WASTEWATER TREATMENT

BASIC SEPTIC TANK OPERATIONS, AERBOIC TREATMENT AND LAGOONS

KT Newman
Utility Contractors, LLC.

Target Audience

- Policy Makers
- Leaders and planners who may have a water quality agenda.

Course Objectives

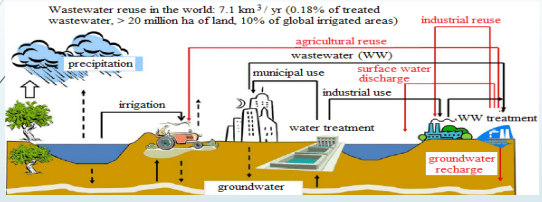
This presentation discusses the fundamentals of basic types of on-site wastewater treatment systems as well as facultative and aerated lagoons.

What is wastewater?

Wastewater can be defined as water that has constituents of human and /or animal metabolic wastes.

Water that has the residuals from cooking cleaning or bathing.

Hydrologic Cycle



Domestic Wastewater

Our focus is wastewater that comes from a home.

Wastewater Components

Wastewater by weight is 99.9% water, the remaining 0.1% that we must remove contains:

- Organic Matter
- Microorganisms
- Inorganic Compounds

Removing Components

The primary goal in wastewater treatment is to remove wastes out of the water. This is often a difficult task, but we have lots of help available to us.

- Gravity
- Sun
- Microorganisms
- Soil

Onsite Wastewater Treatment

Onsite wastewater treatment is a practice that involves collecting, treating, and disposing or reusing wastewater from individual or clustered sources at or near where it is generated.

Population density, the topography of the area, soil conditions and numerous other factors are involved in the construction and operation of a sewage collection system.

Increasing migration to suburban and rural areas make municipal sewers more difficult and costly to build and maintain.

Onsite treatment systems are often the most practical and cost-effective solution for wastewater treatment and disposal.

Onsite Wastewater Treatment

More than 1 in 5 households in the U.S. depend on individual septic systems to treat their wastewater. These systems are also referred to as decentralized systems or on-site wastewater systems.

Septic systems are underground wastewater treatment structures that use a combination of natural and technological processes to treat wastewater from household plumbing produced by bathrooms, showers, kitchen drains and laundry.

Onsite Wastewater Treatment

There are various types of onsite wastewater treatment systems. If a system is properly installed, sited and maintained it can protect public health, preserve valuable water resources, and maintain economic vitality in a community.

Conventional Septic Systems

A conventional septic system is a type of onsite sewage treatment and disposal system that is common for residential properties. It has a septic tank, which is a watertight container buried in the ground, and a drain field or leach field, which is a series of perforated pipes or chambers that release the wastewater into the soil.

The septic tank separates the wastewater into three layers: solids, liquids, and floatable matter. The liquid layer, or effluent, flows out of the tank and into the drain field, where it is further treated by the soil and microbes

Conventional septic systems may have different designs and materials, but they all function similarly. However, they may also pose environmental risks, such as nitrogen and pathogen pollution, especially if they are older or poorly maintained.

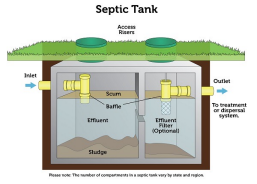
How does a conventional septic system work?

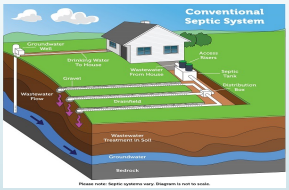
Solid and liquid waste enters through the same septic tank, with solid waste settling at the bottom and liquid waste staying at the top. Anaerobic microbes break down the waste and produce wastewater.

However, conventional septic systems only work when three factors are present:

- Permeable soil
- Unsaturated water tables near the drain field
- No restrictive bedrock

Conventional Septic Systems



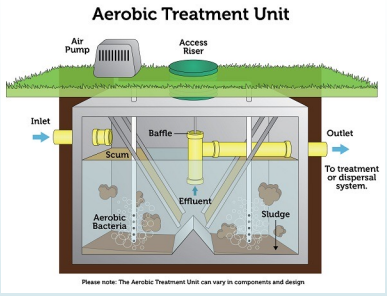


Aerobic Treatment Systems

Aerobic Treatment Systems use many of the same processes as a municipal sewage plant, but on a smaller scale. An aerobic system injects oxygen into the treatment tank. The additional oxygen increases natural bacterial activity within the system that then provides additional treatment for nutrients in the effluent.

