# Microscreens and UV in Aquaculture

Terry McCarthy
Co Founder WMT

# Introduction

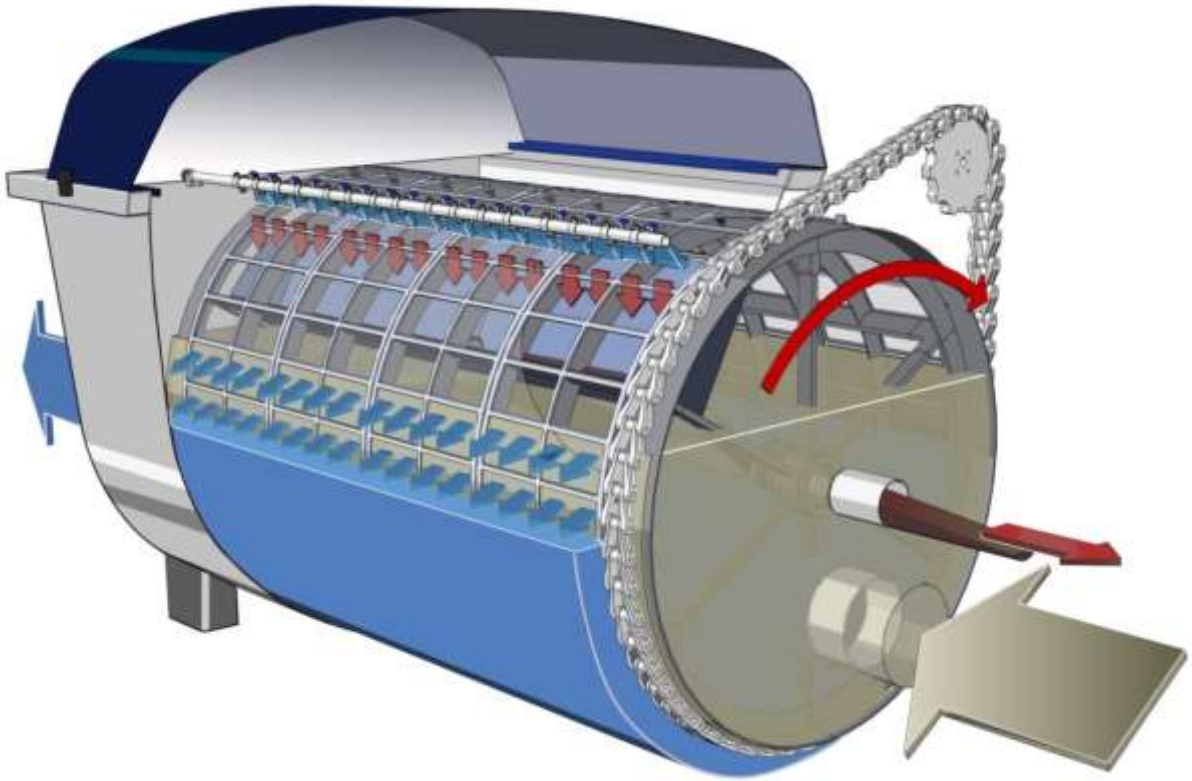
- WMT is a 23 year old company specializing exclusively in design and supply of water treatment systems for aquaculture.
- We currently have Microscreens operating in all 50 states in intake, recirculation and effluent polishing applications.
- We have over 1,000 microscreens installed in aquaculture applications.
- We have UV systems operating in several Federal, state, tribal and commercial hatcheries throughout North America.

# Microscreens & UV in Aquaculture

**Microscreens are mechanical self cleaning filters that can filter down to 10 micron**

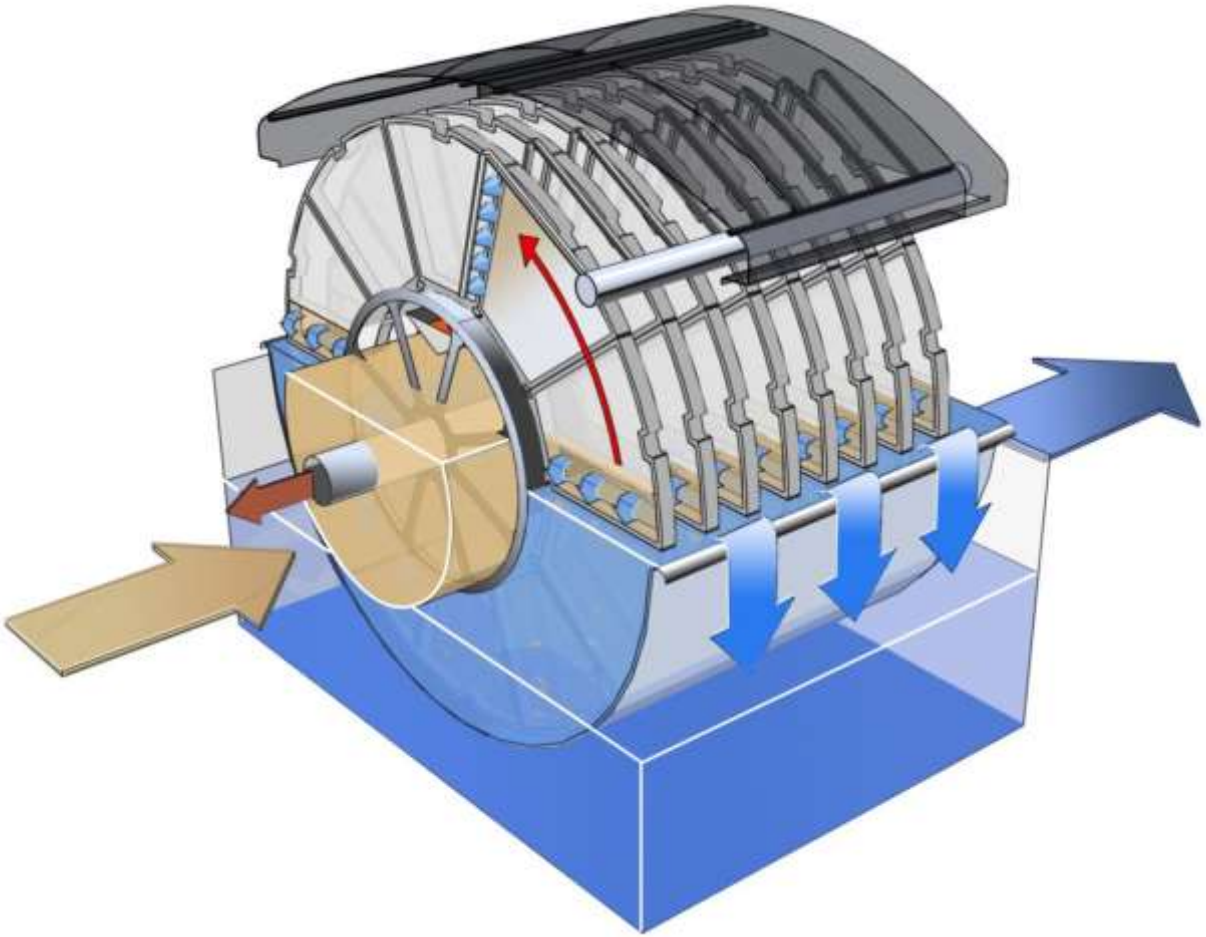
**Microscreens operate with gravity. <1 ft of head.**

