ITT

Sensor-Based Control

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Engineered for life

Water & Wastewater

Designed for worst case conditions

- Max flow rate
- Min water quality (UV transmittance, suspended solids)
- Protective quartz sleeve (transmissivity factor typically 0.92)
- Lamps at the end of life time → **Lamp ageing factor (AF)**
- Quartz Sleeves in fouled condition → **Fouling factor (FF)**
- Disinfection/Permit Requirement

These factors directly impact the sizing of a UV system!

Flow Rate and UVT

- System MUST be designed for Peak Wet Weather flow.
  - Typical average flows are 20% - 50% of the maximum.
- System Must be designed for lowest predicted UVT
  - Low UVT, seasonal or event driven
  - Operational UVT is above design UVT.
  - 10% change in UVT = 30% dose.

Ageing factor

- Ageing is a reality with amalgam-discharge lamps
- Typical ageing factors range from 0.8 to 0.9
- Ageing factor is non linear
  - 2% - 5% output fluctuation, variability of lamp manufacturing
  - Aging in the field:
    - Cycling
    - Temperature

Fouling factor

- Fouling is
  - Site-specific (!)
  - Depending on constituents such as Iron, Manganese, Hardness
- Fouling factors have typically been established according to NWRI, i.e. with tertiary treated effluent
- Cleaning mechanism is subject to maintenance issues.
- Concern: quartz sleeve fouling not directly measured

System will be Oversized

- Operational conditions;
  - Lower flow needs less lamps
  - Better UVT needs less lamps
  - Lamps new or at the end of life
  - Sleeves clean or fouled
- Turning down
  - save operating costs – electricity, consumables.
- Must still meet the disinfection/permit limits.

How to Measure the Dose

- Real time dose is a function of:
  - Flow (residence time)
  - UVT (water quality)
  - Intensity (delivered UV energy)
- Current UV system sizing is typically based on a bio assay or validation test that uses all the above parameters to generate the dose algorithm.
- Use the above measured parameters and algorithm, the control system is able to calculate a real time dose.

How to Measure the Dose

- **Typical validated dose equation**
- Based on intensity measurements during validation
- Function of UVT value and ballast/lamp power
- Resulting equation (new lamps, no fouling):

$$S_o = A * UVT^2 + B * UVT$$

Where:

S_o: UV intensity of a new lamp operated at 100% output with clean quartz and sensor window, mW/cm²

UVT: Water UVT transmittance at 254 nm, %/cm

How to Measure the Dose

- **Typical validated dose equation**

$$Dose = RLO_o * 10^{A + B * Log\ flow + C * Log\ UVT}$$

Where UV dose is a function of:

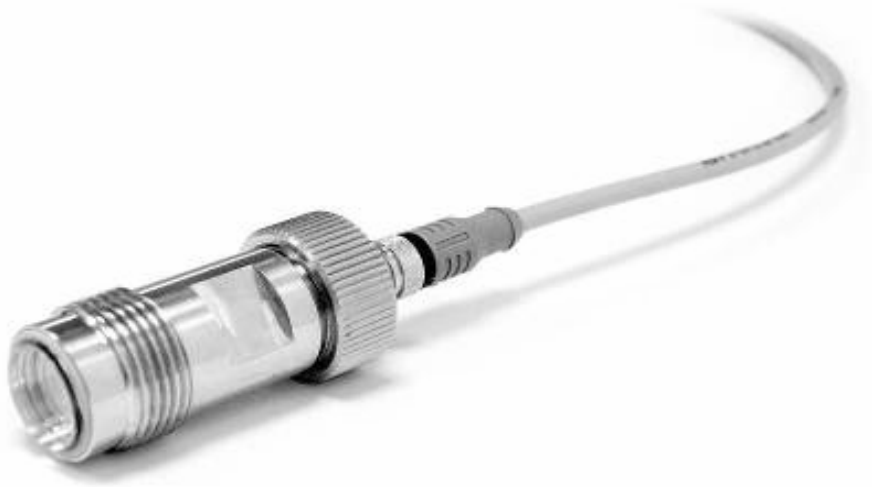
RLO_0: Operational Relative Lamp Output (S/So)

Flow: Flow rate/lamp, gpm

UVT: Water UV transmittance at 254 nm

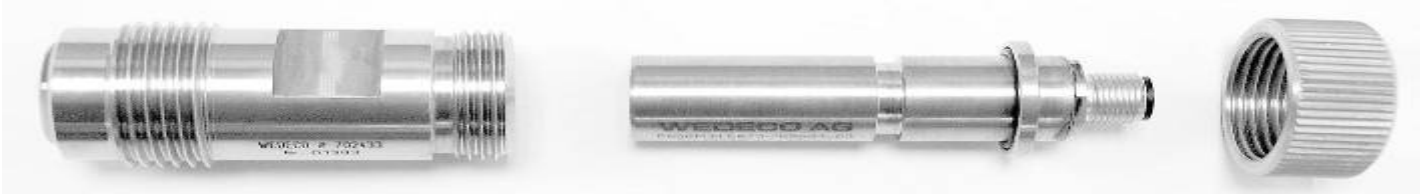
Reliable operation of UV disinfection equipment

- Flow and UVT are relatively easy to measure using industry standard devices.
- Intensity MUST be measured in real-time by a highly selective, calibrated UV intensity sensor
- Intensity accounts for:
  - Lamp output / power setting
  - Lamp ageing
  - Sleeve fouling
  - Quartz sleeve transmissivity
  - UV transmittance (water quality)



Intensity based UV system control

- Sizing of UV systems is based on design factors such as lamp aging, quartz sleeve fouling and predicted worst case UVT.
- Only intensity based UV system control allows to
  - Observe worse or better fouling conditions during operation
  - Reduce the number of lamps and / or the UV lamp output with higher UVT or less fouling than expected
  - Saving power & consumables without compromising discharge permits



Sensor Based Control

Advantages:

- No under dosing, no assumed values, real time measurements
- No overdosing with higher UVT, lower sleeve fouling
- Maximum flexibility, optimized operation and minimised permit violation risk
- Saving power and consumables

Thank You For Your Attention!

Questions?