

# Water Treatment Solutions to Reduce E Coli and Listeria in Food Applications

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Advancing the Utilization of Germicidal UVC in Food Processing  
November 2, 2021

The logo for Aquisense Technologies features the word "aquisense" in a lowercase, sans-serif font. The letter "i" is lowercase, while "a", "q", "s", "e", "n", "s", and "e" are uppercase. The "i" is positioned to the left of a dark blue rectangular box that contains the lowercase letter "i". Below this box, the word "technologies" is written in a smaller, lowercase, sans-serif font.

aquisense  
technologies

# Why is Food Safety so Important?

## Industrial

50% of tropical produce  
is lost to rot



## Human

- 600,000 annual cases
- 420,000 deaths
- 125,000 under 5



## Economic

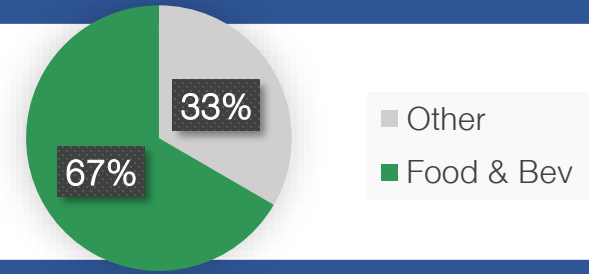
- Strain on health care
- Lost wages due to illness
- Loss of business



# The Numbers: Recalls & Outbreaks

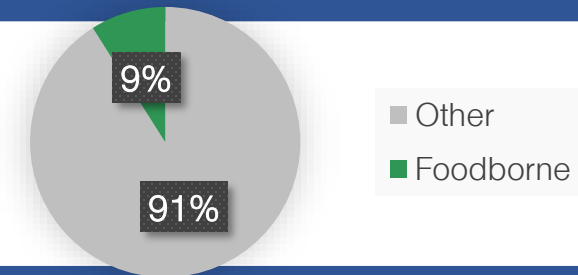
## FDA Food & Beverage Recalls

- There have been 1,164 recalls in the USA since 2017
- Avg of 233 a year, but only 142 in 2021



## CDC Outbreaks

- 4,564 foodborne outbreaks between 2014 and 2018
- Nearly 9% of the outbreaks during that time



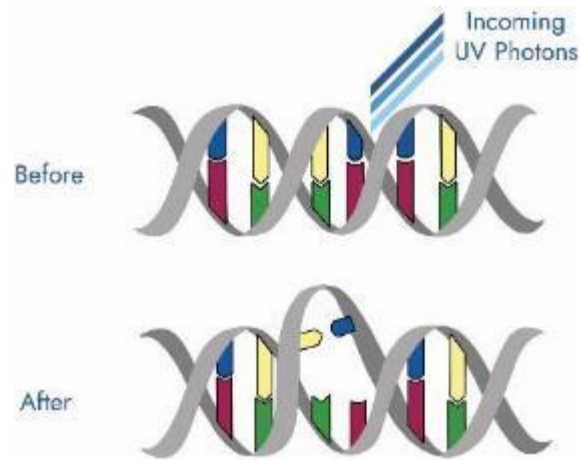
## Economic Cost

- 1 recall costs a company \$10M → \$11.64B since 2017
- Does not include reputation damage or lost sales



# How can UV Disinfection Help?

- UV-C photons penetrate organic cells and damage their DNA, rendering them incapable of reproduction
- No pathogen is resistant to UV disinfection
- All pathogens respond to UV in a unique way so they may require different amounts of treatment



Researchers have identified more than 250 foodborne diseases

- *Norovirus*
- *Salmonella*
- *Staphylococcus aureus (Staph)*
- *Clostridium botulinum (botulism)*
- *Listeria*
- *E. coli*

# How can UV Disinfection Help?



Air



Water



Surface

← Same disinfection method, 1000s of applications →

# Sizing a UV System for Water Treatment

Flowrate

- Driven by application, but can be optimized
- Lower flow → longer exposure time → higher treatment