# Principle Drumfilter



How it works

# Principle Discfilter



How it works

# How To Size a Microscreen

1. **Maximum Water flow rate**
2. **Solids loading – expressed in ml/L TSS**
3. **Filter element – Microns?**
4. **With Tank or for installation in concrete sump or channel**

# Drum vs Disc Filter Comparison

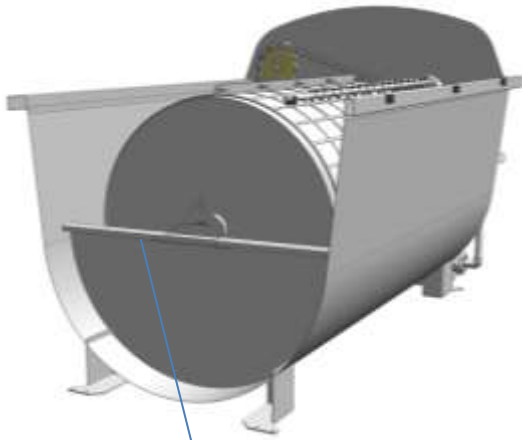
| | • **Drumfilter** | **Discfilter** |
|---|---|---|
| Filter area | 1-20 m2 | 12-60 m2 |
| Hydraulic capacity | Max 4500 m3/h<br>20,000 gpm | Max 4000 m3/h<br>17,500 gpm |
| Applications | Aquaculture large filter um openings | Aquaculture small um openings |
| | Intake water large µm | Intake water small um |

# Hydraulics

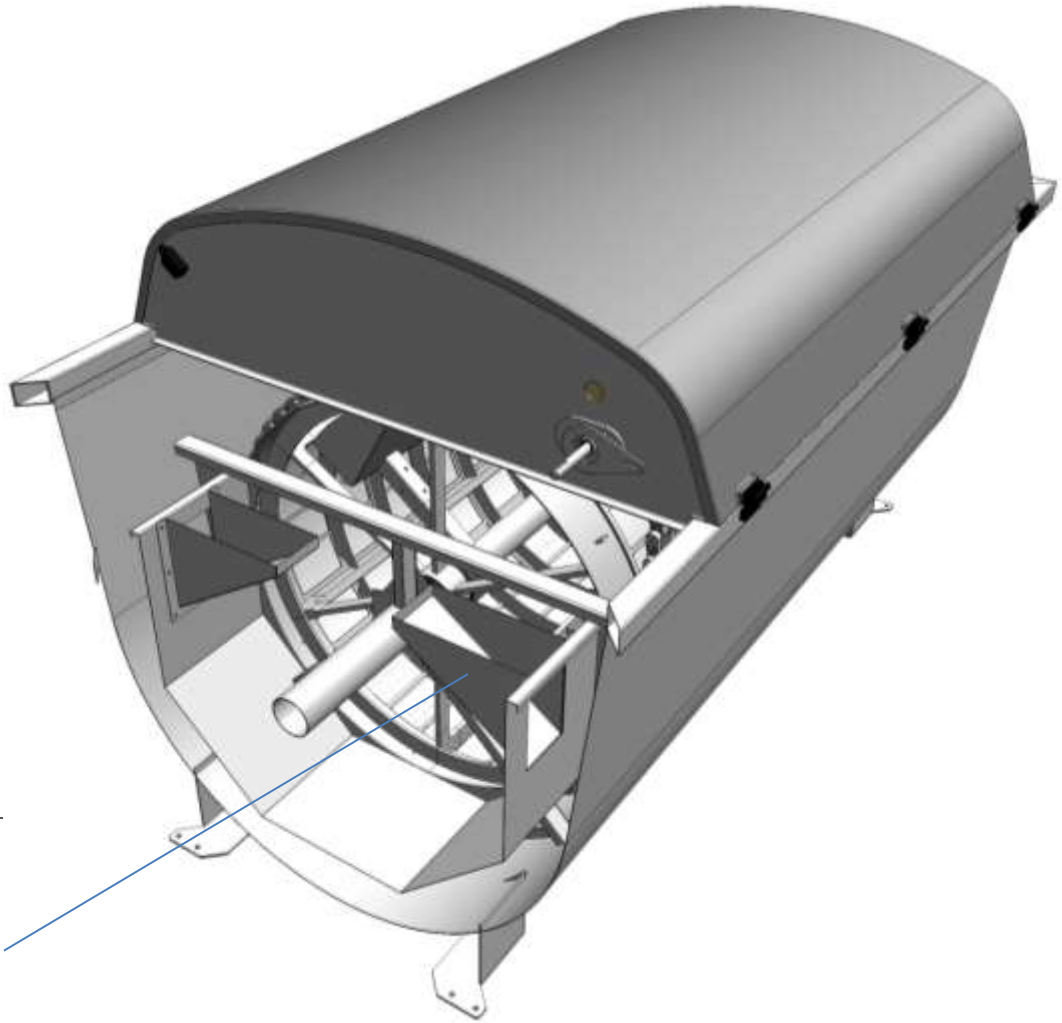
# Improper Hydraulics in Chile

Too short weir=
Too High Head!

