


**When Innovation Surpasses Tradition**  
**3 Advantages of Closed Vessel UV Disinfection that Pay Off**

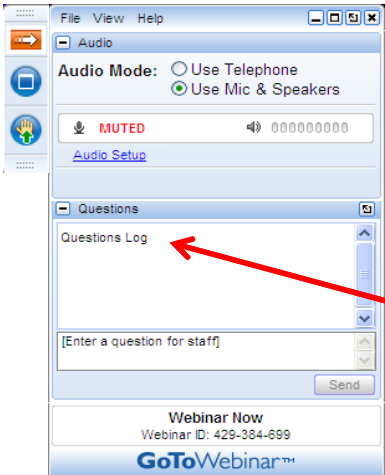
Presented by ETS-UV™ Patrick Bollman, P.E.




**TRANSFORMING WATER. ENRICHING LIFE.**

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## How to Participate Today



- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select “Use Telephone” and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**



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**TODAYS AGENDA ANSWERS IMPORTANT QUESTIONS ON UV DISINFECTION AND HOW THE CLOSED VESSEL APPROACH CAN BENEFIT**

1. What is UV and where is it used
2. What parameters are required to properly size a UV system
3. What advantages does closed vessel UV have for wastewater treatment
4. Case studies

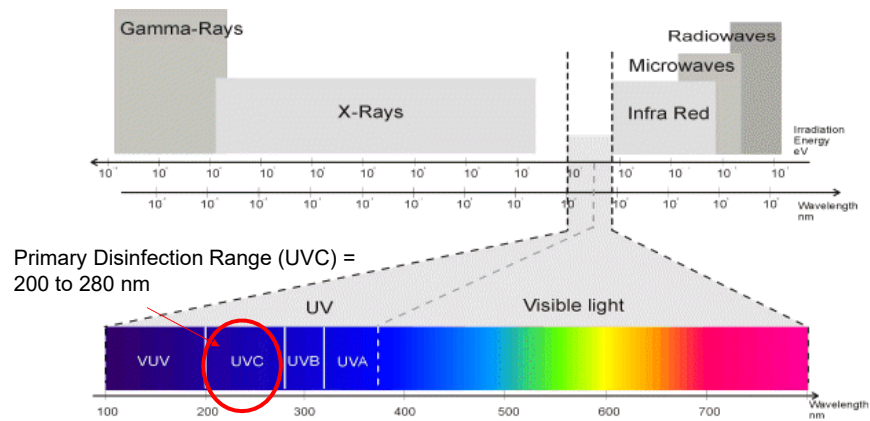
**UV 101**



## UV History

Year	Event
1878	Scientists discover sunlight "kills" microorganisms
1901	Fluorescent mercury vapor lamp invented
1910	1 <sup>st</sup> drinking water installation
1920s	Medium pressure UV lamp invented
1978	1 <sup>st</sup> wastewater installation
1980s	Expansion industrial (worldwide); drinking water (Europe)
1990s	Expansion wastewater (US)
2000	Used against Cryptosporidium and Giardia
2001	Wastewater reuse guidelines
2006	USEPA drinking water guidance manual
2012	Revised reuse guidelines published

