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Onsite wastewater treatment systems

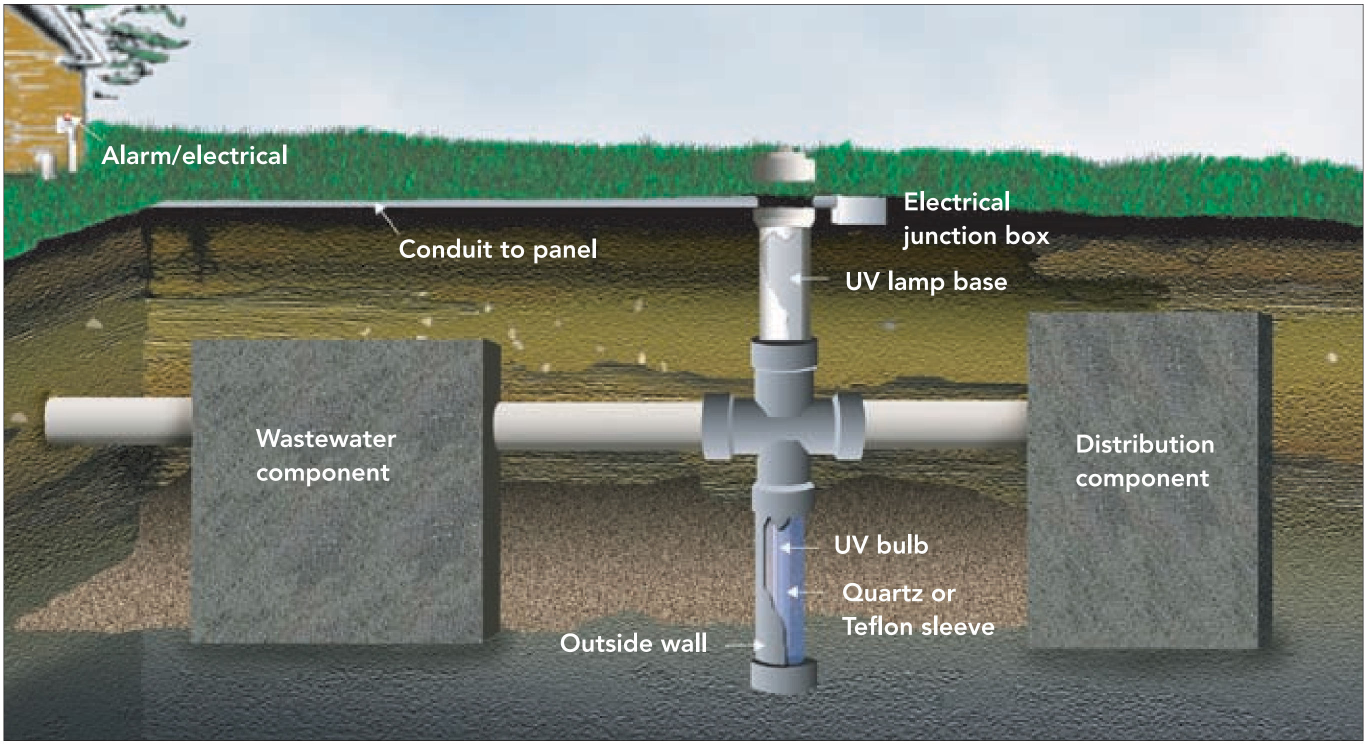

Figure 1: Possible configuration of an onsite wastewater treatment system using UV disinfection.

Ultraviolet light disinfection

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Some onsite wastewater treatment systems include a disinfection process in the pretreatment component. Disinfection is required when there is a risk that people may come in contact with the effluent or when the soil into which it is distributed will not disinfect the effluent. In water reuse systems where the effluent is sprayed on the ground surface, there must be a disinfection component. Disinfection is the destruction or inactivation of disease-causing organisms. Homeowners can disinfect wastewater with tablet or liquid chlorine or with ultraviolet light.

For more information on tablet or liquid chlorination, please see Extension publications L-5344, *Tablet Chlorination*, or L-5460, *Liquid Chlorination*.

The ultraviolet light disinfection process

Before the disinfection process, wastewater leaves the home and passes through an advanced pretreatment system such as an aerobic treatment unit, sand filter, or media filter. These advanced pretreatment systems remove most of the organic matter and suspended solids from the wastewater and facilitate the disinfection process. Because ultraviolet light systems are highly sensitive to the total suspended solids (TSS) in the waste stream, pretreatment should remove most of the TSS. If the water is so turbid that UV light can not reach the organisms in the wastewater stream, the wastewater will not be disinfected properly.