# Water levels

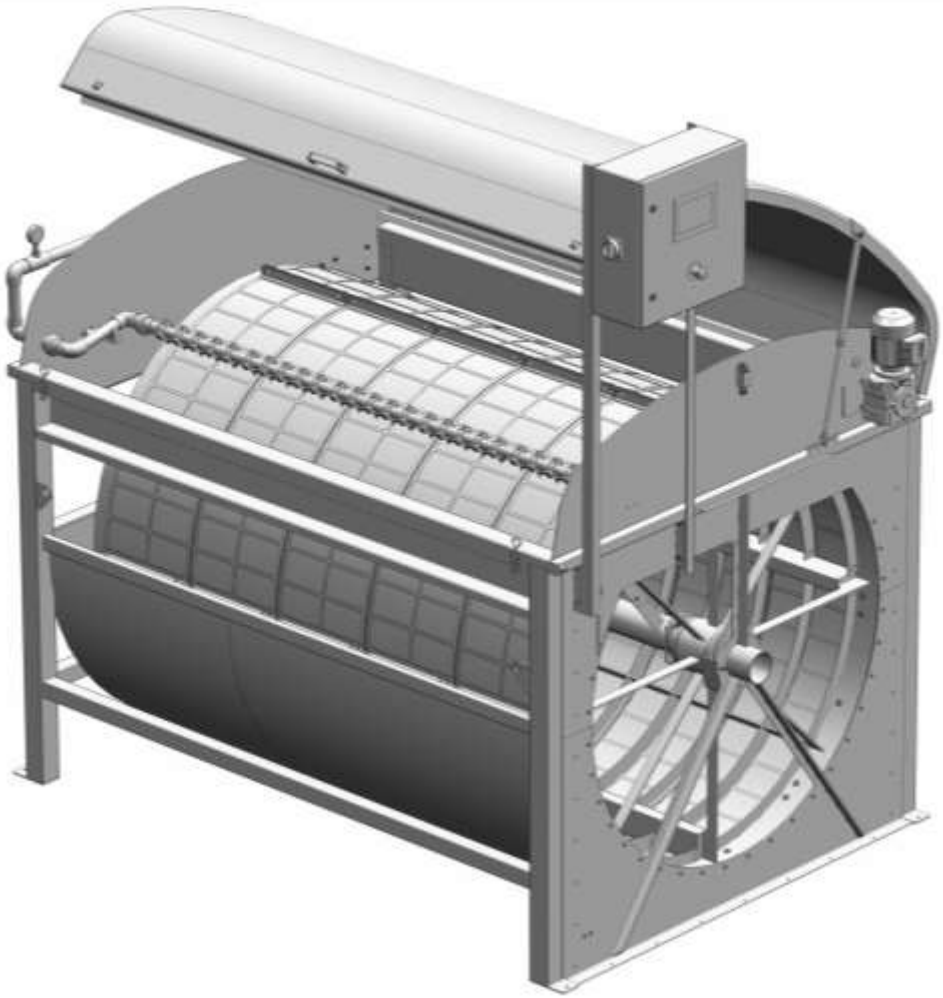


Inner level weir for filtrate.



Built-in weirs at inlet for internal or external emergency by-pass.

# Model with level tank



Frame version

With level tank

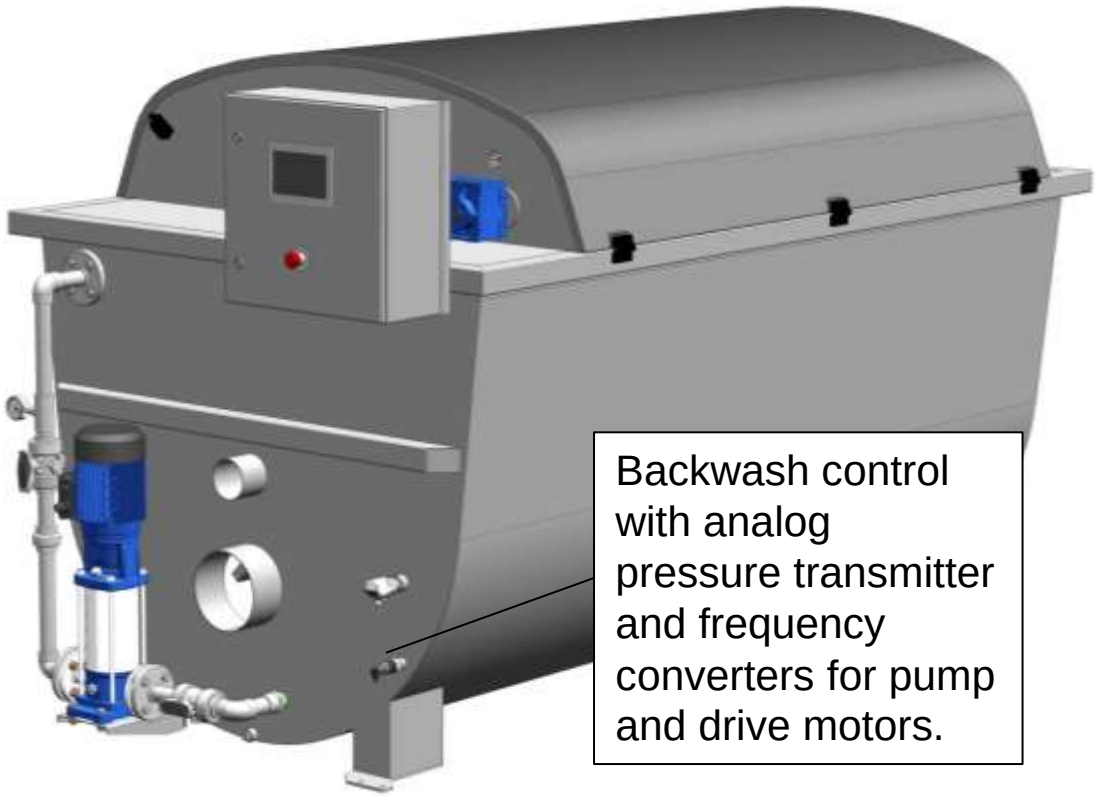
# Hydraulics

- Never permit the inlet water velocity entering the Microscreen to exceed 1 meter / second.

# Backwash & controls

Automatic control system with user friendly touch screen HMI.

Max efficiency of cleaning and minimal energy consumption.

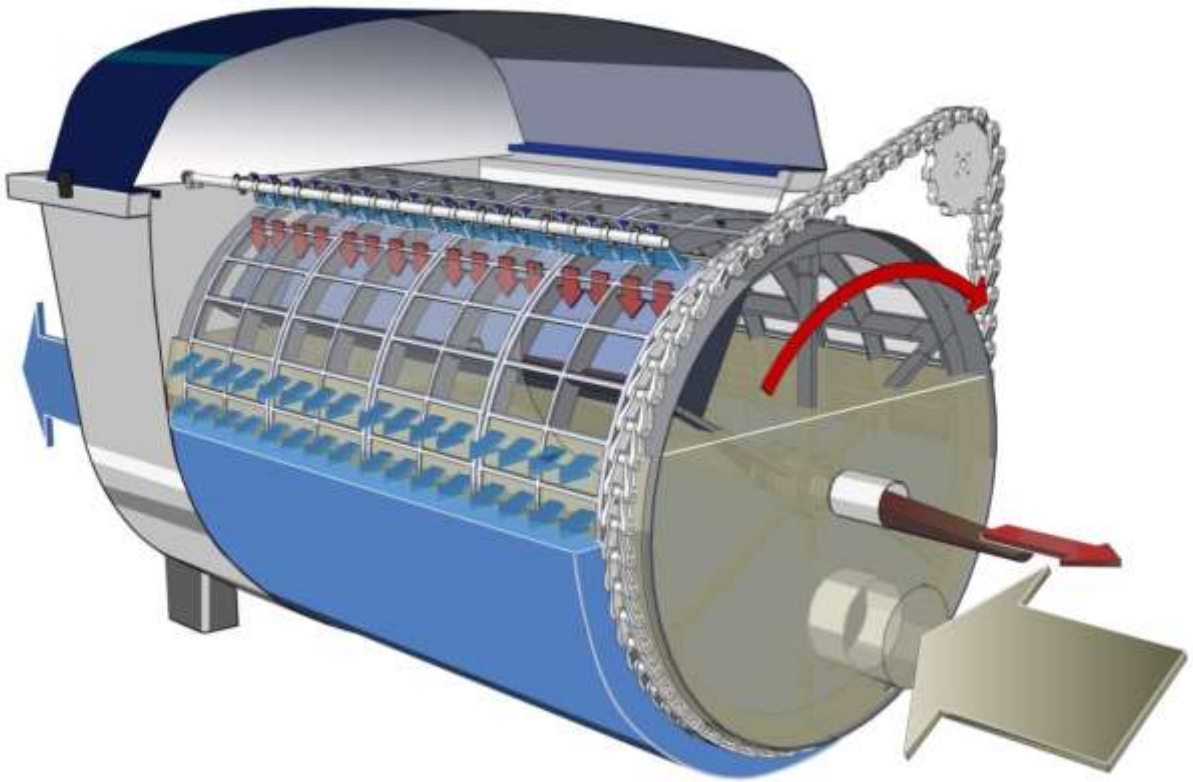


Backwash control with analog pressure transmitter and frequency converters for pump and drive motors.