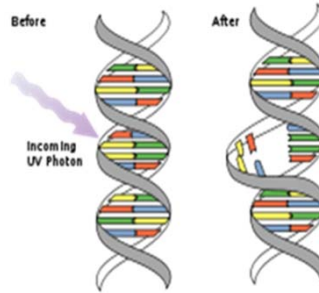
## UV and the Electromagnetic Spectrum



## What Does UV Do?

### Disinfection of microorganisms

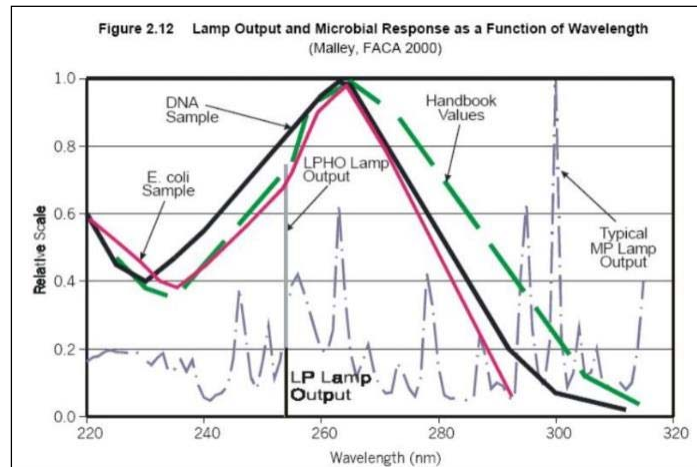
- Photons absorbed by DNA in microorganisms leads to inactivation (inability to replicate) by altering of thymine base units in the DNA



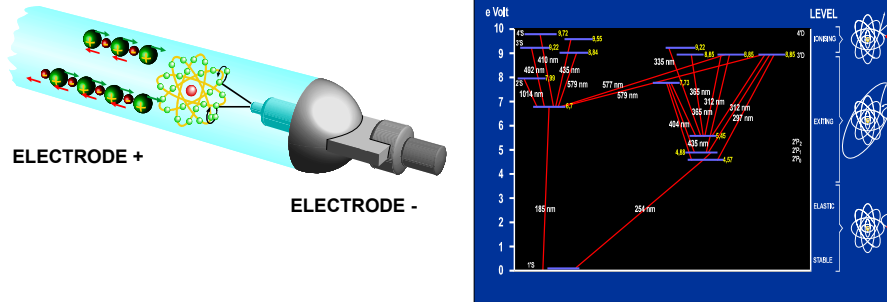
### Photochemistry/Photolysis

- Photons of UV light absorbed by molecules such as chloramines or NDMA lead to chemical change, resulting in their destruction

## Microbial Response to UV



## How is UV Light Generated?



Voltage is applied across the electrode, exciting the mercury to create UV

## UV Lamp Types

### Low Pressure High Output (Amalgam)

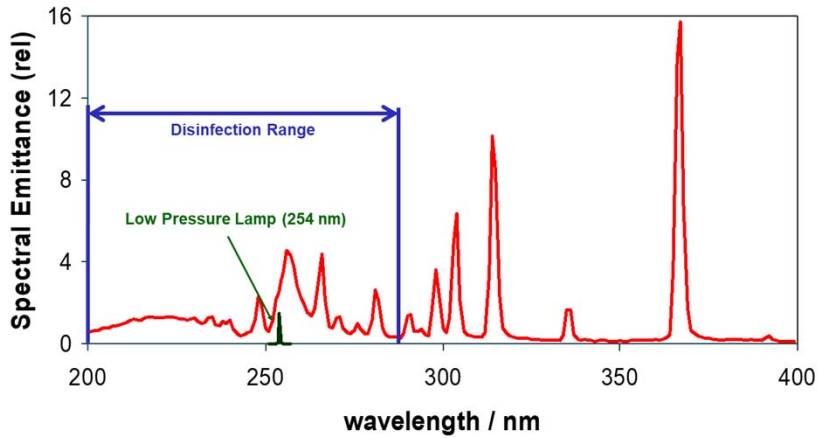
- Improved electrical efficiency
- Medium UVC output per unit length
- Monochromatic
- (35%, 35%, 30%) UV, VIS, IR
- Large footprint

### Medium Pressure

- Poor electrical efficiency
- Very high UVC output per unit length
- Polychromatic
- (15%, 20%, 65%) UV, VIS, IR
- Small footprint



## Spectral Output of UV Lamps



## Where is UV Used?

- Wastewater & Reuse
- Drinking Water
- Pools, Waterparks, & Splash Pads
- Aquaculture & Fish Farms
- Marine & Offshore
- Soft Drinks & Breweries
- Food Production
- Electronics & Pharmaceuticals
- Oil & Gas





