ULTRAVIOLET DISINFECTION SYSTEM

Shedding the Light On Ultraviolet

Properly installed lamps can effectively kill contaminants
by James Dallan

Ultraviolet (UV) technology can be more effective than chemicals in destroying certain waterborne contaminants without altering the taste of water. This makes it a practical process for treating water used for drinking and food preparation.

UV light penetrates germs and disrupts their DNA, preventing them from multiplying. UV is a section of the electromagnetic spectrum. This includes bands such as cosmic rays, gamma rays, X-rays, visible light, infrared light, microwaves and radio waves. The UV energy band, which is stretched out between the visible light band and the X-ray band, is divided into three sub-bands. The UV-C band, which spreads between 200 and 300 nanometers (nm) wavelengths, is used in water disinfection. Its germicidal effectiveness peaks at 253.7 nm.

UV energy is created by an electrical current between two electrodes through mercury vapour inside a lamp. UV lamps differ from regular fluorescent lamps in only minor ways. Germicidal lamps are normally made from UV transmitting quartz, while fluorescent lamps are made from soft glass with an inside coat of phosphor, which turns UV light into visible light. Lamps made from quartz emit about 90 percent of UV energy, while soft glass lamps emit a very small amount of UV energy.

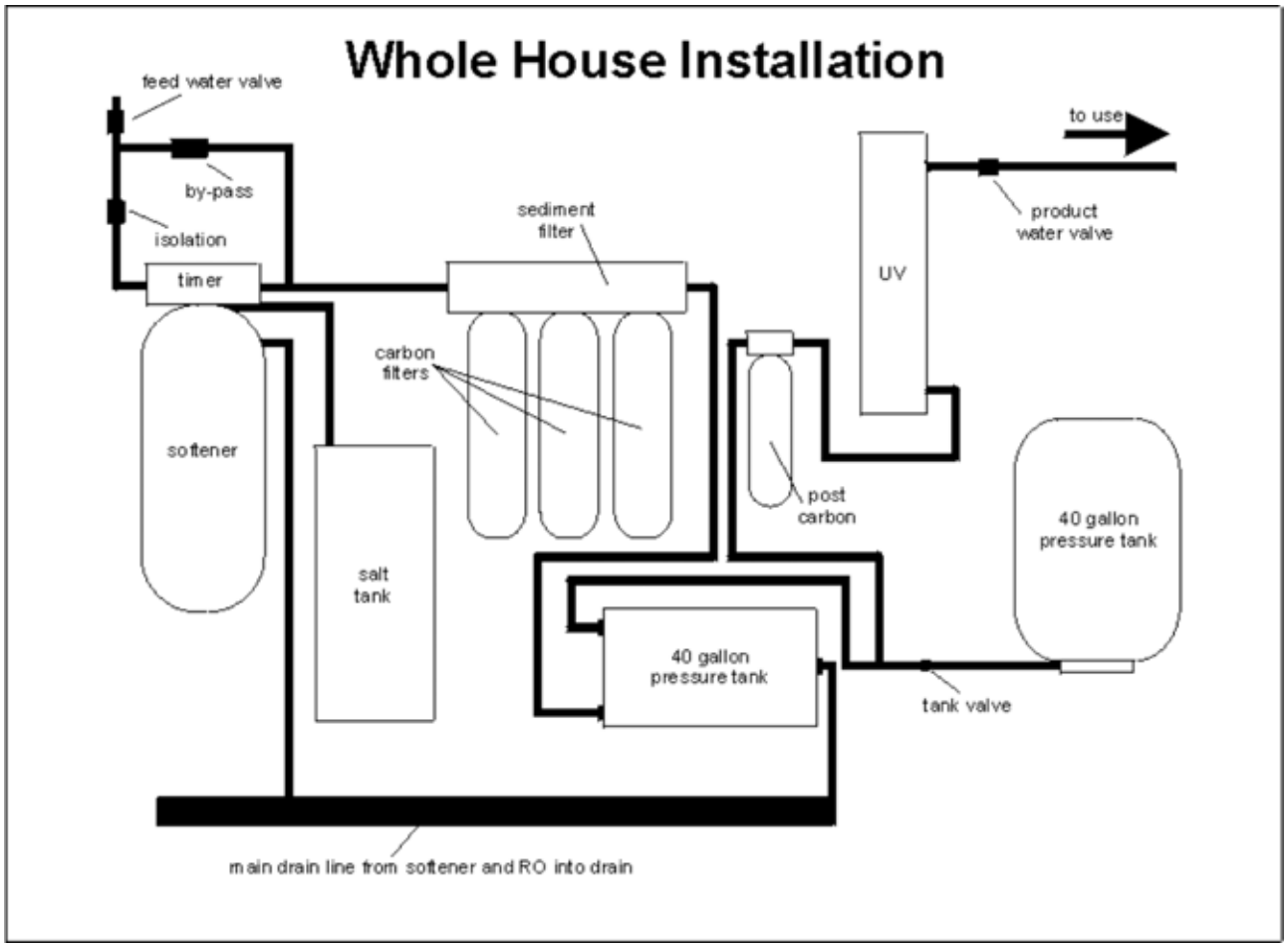
Determining Dosages

The UV disinfection process is quick, but different germs require different amounts of UV energy, or dosages to be destroyed. By definition, dosage is a function of intensity multiplied by time.

$$\text{Dosage} = \text{Intensity } (\mu W/cm^2) \times \text{Time (seconds)}$$

Intensity is the magnitude (amount) of UV energy that lamps generate at a given distance from the lamp per centimeter square of surface area (expressed in microwatts per centimeter squared). The lamp's intensity is measured at different distances from its surface. The intensity decreases by the square of the distance from its source - as the distance from the lamp increases, the intensity decreases. Usually, in UV system design, the level of intensity is usually measured at the farther point in the UV chamber, or the distance from the lamp's surface to the chamber's inside wall.

Time is the period it takes water to travel from the inlet port to the outlet port of the UV chamber. This is expressed in seconds and is calculated at a given flow rate, taking into consideration the dimensions of the chamber.



Factors Affecting UV Performance

UV is only effective if it hits its target. Several factors, including the quality of the water to be treated, will affect a UV system's efficiency:

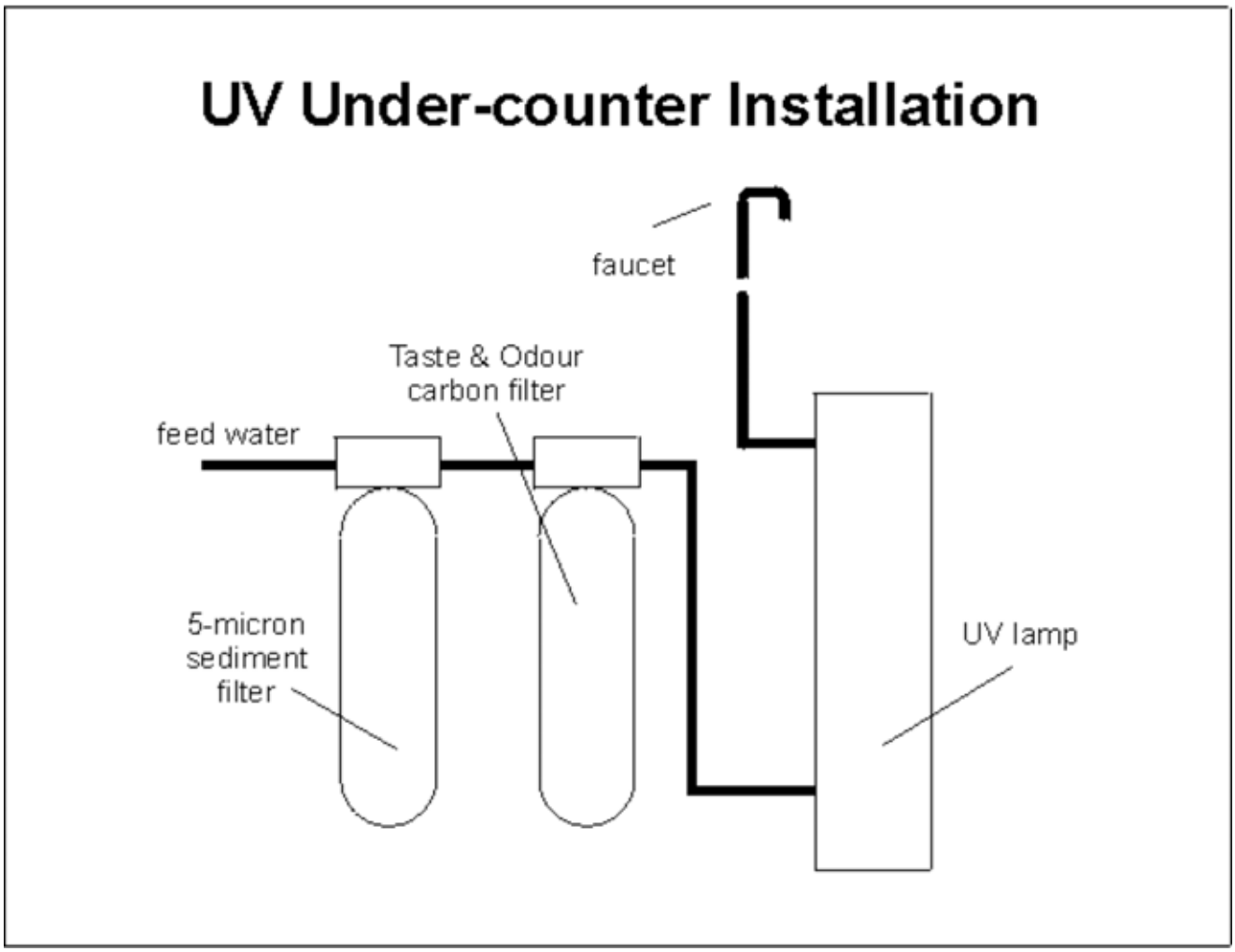
- **UV absorption.** Dissolved substances such as iron and manganese and certain organic substances will absorb UV energy and leave little for disinfection.
- **Suspended solids.** Contaminants can be shielded from UV by suspended solids, which act like an umbrella covering organisms from the germicidal light.
- **Hardness.** Depending on its level, the water's hardness can cause scale to form around the lamp's sleeve. This can reduce UV light transmission and the germs-kill ratio.
- **Temperature levels.** Water temperature will affect the UV energy produced. Quartz sleeves can minimize the temperature fluctuation effect and regulate UV dosage level transmitted into the water.

UV's Parameters

UV disinfection has certain limitations for treating contaminants in drinking water. For example:

- Excessive bacteria may be higher than what a typical UV unit is designed to treat. In this case, a unit's design flow rate could be adjusted to suit the amount and/or type of microorganism present in the feed water.
- UV is not effective against cysts like Giardia. Cysts have a hard shell that repels UV light. Cysts can more effectively be controlled by physical filtration, which removes the contaminants from feed water.
- Water colour and turbidity can limit the use of UV and require auxiliary pre-treatment equipment before UV can be used effectively.
  However, UV does offer several advantages when treating drinking water. It does not alter the taste, odour

or colour of water and requires no chemicals that may add toxic by -products to water.



Other advantages include:

- UV systems can be compact and easy to install.
- UV does not require holding tanks or long reaction times.
- UV can be used in conjunction with other water treatment methods.
- UV systems require little maintenance as long as the water is properly pretreated.

Try on the Right Size

Follow these guidelines to accurately size and install an ultraviolet (UV) treatment system:

- Consider the following parameters: capacity (flow) required, feed water quality, the pretreatment used and the purpose of treatment.
- If in doubt, always oversize the UV unit instead of undersizing it to save on cost. Often the cost of a larger unit is only a few dollars more. Usually an 8-gallons-per-minute (gpm) UV unit is adequate for an average-size home.
- UV units should be placed as close to the point-of-use (POU) as possible.
- Pre-sterilize all pipes and tanks by chemical shock treatment and flush thoroughly prior to using a UV unit for the first time.
- Install the system on the cold water line before any branch lines.
- The UV unit should be installed after all other treatment processes except microfiltration.
- To insure the safe operation of a UV system, test the water periodically for bacteria and other contaminants.