# Recent Innovations

- Bearings in both drum ends - large length/diameter ratio gives higher capacity at less investment.
- Drive on preiphery - less energy cost and less stress on drum structure
- Lubrication free and corrosion free chain drive – less maintenance
- Oscillating backwash header – less reject water and better cleaning of filter media and longer filter media life.
- 15 % larger effective filter area and less reject water with the MR-panels
- High degree modular design - lower investment cost and  better quality

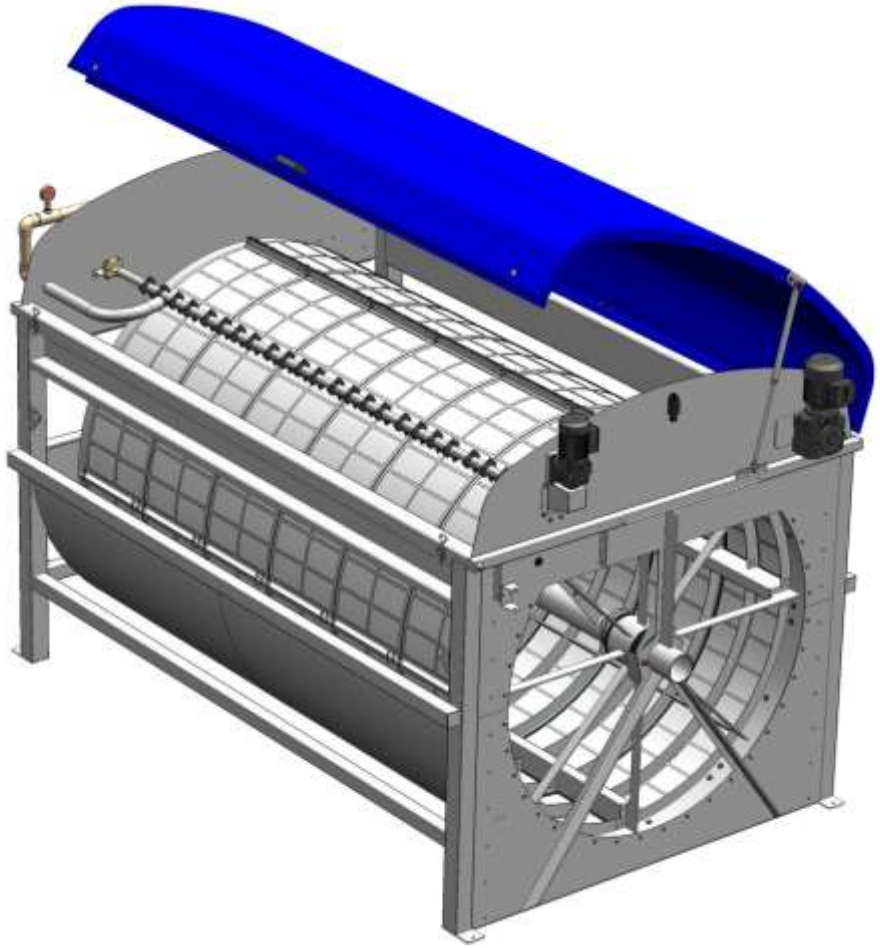
# Periphery Drive

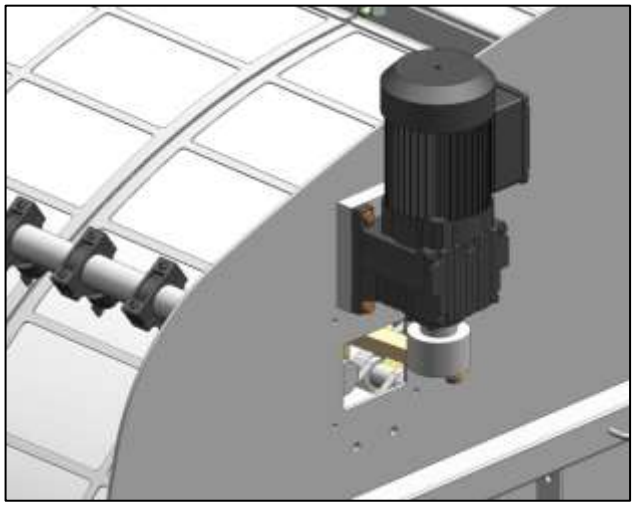


1. Lower Torque
2. Lower Hp.
3. Less Metal Fatigue results in Longer service life
4. Non Metallic Chain no lubrication
5. Elevates Drive

# Oscillating backwash

- 20% less backwash generated
- Longer filter element life

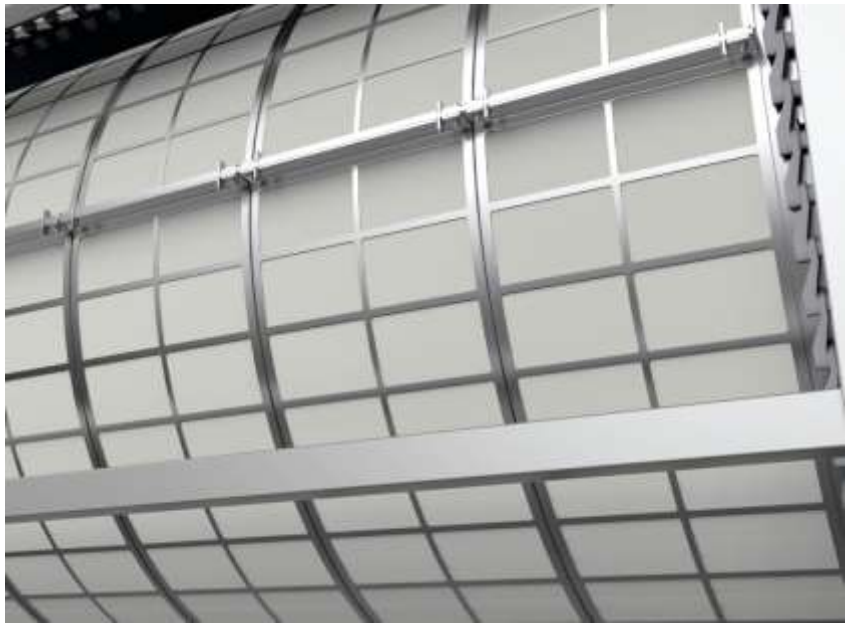


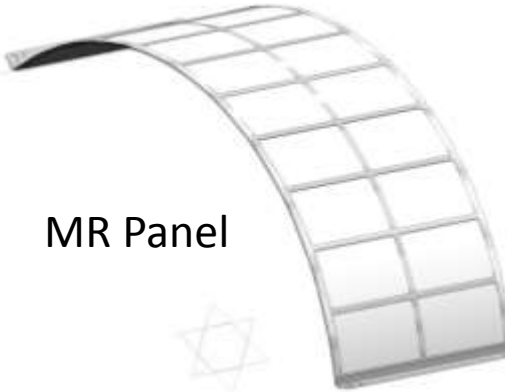


Design based on sheet material – special alloys possible.