## UV Design Parameters

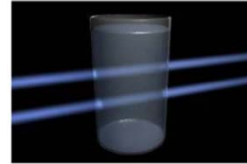


## Required Parameters

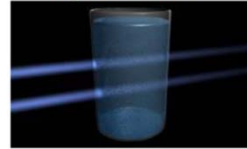
- Flowrate (minimum, average, peak, decant)
- Water Quality (transmittance, TSS, dissolved organics, metal concentrations)
- Required Disinfection (dose/log reduction)
- Plant Hydraulics
- Redundancy Requirements

## Typical UV Transmittance Values

Water Source	Transmittance (T10%)
Ultrapure Water	100%
Distilled Water	98%
Drinking Water	85-95%
Membrane (WW)	70-80%
Secondary Filtered	65-70%
Secondary Unfiltered	50-65%
Meat Brine, Soft Drinks	0%

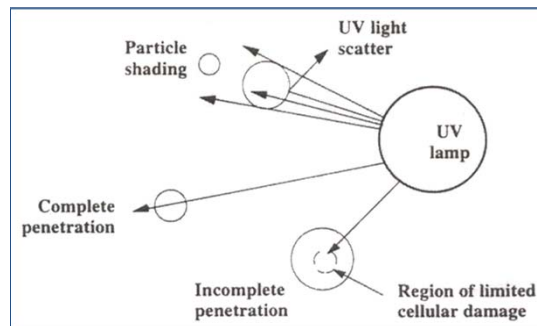


High Transmittance



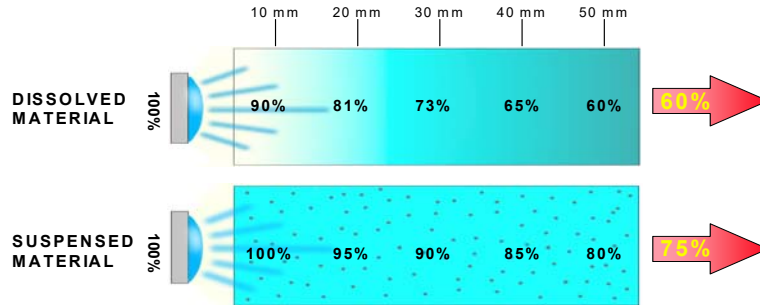
Low Transmittance

## Total Suspended Solids





## Dissolved Organics



\*Based on a given water quality

UV “operates” below the visible spectrum, thus effectiveness and performance of UV cannot be assumed based on visual inspection of effluent



## Iron and Manganese Fouling



Quartz sleeves have a negative (-) charge while heavy metals have a positive (+) leading to fouling on the sleeves.



## Closed Vessel Advantages



## Closed Vessel UV Systems

Primary UV solution for all applications except for municipal wastewater:

- Drinking Water
- Beverage and Brewery
- Ultrapure Water Applications
- Aquatics
- Aquaculture
- Ballast Water
- Surface and Air
- Aquifer Storage and Recovery Wells



## Closed Vessel UV in WW

- 1000+ currently in operation
- Flows from 10 GPM up to 120 MGD
- 2 inch connections to 30 inch connections
- All manufacturers actually have a closed vessel UV product
- Installed after all upstream processes (lagoons to membranes)



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## Closed Vessel



Horizontal – Medium Pressure



Horizontal – Low Pressure High Output



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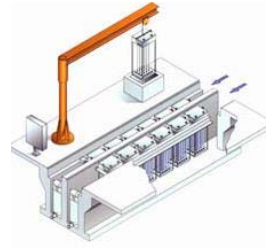
## Open Channel



Horizontal Low Pressure or Low Pressure High Output



Horizontal Medium Pressure



Vertical Low Pressure or Low Pressure, High Output



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## Closed Vessel

Many configurations & lamp types available

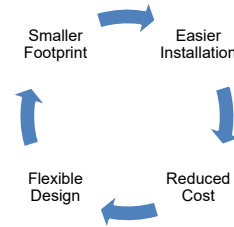
- Horizontal lamps
- Vertical lamps
- Medium pressure lamps
- Low pressure high output (amalgam) lamps