UV Dose

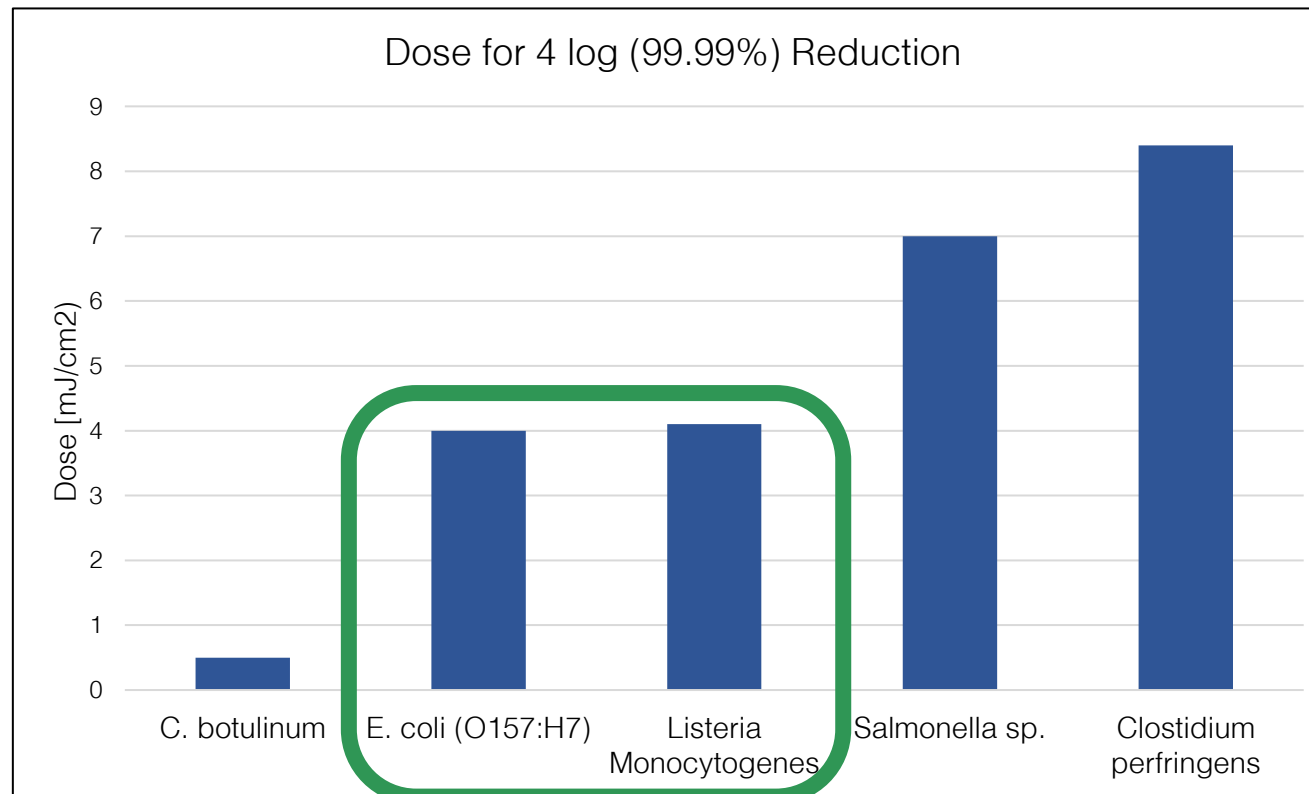
- Level of Treatment

UVT



# E Coli and Listeria

- E Coli and Listeria get to food via manure fertilizer or improper hygiene
- Thankfully, both pathogens are very responsive to UV treatment



# Sizing a UV System for Water Treatment

## Flowrate

- Driven by application, but can be optimized
- Lower flow → longer exposure time → higher treatment