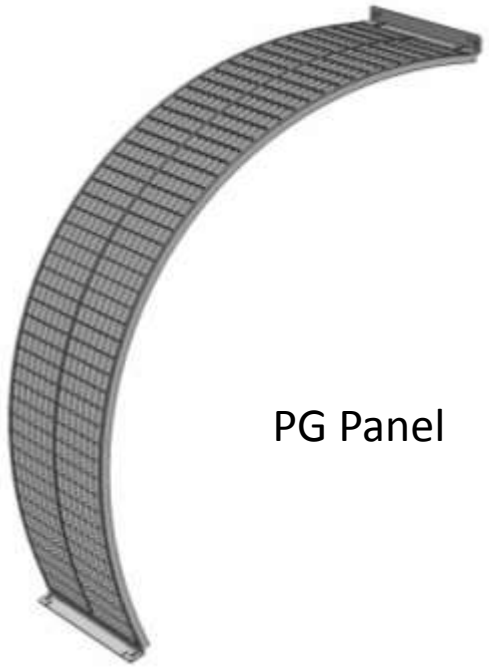
Weir extensions of FRP, for emergency bypass or filtrate level.

# Filter Elements for DrumFilter





MR Panel



PG Panel

**Two alternatives of Drumfilter panels:**

PG-panel with polypropylene grid

MR-panel with FRP frame, with 15 % larger effective filter area. The MR-panel is recommended with fine filter openings (20 micron and less)