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## Installation Advantage

- Smaller footprint 1 MGD WW <2 feet of lay length
- Lower costs, easier, quicker installation
- Eliminate the need of precision alignment of poured concrete walls and floors
- Chambers can be installed in horizontal or vertical pipe runs providing design flexibility
- Some estimates show 60% installation cost reduction



## Installation Advantage

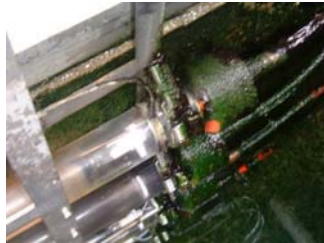
Many open channels become covered after operating for a short period of time or are covered during installation





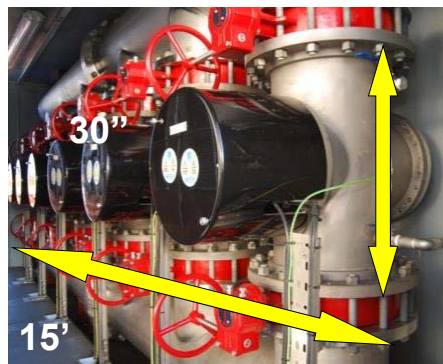
## Installation Advantage

- Sunlight encourages formation of algae
- Sloughing off, elevated coliform levels, breaking permit
- Impacts hydraulics and transmittance
- Maintenance issues



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## Installation Advantage



- Vertical installations
- Six parallel reactors
- Treating up to 4 MGD per reactor

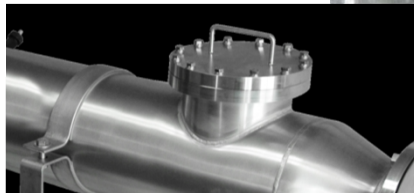
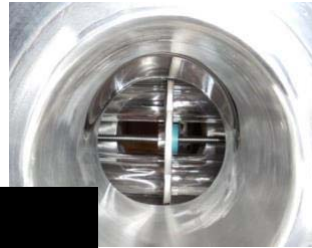
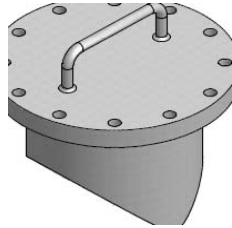


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## Maintenance Advantage

Easy access to internal parts of the chamber



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## Maintenance Advantage

- Wiping mechanism is external to water
- Wiper rings easily replaced



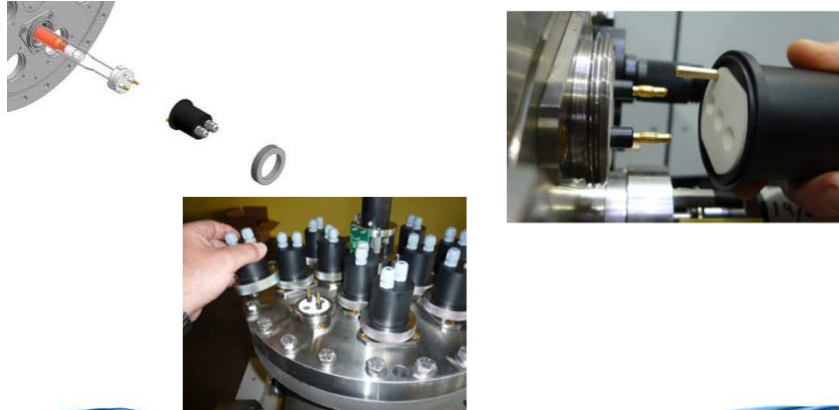
Wiper Yoke



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## Maintenance Advantage

Individual lamp and sleeve replacement



## Safety Advantage

No open water surface

- Lost/damaged tools, cell phones, etc.
- Algae growth
- Inhalation risk
- Potential bug nuisance

## Safety Advantage

Reduced UV exposure

- Burn exposed skin
- Eye injury



## Case Studies



## Scottsburg, Indiana WWTP

### Design Parameters

- 3.0 MGD
- 2.5 log reduction fecal coliform/E. Coli
- 65% transmittance
- 15 mg/l TSS

