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Michael Urbans and Jesse Rodriguez discuss UV technology.

What is Ultraviolet Light

- Ultraviolet light is an approved method of water disinfection.
- Ultraviolet light attacks microorganisms, disease-causing bacteria, and viruses in the water supply.
- Ultraviolet is part of the electromagnetic spectrum.
    - Everyone's seen a rainbow in the sky after it rains. Beautiful rainbow with reds, yellows, greens, and purples. Ultraviolet is on the other side of the visible light. Between the visible light and x-rays is the ultraviolet spectrum. (That is the sun's disinfection for the water and the earth.)
- The disinfection wavelength is 254 nanometers and is known as the germicidal action curve.
    - It is the wavelengths in the electromagnetic spectrum that are absorbed by microorganisms.
    - It destroys the cell wall of the microorganism by hitting the DNA, breaking it down, effectively destroying it or killing the microorganism.

How It Works

- 254 nanometers is the wavelength used to produce ultraviolet lights- a quartz tube with filaments, like a standard household light bulb that has filaments.
- A triple mix of gases, called a tri-mix, is added, and sealed at certain pressures.
- There is a small amount of mercury in that tube which, when excited by electricity through the filaments, forms a mercury vapor line which is the 254-nanometer wavelength.
- The ultraviolet lamp emits UV light 360° around the lamp, but its energy zone is at a certain distance from the lamp. A typical zone where UV goes is somewhere between two and a half to three- inch area from the lamp alone.
- Because it is an electronic device, the lamp is encased in a quartz sleeve to protect it from the water.
- Once electrified it is sealed inside an ultraviolet chamber, typically manufactured out of stainless steel- 304 or 316 stainless steel. Water passes through an inlet, comes into the chamber, spins around the ultraviolet lamp, is exposed to ultraviolet energy, and kills the bacteria before it goes out of the UV chamber outlet.

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Design

- It is a stainless-steel pipe anywhere from 22 to 36 inches in length.
- A typical household unit ranges from 14 to 20 inches long with a 1-inch inlet or outlet.
- And as the water passes through and goes out the other side, the dose that's applied is based upon the flow rate going through the contact chamber exposed to ultraviolet light.
- The design flow rate is based on the amount of UV energy that's exposed in that chamber and the contact time in seconds or GPM.
- **Caution** - Direct exposure to the light over time will hurt your eyes. People that have experienced this may feel a sandy or burning sensation in their eyes. It's important, when working on a system, to turn the power off and wear UV rated safety glasses safety glasses when it's in operation.

What To Look for When Specifying a UV System.

- There are four aspects in ultraviolet design:
  - The lamp - how many UV watts does the lamp have, how much exposure does it have, intensity, output?
  - The ballast, how the ballast interacts with the lamp, there are several diverse types of ballasts. We recommend an electronic ballast.
  - The chamber - how it's manufactured, is it convenient for installation with the inlet and outlet designs?
  - Does it come with a type of UV monitor? Typical monitors would be a lamp out alarm or a timer that gives you the lamp hours, and a UV sensor.

- **Alarms**
  - There is an option for a normally closed solenoid installed on the UV outlet side. If a UV lamp goes out or power is lost, it would shut off that solenoid valve. This prevents any untreated water from going past the solenoid valve.
  - Once power is restored or the lamp is replaced the UV light will come on after reaching its warmup period and proper UV dosage. The control panel will recognize that and open that solenoid valve.

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Product Improvements

- The ultraviolet lamp itself has been designed to last longer under various operation conditions.
- Voltage changes would affect the lamp and the filaments would typically burn out. The filaments are now triple coiled, monofilament connections, and they typically last through the lamp life.
- Electronic ballasts have increased the ability to stabilize the electrical current going to the UV lamp. The ballasts take the electrical current and boost it up to start the lamp and produce ultraviolet light energy. Once the lamp is lit the ballast controls and stabilizes the current to the lamp, so you maintain the optimum operating output of the UV lamp over the lamp's life. It doesn't send too much or too little, it gives the exact operating current you need to keep the lamp at its best operating value for disinfection.

Future

- LED lights that have the germicidal spectrum are being produced.
    - They currently make LED lights in a string of what looks like photocells, and each one of those cells has a specific amount of UV energy output.
    - They are very directional. For example, straight forward, or straight up, or straight down, depending on how you position that.
    - Not aware of an LED for a whole house that has enough power to do 8, I0, 20 GPM.
    - Currently, you see the LEDs in point of use, for example, faucets or refrigerators, that's typically I gallon per minute or less.

Effectiveness

- Every microorganism requires a specific amount of ultraviolet light energy values for complete destruction.
- Microorganisms such as E. coli, cryptosporidium, giardia, and viruses can be reduced by one log, which is 90% reduction, or 2-log at 99%, or 3-log at 99.9%, or 4-log 99.99% reduction.
- Back in the early '80s, the UV dose requirement was two-log or 99% reduction E. coli and coliform bacteria. E. coli and coliform take about 6 millijoules to 8 millijoules of UV dose to destroy it. If you wanted to get over 90 percent, for example, 99 percent reduction, you would take that 6 to 8 and double it to get that UV dose amount of 12 to 18 millijoules.

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- UV manufacturers wanted a safety factor on top of that for various water quality fluctuations and determined a value of 30 millijoules - or 30,000 microwatts for UV disinfection.
- This increase compensated for loss of UV transmission in water, which is known as UVT. Ultraviolet test kits are available in the marketplace.
    - It is a small ultraviolet light placed at a certain distance from a test cell.
    - It's calibrated with high purity water, such as RO DI water, at 100 percent.
        - For example, ultraviolet light transmits, let's say, 100% in air, there's not much to interfere with the light transmission.
        - DI RO water is about 98 to 99% ultraviolet transmission.
        - Typically, clear fresh well water is somewhere between 94% to 96% ultraviolet transmission.
        - A typical wastewater treatment facility's effluent would be about 65% ultraviolet transmission when the water is ready for discharge.
- The cleaner the water, the better the ability for light to transmit through it. "Clean, dirty water".

WQRF Water Contaminant Map

https://www.wqrf.org/map.html

USGS Water Data Map

https://dashboard.waterdata.usgs.gov/app/nwd/?region=lower48&aoi=default

WQA National Convention

https://www.wqa.org/convention

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