The configuration of the UV lamp is as important as its location in the treatment train. The distance the UV light has to travel affects treatment. It is also important to have a very thin flow of effluent across the UV bulb. This can be accomplished with a straight tube to direct the effluent along the tube, or by looping the tube around the bulb to increase the contact time.

The lamp can be located in the ground between associated treatment components, in an insulated outdoor structure, or in a heated space within the structure served. The lamp must be protected from dust, excessive heat, freezing, and vandals. In extremely cold climates, the UV system can be housed inside the home with minimal danger to the inhabitants. There should be adequate ventilation to keep the ballast from overheating, which shortens the unit's life and can even cause a fire.

A UV disinfection system can be gravity or pressure dosed. Pressure dosing can ensure that a constant, thin film of wastewater passes over the lamp. Gravity dosing systems need a moderated flow to equalize the sporadic dosing and ensure proper contact time.

The disinfected effluent collects in the pump tank, which serves as a reservoir for the wastewater until it is distributed into the soil. The effluent is distributed periodically to the soil using a final treatment and dispersal component such as a spray distribution system, which resembles a lawn irrigation system. The frequency of distribution is based upon the system design, which can specify a demand-dosed system or timer-controlled system. A demand-dosed system distributes effluent any time a specific volume has collected in the pump tank.

System components

Pretreated effluent passes through the ultraviolet light component. UV light is typically generated by lamps and shines through quartz glass or Teflon-coated tubes (sleeves) into the water.

Ultraviolet light has a wavelength of about 40 nm to 400 nm. It is germicidal in the wavelength range of 250 nm to 270 nm and is most effective for wastewater disinfection at 254

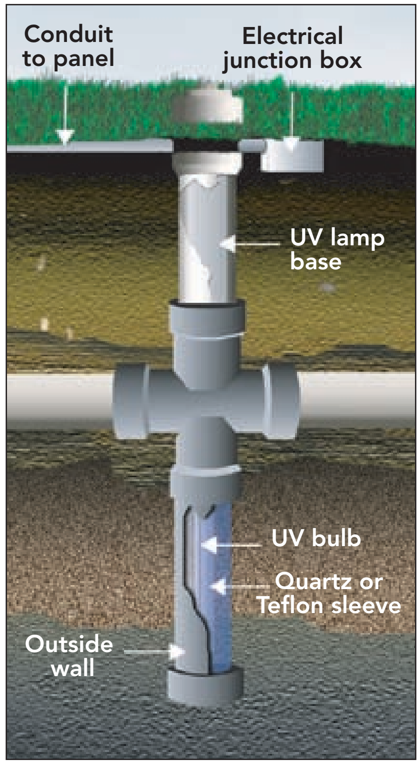

Figure 2. Possible UV unit configuration.

nm. For UV disinfection to be effective, the light from the UV lamp must pass through the wastewater to reach the pathogenic organisms. Ultraviolet light disinfects wastewater by damaging the genetic material of these organisms. The radiation penetrates the cell wall of the organism and is absorbed by cellular materials, which either kills the cell or prevents it from replicating. When treated cells die without replicating, the wastewater stream is left pathogen-free.

A power sensor is built into some disinfection systems. The sensor measures the intensity of the UV light passing through the wastewater stream. A decrease in intensity could be caused by an aging bulb, particulate build-up on the sleeve, or a cloudy wastewater stream. When the intensity drops, maintenance is required. The quartz glass tube may need to be cleaned or the bulb replaced. An alarm can be connected to the sensor to alert the homeowner or service provider of an intensity drop.

Factors affecting performance

Several factors affect the performance of ultraviolet light as a wastewater disinfectant (US EPA, 1999):

Effluent clarity. Wastewater must be pretreated so it has low turbidity (low suspended solids). Suspended solids inhibit disinfection because they can shield organisms from the UV radiation. If the UV light does not come in direct contact with the bacteria and viruses, it will not work as a disinfection method.

Hardness. The hardness of water affects the solubility of metals that may absorb UV radiation. It can lead to the precipitation of carbonates on quartz tubes. Nitrites and nitrates have little or no effect on disinfection.

Iron. Organic iron compounds also can absorb UV light. Iron precipitates can coat the sleeve, inhibiting the passage of UV light through the water to the organisms.

pH. pH affects the solubility of metals and carbonates that may absorb UV radiation.