### Installation

- New construction, replaced chlorine gas



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## Scottsburg, Indiana WWTP

### Jason Combs, City of Scottsburg Sewer Department Testimonial

- Reasons for wanting ETS-UV™ closed vessel for wastewater
  - Installed in controlled climate building, can work on units during any weather conditions (and stay dry)
  - 8 lamps vs 64 lamps
  - We can change all lamps in just 10 minutes or less. Quartz sleeves can be changed in just 15 minutes
  - Access hatch, gives access to wiper and cleaning, in just a few minutes
  - Control panel gives full control and monitoring, we can see amp draw or current, lamp hours, power level, alarms, etc.
  - I operated an open channel this should be number 1 reason
  - **This ETS-UV™ system is a no brainer idea for wastewater facilities**



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## Scottsburg, Indiana WWTP

- I have operated several open channel units, one of my guys I hired came from a 3 MGD plant that has 2 = 64 lamps open channel UV systems
- I asked what he thought about our UV as it was already installed before he came to work for me
  - He said he spent ½ hour to 4 hours a day messing with the open channel. Now he only spends 15-20 minutes a week. This allows my guys to do other things: lift stations, camera work, grass, or whatever we need and not tied up working on 128 lamps in the rain



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## Indiana WWTP

### Design Parameters

- 3.65 MGD
- 35 mJ/cm<sup>2</sup>
- 65% transmittance
- 10 mg/l TSS

### Installation

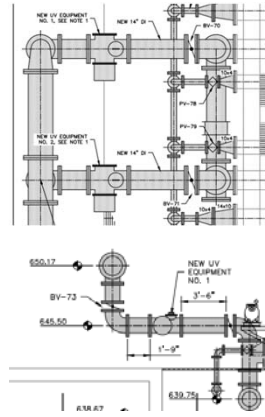
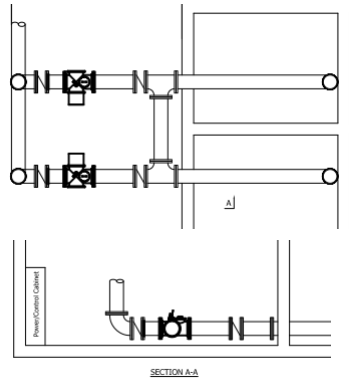
- Retrofit into sand filter pipework in basement



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# Indiana WWTP



# Indiana WWTP





## Pennsylvania WWTP

### Design Parameters

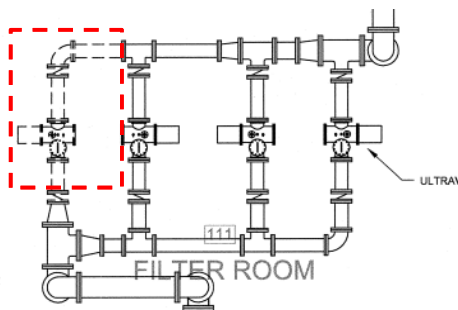
- 1.083 MGD
- 2.5-log reduction fecal coliform
- 60% transmittance
- 10 mg/l TSS

### Installation

- Replacement of chlorine contact basin
- Installed in new filter room
- Designed for future expansion – additional reactor installed in parallel



## Pennsylvania WWTP



## Texas WWTP

### Design Parameters

- 9.0 MGD
- 2.0-log reduction fecal coliform
- 75% transmittance
- 10 mg/l TSS

### Installation

- Greenfield
- Total installed costs approx. 2X cost of UV equipment



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## Texas WWTP



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## Summary

- UV technology has a long history in water and wastewater treatment
- UV design parameters are the same for closed vessel as open channel
  - Flows
  - Water quality
  - Disinfection requirements
  - Hydraulics
  - Redundancy
- Closed vessel can provide 3 advantage
  - Installation
  - Maintenance
  - Safety



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## Questions

Thank you for attending today's webinar!

E-mail [patrick.bollman@evoqua.com](mailto:patrick.bollman@evoqua.com) for more information or if any additional questions.



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