## UV Dose

- Level of Treatment → UV Dose
- Dependent on the target pathogen

## UVT

- Ultraviolet Transmittance



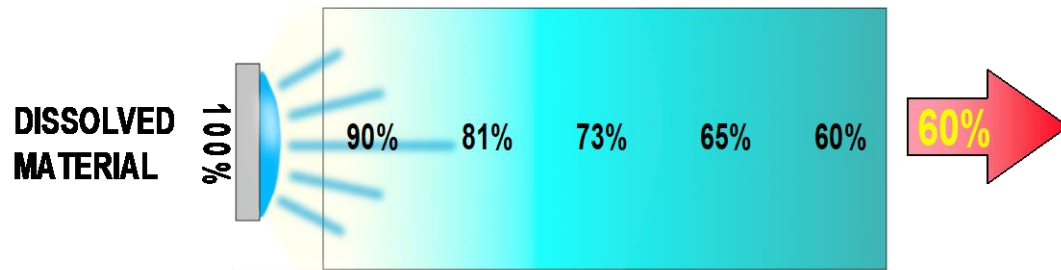


# Ultraviolet Transmission and Turbidity

## UV-Transmittance (UVT)

Measure of UV absorption

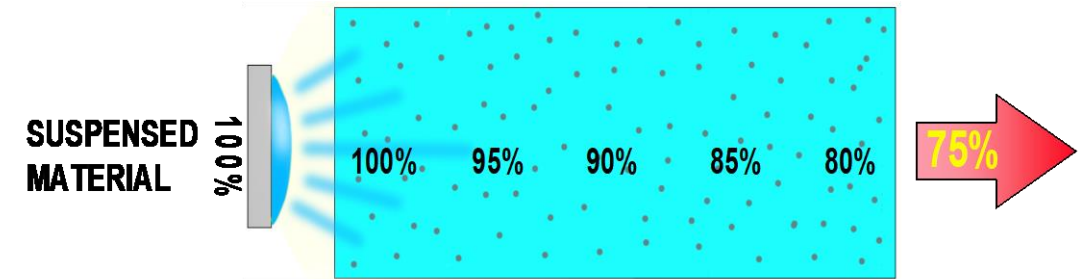
High % is good



## Turbidity

Measure of visible light scattering

Low % is good



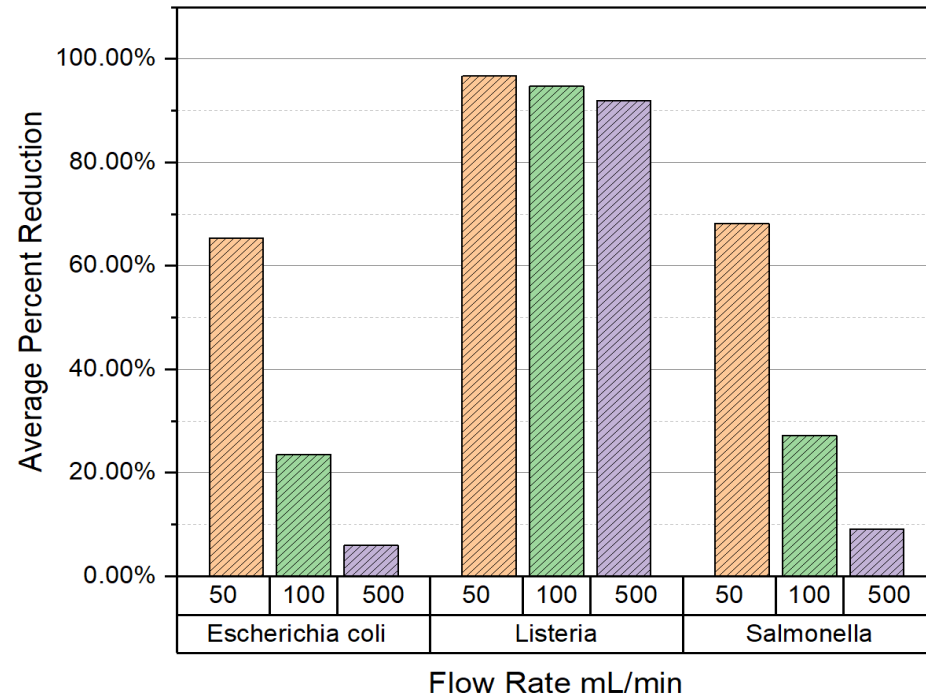
# UVT Discussion: Cold Brew Tea

- The Problem: Cold brew tea is at risk for microbial contamination due to no thermal brew cycle
- Key Design Parameters
  - No physical filtration (lowers concentration)
  - Small, on-demand operation
- Feasibility Study
  - UV LED system investigated as a potential solution



