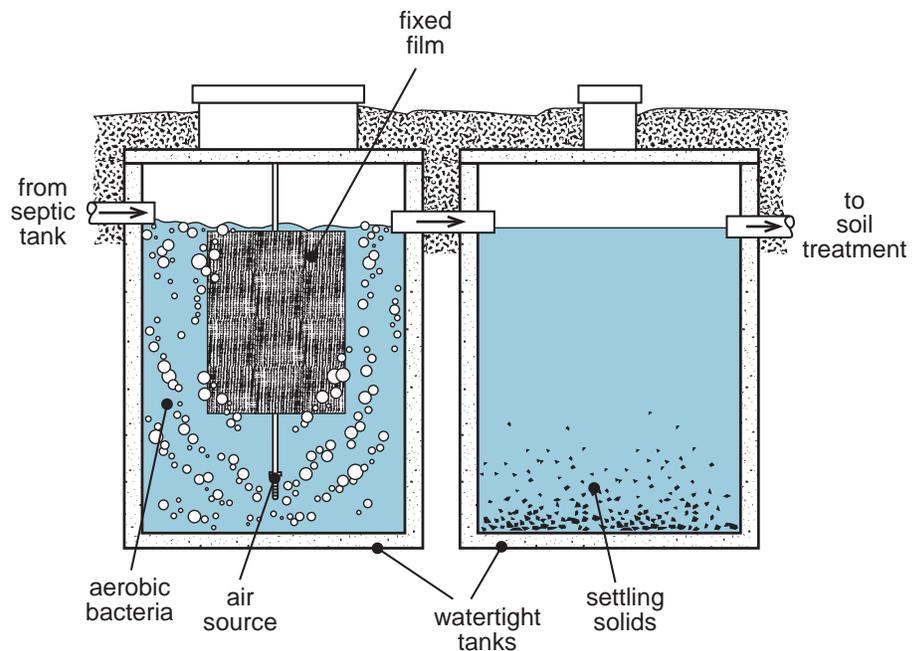


Figure 3. Fixed-film reactor ATU

In a *sequencing batch reactor*, aerobic decomposition, settling, and return occur in the same chamber. Air is bubbled through the liquid during the decomposition cycle. The bubbler shuts off, and the wastewater goes through a settling cycle (Figure 4). Once the bubbler turns back on, the tank reenters the decomposition cycle, and settled bacteria mixes back into the aerobic environment. After settling of bacteria and solids, the treated effluent is discharged to the soil treatment system. Bacteria settle out more consistently in this kind of tank, but since it has more moving parts and requires a controller, it has more potential for mechanical and electrical failure.

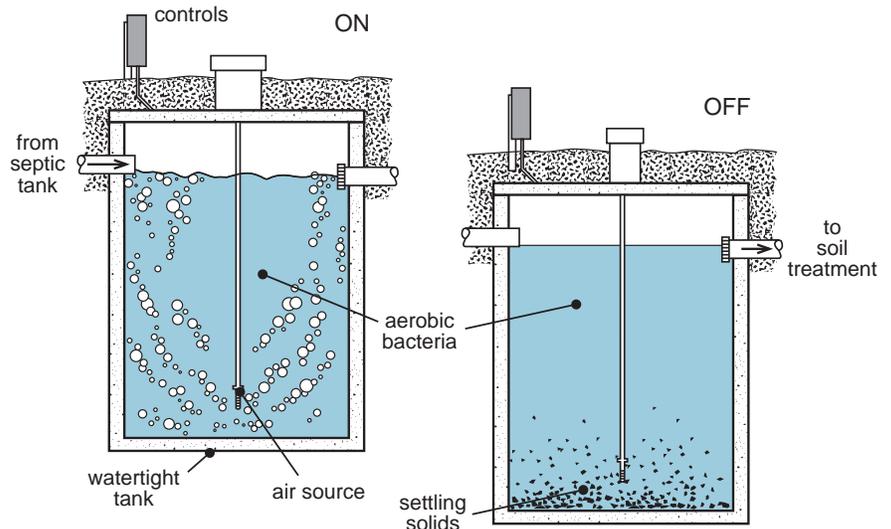


Figure 4. Sequencing batch reactor ATU

Placement

ATUs require very little installation space, which allows placement flexibility. A typical ATU space requirement is 25 square feet for a 3-bedroom home. Most ATUs are located after a septic tank. However, because of strict permitting requirements this is not practical for onsite systems.

Designing Aerobic Treatment Units

When sizing an ATU, consider the amount of water generated by the home, the addition of oxygen, the concentration of organic matter in the wastewater, and the settling characteristics of the chosen system. Proper design of these systems depends on the waste strength. Siting and construction considerations are the same as those for typical onsite treatment systems.