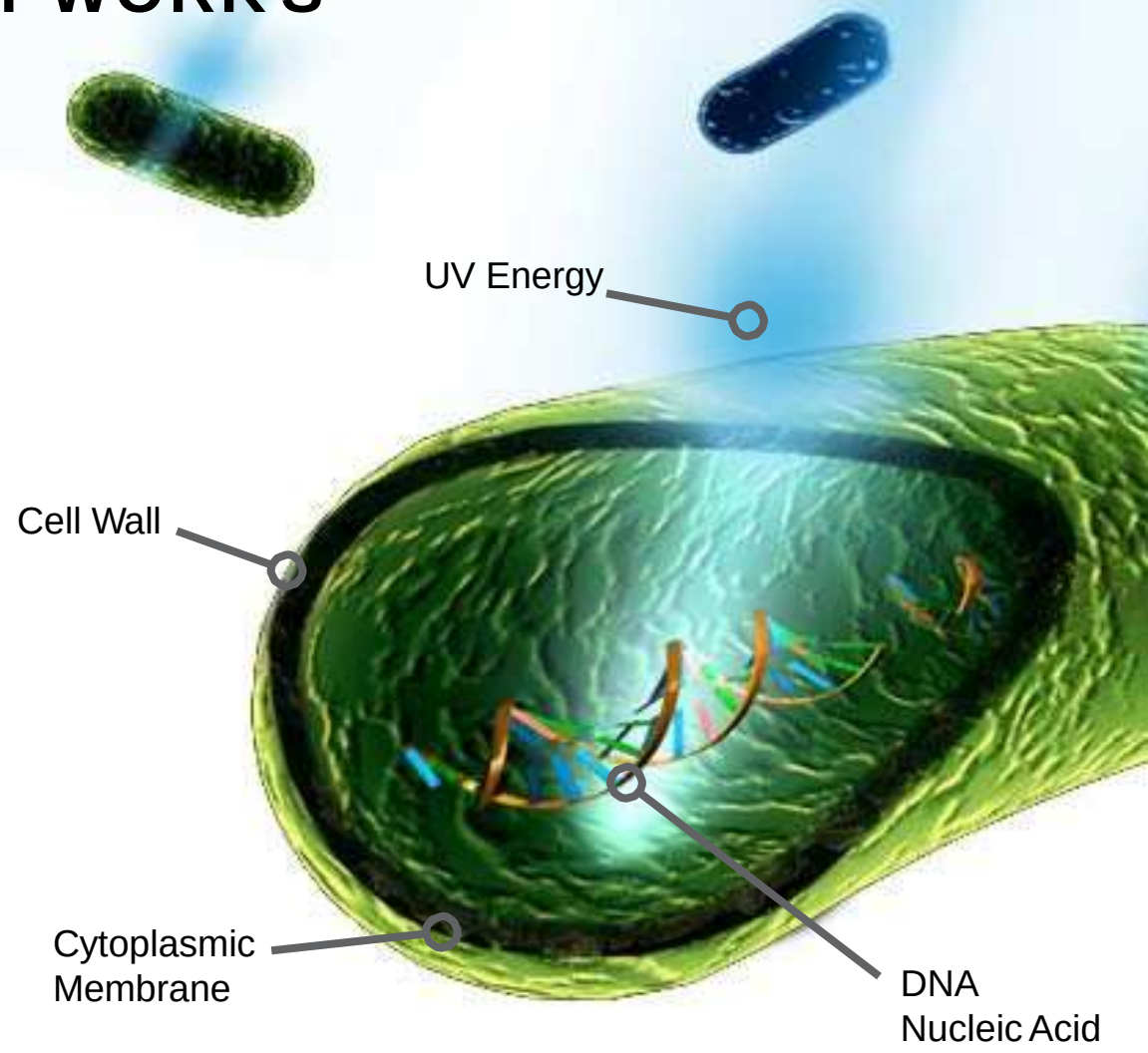
# Microscreens & UV in Aquaculture

**Model F 2050 = 2000 mm Drum Diameter & 50 filter elements**

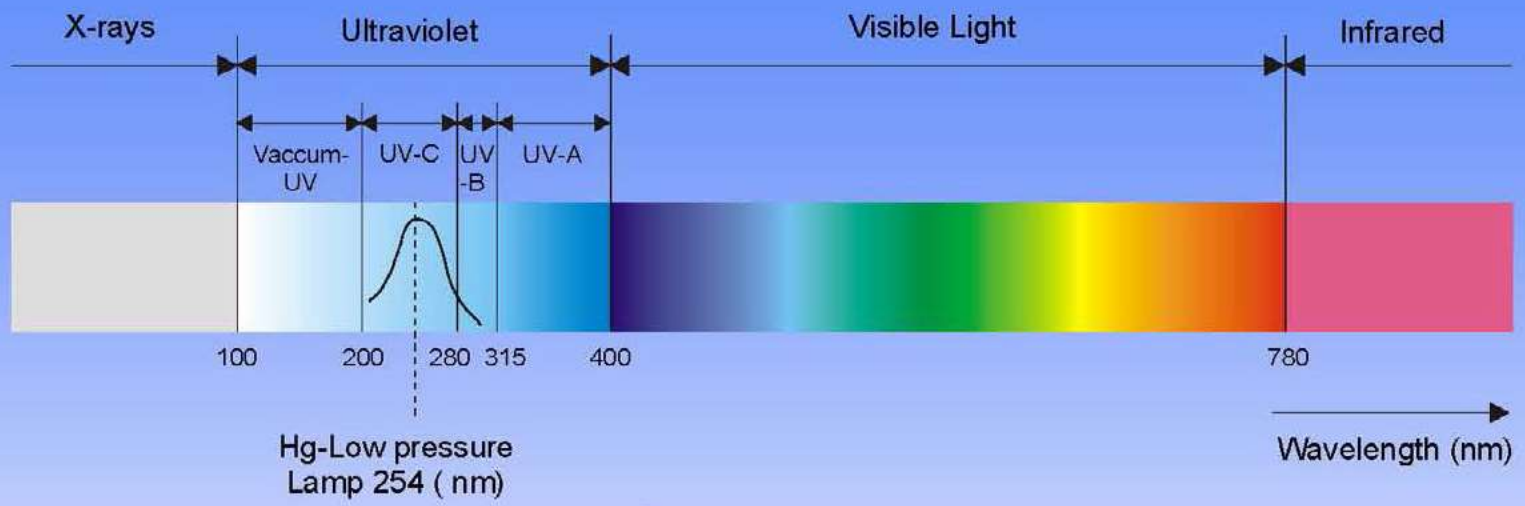
# UV DISINFECTION - HOW IT WORK S

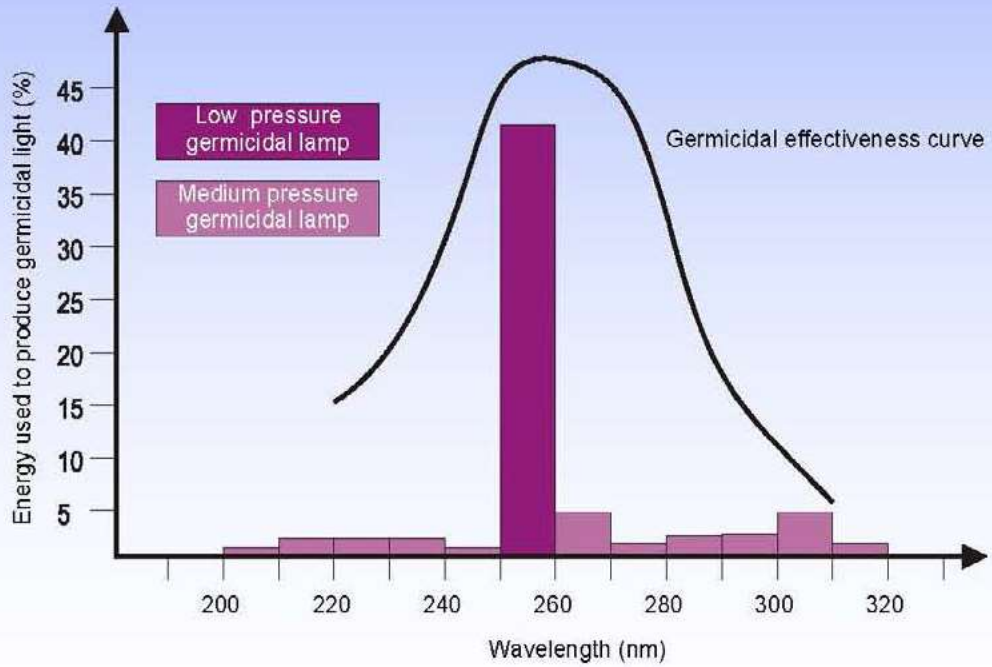
UV light at the 254 nm wavelength penetrates the cell wall of the microorganism, such as viruses and bacteria.

The microorganism is “inactivated” and rendered unable to reproduce or infect.



# UV LIGHT




Ultraviolet light efficiency from Low-pressure and Medium-pressure UV lamps.

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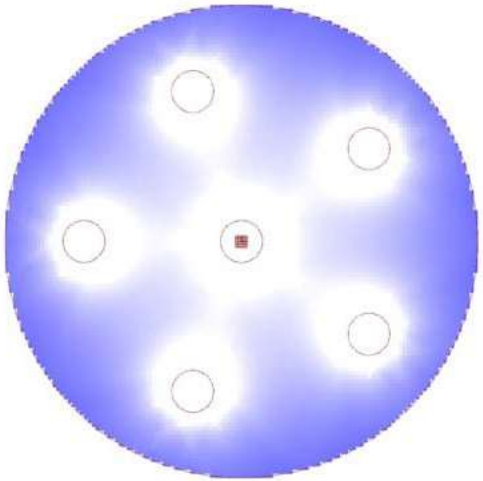
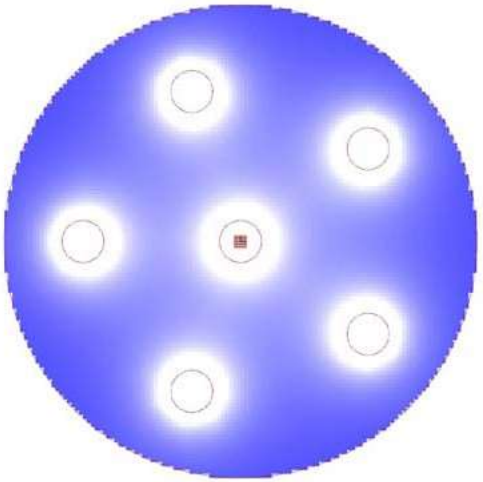
# BASIC DESIG N PARAMETERS FOR UV SYSTEMS

- **Design flow, in m³/h / GPM / CFS**
- **Desired dose, in mJ/cm²**
- **UV transmission factor, UVT. *Clarity of the water.**



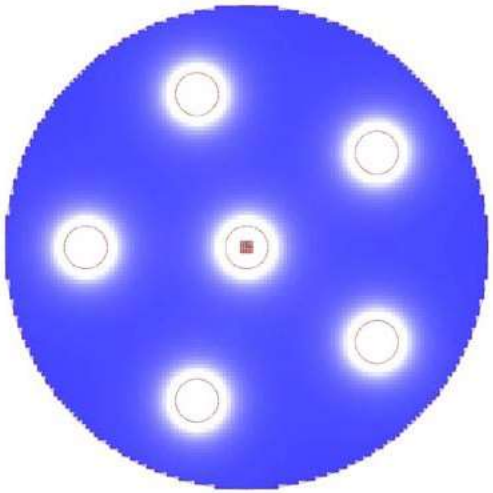
**100% UV radiation**

UVT 95%



**58% UV radiation**

UVT 85%



**24% UV radiation**

UVT 60%

# DESIGN PARAMETERS – UV TRANSMITTANCE *Special note*

Water clarity is not an effective indicator, because both solid and dissolved material can absorb UV light.
For example: metals (iron) in water are not visible to the human eye but absorb UV light and have a negative impact on UVT. Look at water quality / chemistry as well as UVT.