Organisms. The organisms in the wastewater stream also determine the effectiveness of UV disinfection. If there are many organisms present, there is no guarantee that they will all be destroyed. The fewer organisms present to begin with, the fewer there are to destroy. Viruses are harder to destroy than are bacteria because they are smaller.

Sleeve condition. If microbial growth or other precipitates build up on the sleeve, it must be cleaned to allow the light to penetrate the wastewater stream at the appropriate intensity. A sleeve with a Teflon coating does not have to be cleaned because the Teflon prevents particles from sticking to the sleeve. Quartz glass tubes, however, must be wiped clean every few months (maybe more often, depending on the wastewater characteristics). The pretreatment system installed before the UV unit can affect the frequency of necessary maintenance.

Contact time. The ultraviolet light must come in direct contact with the organisms to kill them. The contact time is the amount of time a wastewater particle spends passing over the surface of the light bulb. Contact time usually should be 6 to 40 seconds. The flow rate through the UV unit will affect the contact time and the effectiveness of disinfection. A high flow rate reduces the exposure of wastewater to the UV light.

Ultraviolet intensity. The brightness of the light bulb is important. As the UV bulb ages, the intensity decreases. The UV bulb must be replaced when it becomes too weak for proper disinfection, usually every 12 to 24 months, based on the manufacturer's recommendations. UV bulbs should be run continuously because repeated on/off lamp cycles can reduce their life.

How to keep it working

It is very important to follow all installation and maintenance guidelines. Manufacturers may recommend specific operation and maintenance activities for their products. If so, be sure to perform them and document each activity. Some general kinds of maintenance should be done on all systems:

- ✔ Be sure to unplug the lamp before inspecting or servicing it, and always wear proper eye protection. Even with protective goggles, you should never look directly at the UV light with the power on.
- ✔ Power requirements are 1 to 1.5 kWh/d. Look for corrosion at the point where the lamp plugs into the electrical lead. If there is corrosion, clean the surfaces and check the voltage at the end of the lead. The lamp ballast should generally be replaced every 10 years. Keep a record of when the ballast and the bulb have been replaced.
- ✔ If the UV unit is equipped with a light sensor, regularly record the intensity reading. Check its function manually by turning the light off to be sure it is operating as designed.
- ✔ Check for any damage to the UV unit and contact chamber that might cause effluent leakage. Note whether the contact chamber is clean. (Material removed or flushed from the chamber should be returned to the beginning of the pretreatment system.)
- ✔ Note whether the sleeve is quartz, Teflon-coated or some other material. Unless the sleeve is Teflon, it should be cleaned at the recommended frequency—one to four times per year (or more), depending on the site specifics. To do this, use gloved hands to remove the sleeve assembly and lamp from the housing. Separate the UV lamp from the protective tube. Wipe the outside of the protective sleeve with a clean cloth. If the sleeve is replaced, make note of the date. If it is not replaced, note the last time this was done. Sleeves should be replaced every 5 years, or sooner if cracks appear or if discoloration cannot be removed. Also note whether the lamp is replaced. If it is not replaced, note the last date this was done. Replace the lamp yearly, as recommended by the manufacturer or as required by permit.
- ✔ The system requires clear effluent for effective light transmission through the effluent. Check the turbidity with a meter. Also monitor the flow rate, as excessive flow results in limited treatment. Make note of any other wastewater characteristics that may compromise treatment.
- ✔ If a control panel is used, it should be watertight with all connections sealed to prevent moisture or sewer gases from entering. Check the function of the alarm test switch. A control switch (HAND-OFF-AUTO) allows the service provider to check pump function (required only for pumped systems) without activating a float or program. Note the position of the control switch, keeping in mind that under normal operating conditions it should be in the AUTO position. If the panel has a cycle counter and/or an hour meter (elapsed time meter), record the current and last readings. If there are no meters, it would be wise to add them to systems that use pumps.
- ✔ Note where the housing unit is located (buried directly in the ground, in a pump chamber, or in a separate building). The UV housing unit or chamber must be inspected for cracks or leaks. Check for excessive dust in the housing unit.
- ✔ The effectiveness of disinfection is generally measured in terms of coliform bacteria. Coliform is an "indicator" organism in that it indicates the possible presence of fecal material. However, the fact that no coliform survived UV disinfection doesn't mean that nothing else survived. Viruses are more resistant to disinfection than bacteria, particularly the Hepatitis A virus. Texas regulations require that a fecal coliform concentration must be less than 200 CFU (Colony Forming Units) per 100 mL for surface distribution.

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