Final Disposal of Wastewater

Some ATUs produce the same high-quality effluent as large wastewater treatment plants that discharge to surface water. Therefore, in an onsite system, effluent is sent to a soil treatment system for final treatment. Options for a soil treatment system include trenches, mounds, and drip distribution.

Pressure distribution (rather than gravity) to the soil system is necessary, since the effluent from ATUs contains very little organic matter. The effluent is so “clean,” a biomat layer does not form the way it does in a soil treatment system receiving effluent from septic tanks. A pressure distribution network is needed to apply effluent evenly throughout the system. Figure 5 shows an ATU using pressurized trenches for final treatment.

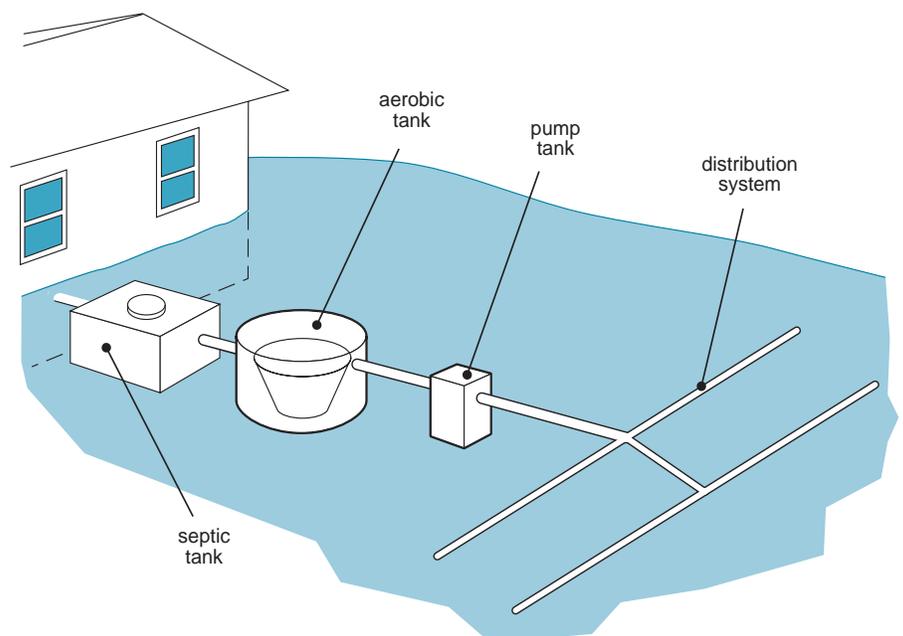


Figure 5. ATU using pressure distribution trenches for final treatment

System Classification

The soil treatment system may last longer when receiving effluent from an aerobic tank than it would receiving effluent from a septic tank, since ATUs remove more solid matter from the wastewater. It may be possible to make the soil treatment systems somewhat smaller than those used for conventionally pretreated effluent. It also may be possible to reduce the vertical separation to the seasonally high water table or bedrock. Changes to size or vertical separation would put these systems into the “performance” classification, requiring local approval and an operating permit. An operating permit requires a monitoring and mitigation plan and the installation of a flow meter.

Operation and Maintenance

All routine operation and maintenance practices suggested for any onsite treatment system apply to ATUs. (See *Septic System Owner's Guide*, PC-06583, for details.)

ATUs are more maintenance intensive than septic tanks. A maintenance contract is strongly recommended and required for standard use according to Minnesota Rules Chapter 7080. Depending on the local governmental unit requirements and the recommendations of the manufacturer, the system may require quarterly to yearly maintenance. Maintenance includes inspecting all components and cleaning and repairing the system when needed. A visual inspection of the effluent is required and often a lab analysis is necessary.

If problems arise with the supply of air to the bacteria, the tank loses all effectiveness. If there are problems with settling, which are more likely in these designs than in conventional tanks, there will be problems in the soil treatment system. These tanks must be monitored frequently and repaired as needed.

The costs to operate an ATU are based on the run-time of the compressor, and average less than ten dollars per month for an individual home. Overall operational costs of \$200–\$500 per year include pumping, repairs, maintenance, and electricity. Some homeowners notice the constant hum of the blower.

Summary

With proper design and a good maintenance program, the aerobic system should perform well and treat wastewater for a long time. ATUs have a small land requirement, but are highly mechanical and require more management than most onsite systems.

Visit our Web site at www.bae.umn.edu/septic/ for additional information.



Figure 6. Finished installation of an ATU in Minnesota

Funding provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative Commission on Minnesota Resources.

FO-07667-S
2001

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