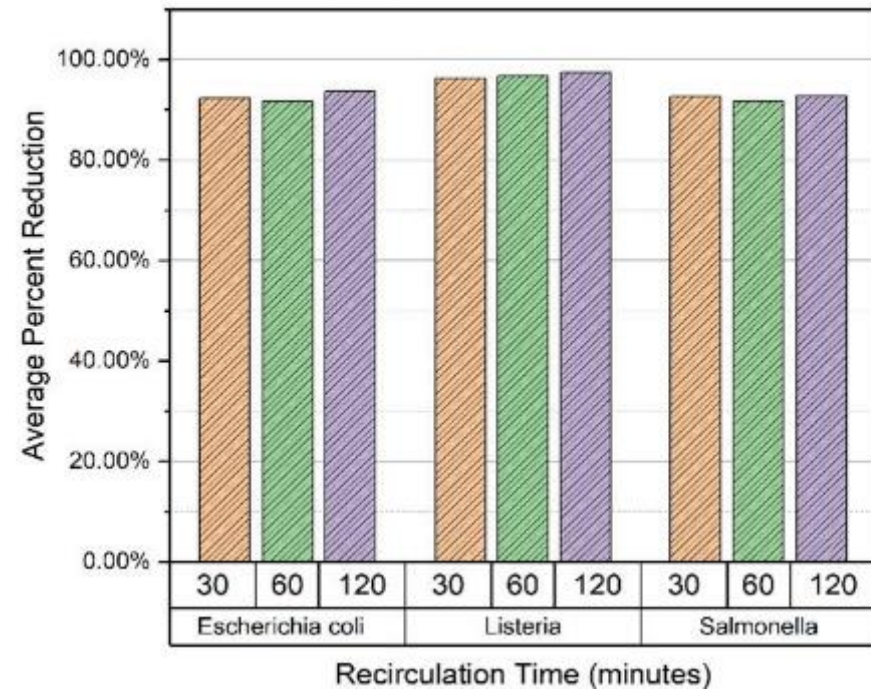
Tea Type	A	B	C	D
Time Lapsed (min)	UVT (%)	UVT (%)	UVT (%)	UVT (%)
1	99	75	90	42
2	71	68	76	45
3	53	58	73	22
4	48	48	67	3
5	41	43	49	0
6	30	22	40	0
7	25	-	28	0
8	20	3	14	0
9	12	5	16	0
10	0	3	13	0
11	-	0	10	-
12	-	-	7	-
13	-	-	4	-
14	-	-	3	-
15	-	-	3	-