Regarding Aquaculture applications, flow-through fish-culture systems requiring influent disinfection typically test at 90-95% UVT. In contrast, RAS recirculating aquaculture systems typically test lower at 70-90% UVT. Application conditions vary and, therefore, must be evaluated individually. For the same flow rate: If UVT is 70% then the UV-system will need up to three times as many UV-lamps compared to UVT of 95%.

# UV in AQUACULTURE - *WHY AND WHAT DO YOU WANT TO DISINFECT?*

## RECIRCULATED WATER

RAS system can contain high loads of bacteria. After some time pathogen organisms might be seen in the water.

Effective UV disinfection ensures a low and stable load of organic material, and is therefore crucial for the performance of the biofilter

## INTAKE WATER

Depending where the water is sourced it may contain living microorganisms. different sources, Rivers, ponds, wells, public water.

Effective UV ensures that no harmful microorganisms enter to the Hatchery

## WATER IN WELLBOAT LIVESTOCK TANK

Retrofit friendly UV disinfection solutions to protect your fish while being transported in-land/ out-land.

## DISCHARGE WATER FROM THE FARM

Increasingly also effluent water from the fish farms have to be disinfected before discharging to nature.

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# APPLICATIONS AROUND AQUACULTURE

- Hatchery
- Nursery
- On Growing facility (post smolt)
- RAS (Recirculating Aquaculture Systems)
- Various species – from Salmon to shrimp
- Aquaponics
- Pond Culture
- Fresh & Saltwater
- Cold water and warm water species



# RAS INSTALLATION CATEGORIES

## Intake water

Ensure no unwanted organisms enter the system

- ☑ High average dose typically around 100-250mJ/cm²
- ☑ Focus on high security ‘firewall’
- ☑ Automatic cleaning mechanism
- ☑ Ensure high minimum UV dose

3x MR48-350SS, each treating 1500 m3/h
Ed Weed – Grand Isle in Vermont, USA

## Recirculated water

Reduce overall bacteria count and eliminate the risk of virus outbreak.

- ☑ Average dose typically around 35mJ/cm²
- ☑ Focus on energy consumption
- ☑ Energy efficient technologies
- ☑ Low running costs

2 x MR100-350SS Channel, each treating 2600 m3/h in AquaPri, Denmark

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# INTAKE WATER UV – WHICH FACTORS SHOULD BE CONSIDERED?

## PRE-FILTRATION

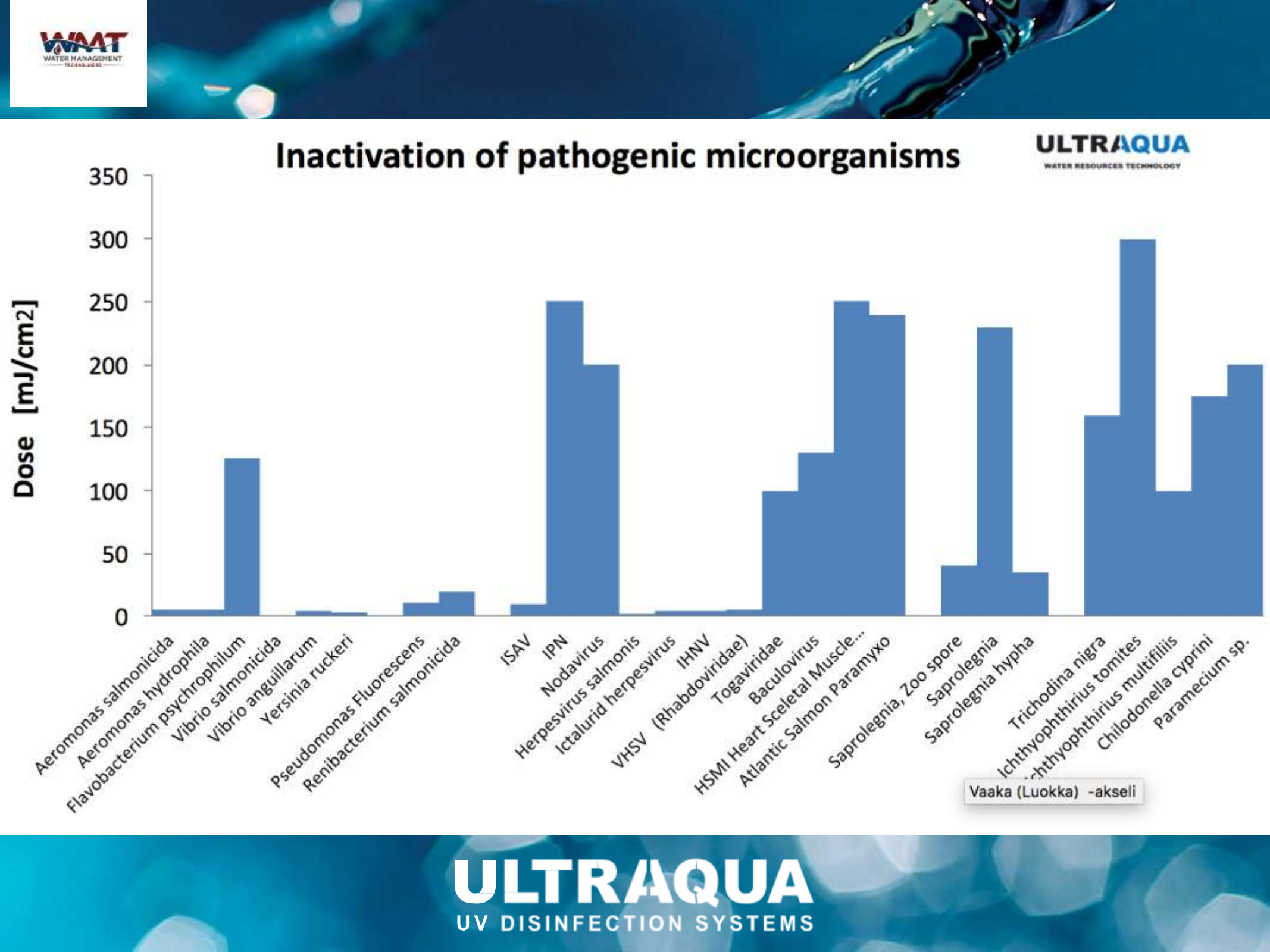
- Depending of the water source recommended < 50 micron filter before the UV

***WHY?***

- Take out particles that could block UV light from reaching microorganisms
- Decrease the turbidity of the water ( better UV-transmittance -> less powerful UV system needed)

## UV SYSTEM

- Target microorganism
- Seawater or freshwater
- Water parameters like UVT can vary depending the season
- Automatic cleaning system


Inactivation of pathogenic microorganisms
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WATER RESOURCES TECHNOLOGY
Dose [mJ/cm2]
350
300
250
200
150
100
50
0
Aeromonas salmonicida
Aeromonas hydrophila
Flavobacterium psychrophilum
Vibrio salmonicida
Vibrio anguillarum
Yersinia ruckeri
Pseudomonas Fluorescens
Renibacterium salmonicida
ISAV
IPN
Nodavirus
Herpesvirus salmonis
Ictalurid herpesvirus
IHNV
VHSV (Rhabdoviridae)
Togaviridae
Baculovirus
HSMI Heart Sceletal Muscle...
Atlantic Salmon Paramyxo
Saprolegnia, Zoo spore
Saprolegnia
Saprolegnia hypha
Trichodina nigra
Ichthyophthirius tomites
Ichthyophthirius multifiliis
Chilodonella cyprini
Paramecium sp.
Vaaka (Luokka) -akseli
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## RE-CIRCULATED WATER – *WHAT ABOUT THE FOULING IN QUARTZ SLEEVES?*

Usually in RAS, nitrifying bacteria eats alkalinity which is the main reason why we have not seen fouling on quartz sleeves in the RAS loop.