Some aerobic systems may also have a pretreatment tank and a final treatment tank including disinfection to further reduce pathogen levels.

The benefits of this system are that it can be used in homes with smaller lots, inadequate soil conditions, in areas where the water table is too high, or for homes close to a surface water body sensitive to contamination by nutrients contained in wastewater effluent.



How does an aerobic septic system work?

Like conventional systems, solid and liquid waste enters the tank and settles into layers in Aerobic septic systems; however, they are more complex than conventional systems. A typical aerobic system consists of three components:

- A trash tank
- A pump tank
- A treatment plant

How does an aerobic septic system work?

Aerobic systems contain an aerator that circulates oxygen bubbles when the wastewater goes through the treatment plant.

The oxygen provides a stable environment, helping the waste break down faster and more effectively than in conventional systems.

The wastewater then travels through the pump tank to eliminate any pathogens, making it environmentally safe to drain.

Aerobic Septic System Benefits:

- Higher Quality Treatment
- Financial Savings
- Suitable for all types of land
- Longevity
- Durability
- Efficiency

Advantages of Aerobic Systems

Aerobic systems can often be paired with a smaller leaching field than a similar conventional septic system. This can substantially reduce the space required, which can be useful in lots where a large drainage field is unacceptable.

Aerobic systems generally produce cleaner effluent (the wastewater that is returned to nature after processing). This is useful in environmentally delicate locations, areas with high water tables and similar sensitive areas.

Aerobic bacteria typically break down household waste faster than anaerobic bacteria.

Disadvantages of Aerobic Systems

Despite these substantial benefits, aerobic systems are in generally limited use. Their main use is to replace failed septic systems. Here are a few of the substantial disadvantages:

- Their initial cost is often several times that of a conventional septic system.
- Since these systems use electric pumps to circulate air through the sewage, the site must have electricity, and the owner must bear the ongoing cost of electric usage.
- These are substantially more complicated systems than traditional gravity-powered systems, and as such, their ongoing maintenance costs are higher.

Frequent questions on both conventional and aerobic septic systems

- Where should septic tanks be placed?
- Who is responsible for maintaining septic systems?
- How often should my septic tank be pumped?
- How can I prevent a septic system failure?

Lagoon Systems

Many small, rural, and tribal communities across the United States rely on lagoon systems to treat their municipal wastewater.

Lagoons are pond-like bodies of water or basins designed to receive, hold, and treat wastewater for a predetermined period.

In the lagoon, wastewater is treated through a combination of physical, biological, and chemical processes.

What happens in the lagoon?

Evaporation reduces the liquid volume of wastewater, returning water vapor to the environment. Solids settle to bottom and form sludge.

There is an aerobic zone at the top of the wastewater layer where air movement introduces oxygen and aerobic microorganisms convert waste to:

- carbon dioxide
- ammonia
- phosphates

What happens in the lagoon?

Algae in the lagoon use these as a food source and give off oxygen.

There is an anaerobic zone near the bottom of the wastewater layer where anaerobic microorganisms break down waste producing:

- hydrogen sulfide
- ammonia
- methane

Anaerobic Lagoons

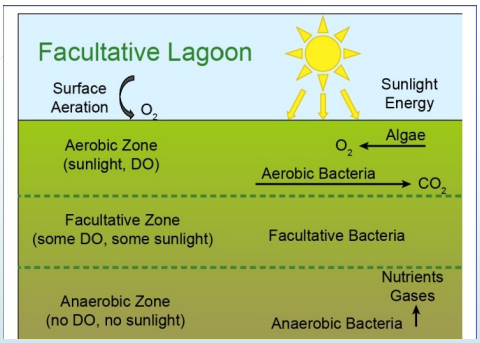
The wastewater is not aerated, the lagoon may function in an anaerobic mode in which organic matter is fermented to simple organic acids and eventually converted to methane.

Facultative Lagoons

Facultative lagoons may be actively aerated or simply have oxygen diffusing from the air into the surface water. Ideally, there are both aerobic and anaerobic bacteria present, active and contributing to the removal of contaminants.