## Single Pass



- Follows expected trend with flow rate
- Lower flowrate = higher treatment

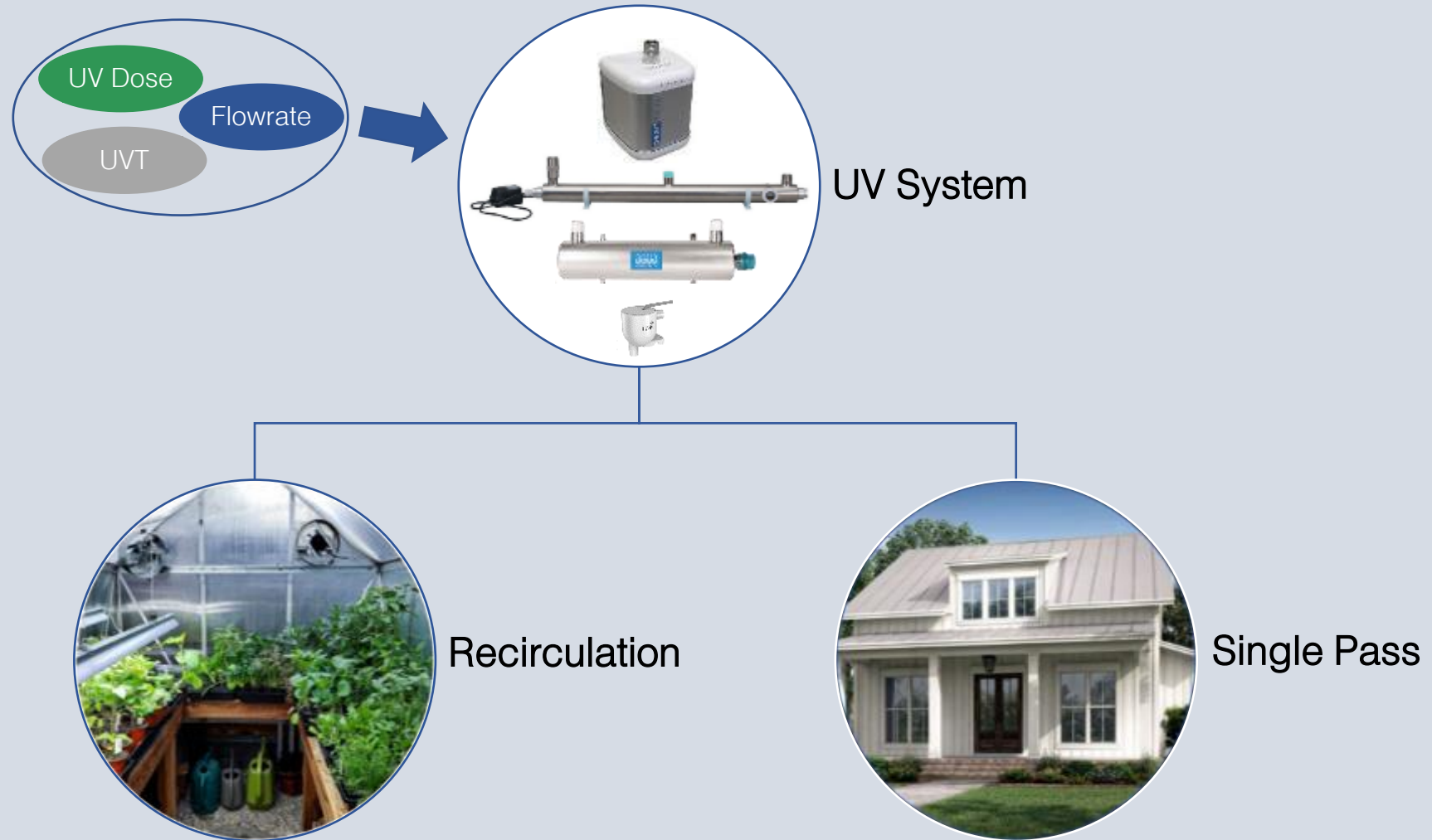
## Recirculating



- 1 log reduction, but almost no benefit seen past 30 minutes
- Window fouling over time



# Where to Place UV Water Treatment



# Recirculation

## Convenience

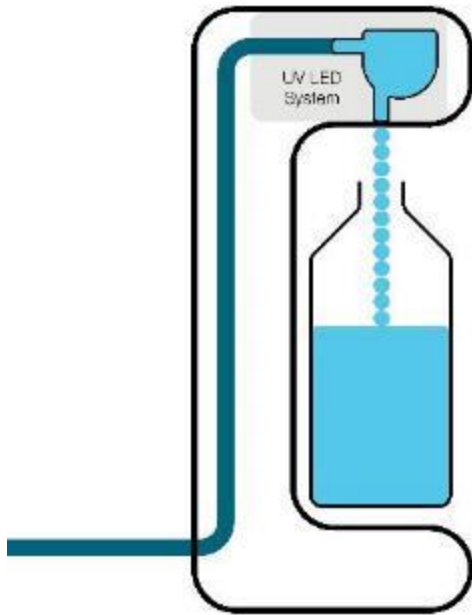
Does not impede process & easy to access for maintenance



# Single Pass

## Point of Dispense

As close to the point of dispense as possible



## Final Treatment

UV is a line-of-sight technology  
Make it the final step to prevent shadowing



# UV in the Food Chain

## Growing



- Seed Treatment
- Air Treatment
- Hydroponics

## Storage & Transport



- Crate Cleaning
- Temp Control
- Humidity

## Processing



- Conveyor Belts
- Packaging
- Food Washing

## Food Service



- Cutting Boards
- Air Handling
- Cooking Water

# Growing: Hydroponics



## Problem

- Pathogens in the water can take out entire harvests
- Need to disinfect without harming the plants



## Key Design Parameters

- Low UVT
- Easy to add to existing system
- Easy to maintain



## Solution

- UV water treatment system

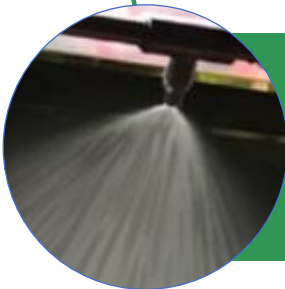


# Storage & Transportation: Mistlers



## Problem

- Mistlers can spray pathogens all over fresh produce
- Inlet for back contamination



## Key Design Parameters

- Small
- Cost effective
- Intermittent flow



## Solution

- Inline UV-C LED on feed line

# Processing: Pasteurization Alternative



## Problem

- Pasteurization changes product
- Non-damaging disinfection process



## Key Design Parameters

- Preserve nutrients
- Maintain product taste



## Solution

- UV liquid disinfection

# Food Service: Quasar



## Goal

- Prevent back-contamination in water systems
- Avoid expensive redesign of the water dispenser



## Key Design Parameters

- Fit in existing design
- Treat dispensing tube and water



## Solution

- Custom UV-C LED inline system

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# Food Service: Commercial Steam Oven



## Goal

- Biological protection in low temperature steam ovens
- Retrofit to ovens in the field



## Key Design Parameters

- Tiny envelope
- Warm environment



## Solution

- Custom UV-C LED inline system

**mychef.**  
by distform

# Authors



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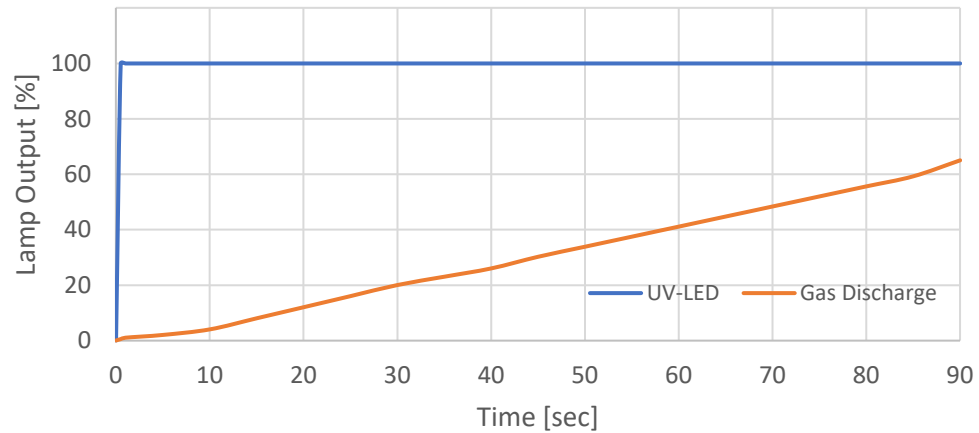
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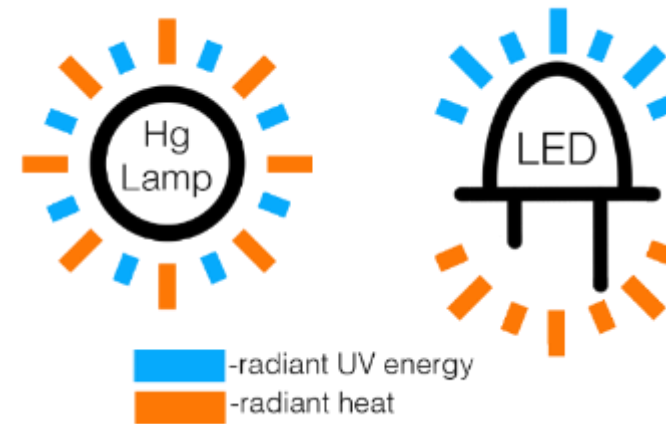
Contact: [info@quisense.com](mailto:info@quisense.com)

# Benefits of UV-C LED Technology

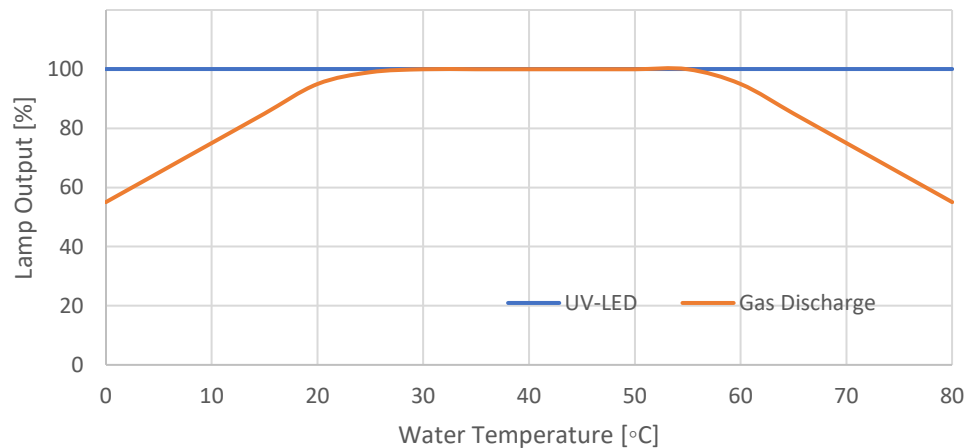
### Lamp Warm-Up Time



### Lamp Heat and Light Direction – Fouling Potential



### Lamp Output vs. Temperature



### Lamp Aging with High On-Off Cycling (over 10/day)