Often, an anaerobic bottom water layer and sediment provide the anaerobic environment for the same processes as the anaerobic lagoon, but aerobic bacteria present in upper water layers can perform additional metabolic processes such as nitrification (oxidation of ammonia to nitrite and nitrate) and more efficient COD removal. Volatile acids are converted to carbon dioxide and water and hydrogen sulfide can be oxidized to elemental sulfur or sulfate compounds.

Nitrite and nitrate formed in the aerobic zone can be reduced to nitrogen gas in the anaerobic zone thus removing some of the dissolved nitrogen. Given enough residence time, wastewater can be cleaned with 90 percent COD removal.



Aerated Lagoons

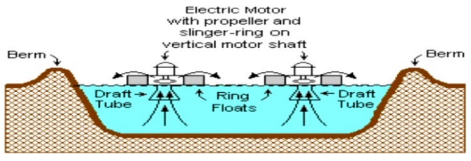
Lagoons are frequently aerated with surface aerators that mix a zone around the aerator as well as increase the dissolved oxygen. Such lagoons are rarely completely mixed or maintain significant dissolved oxygen in 100 percent of the water volume so there are anaerobic processes occurring in the sediment on the bottom and in "dead zones" not thoroughly mixed or aerated.

Aerated lagoons are quite efficient at COD removal and nitrification. Aerobic bacteria produce more biomass than anaerobic bacteria per COD removed so there is more biomass that accumulates if there is a settling zone or if the biomass is removed in a clarifier there is more biomass to be wasted.

If a clarifier is used, bacteria can be recycled to the aerated zone and the lagoon will operate as an activated sludge system with a higher bacteria concentration and thus a smaller required lagoon to achieve the effluent goals.

Methods of Aerating Lagoons

- Motor-driven submerged or floating jet aerators.
- Motor-driven floating surface aerators
- Motor-driven fixed-in-place surface aerators • Injection of compressed air through submerged diffusers.



A TYPICAL SURFACE – AERATED BASIN

Note: The ring floats are tethered to posts on the berms.

Wastewater Disinfection

The impact of untreated domestic wastewater on community reservoirs has raised several health and safety concerns.

The organisms of concern in domestic wastewater include enteric bacteria, viruses, and protozoan cysts. Table 1 summarizes the most common microorganisms found in domestic wastewater and the types of human diseases associated with them.

In response to these concerns, disinfection has become one of the primary mechanisms for the inactivation/destruction of pathogenic organisms. For disinfection to be effective wastewater must be adequately treated.

Wastewater Disinfection

One method that's used to treat wastewater is chlorination, which is known to be particularly effective at removing viruses, protozoa, and bacteria from the wastewater.

Even though chlorination is widely used for its ability to get rid of most pathogenic organisms more effectively than other treatment methods, it can also remove most other contaminants that are found in water.

Chlorination can be important during wastewater treatment if you want to eliminate the pathogenic organisms that can cause waterborne illnesses.

Advantages of Chlorination

Chlorination is a well-established technology.

The chlorine residual that remains in the wastewater effluent can prolong disinfection even after initial treatment and can be measured to evaluate the effectiveness.

Advantages of Chlorination

Chlorine can eliminate certain noxious odors during disinfection

Chlorine disinfection is reliable and effective against a wide spectrum of pathogenic organisms.

Chlorine is effective in oxidizing certain organic and inorganic compounds.

Chlorination has flexible dosing control.

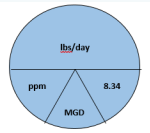
Disadvantages of Chlorination

The chlorine residual, even at low concentrations, is toxic to aquatic life and may require dechlorination.

All forms of chlorine are highly corrosive and toxic. Thus, storage, shipping, and handling pose a risk, requiring increased safety regulations.

Wastewater Calculation

If a treatment plant discharges 150,000 gpd with a chlorine residual of 0.1 mg/l, how many pounds per day of chlorine will the receiving waters receive?



- lbs/day = 0.1 mg/l x 0.150 mgd x 8.34 = 0.1251

Wastewater Calculation

What is the approximate volume of a rectangular septic tank with the following measurements? 72" wide, 96" long, and 84" deep.

72"/12" = 6ft wide
96"/12" = 8ft long
84"/12" = 7 ft deep

- Volume = L' x W' x H'
- Volume = 8' x 6' x 7'
- Volume = 336 cf
- Volume = 336 cf x 7.5 = 2520 gallons

CONCLUSION