However, it should be noted that the cocktail of high organic load, high alkalinity and high amount of manganese and iron may create fouling which is difficult to control with automatic or manual cleaning.

# CHOOSING A CORRECT TYPE OF UV FOR AN APPLICATION

*Aspects that should be considered*

## Installation location

- The installation location is dry and frost-free
- Air bubbles don't accumulate in closed reactors
- For channel systems that it is possible to lift up lamp frames
- Make sure it is possible to remove and re-install UV-lamps and quartz sleeves

**Control cabinet:**

- Ambient temperature (should not exceed 35°C)
- Protected against exposure to direct sunlight and rain

**Thermal control options:**

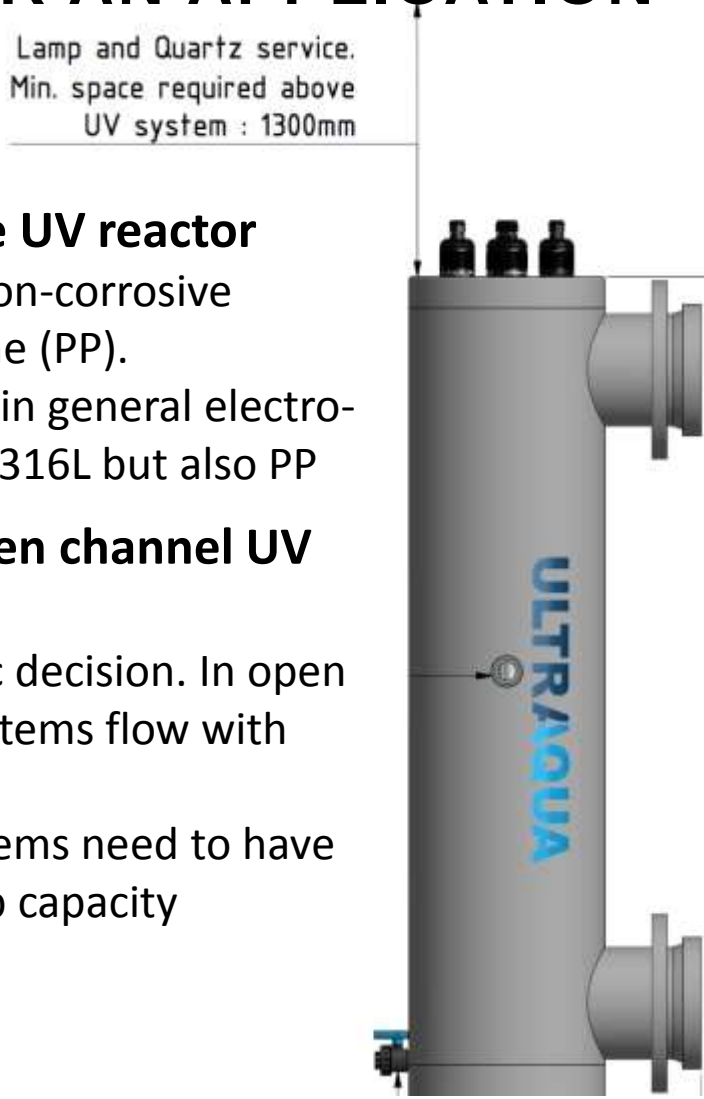
- AC unit or Heat exchanger
- Fully closed cabinet (passive heat dissipation)
- Room with air conditioning

## Material of the UV reactor

- Sea water: non-corrosive polypropylene (PP).
- Fresh water: in general electro-polished AISI316L but also PP

## Closed or open channel UV system

- Site specific decision. In open channel systems flow with gravity.
- Closed systems need to have some pump capacity



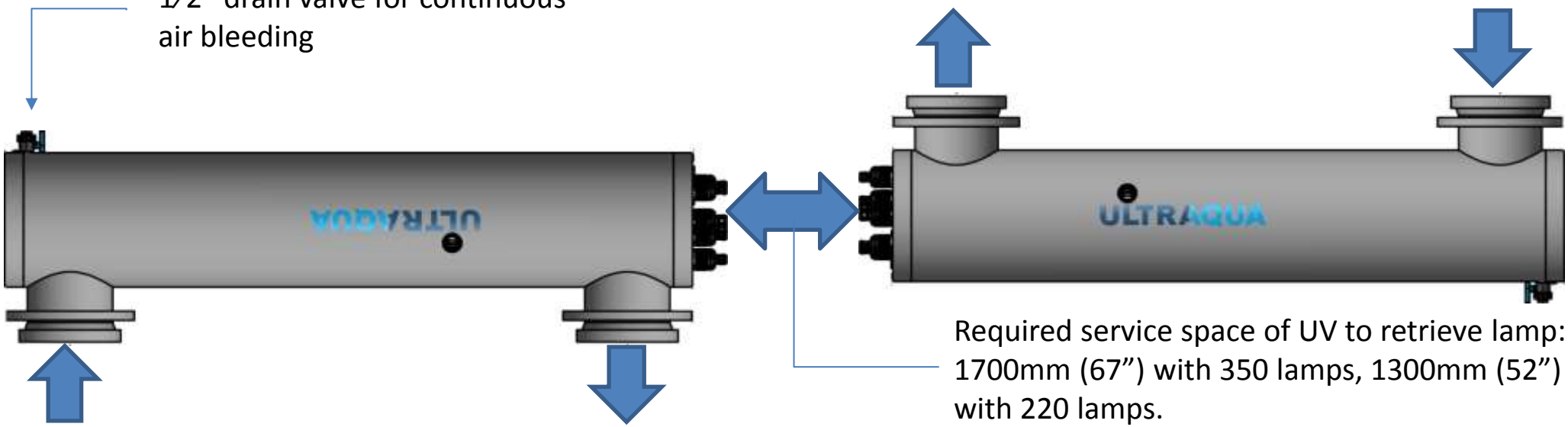
# CLOSED PRESSURIZED REACTOR INSTALLATION

*Horizontal installation*

If inlet/outlet are pointing downwards, 1⁄2” drainage valve can be used for continuous air bleeding. New drainage valve mounted in connecting pipe is then required.

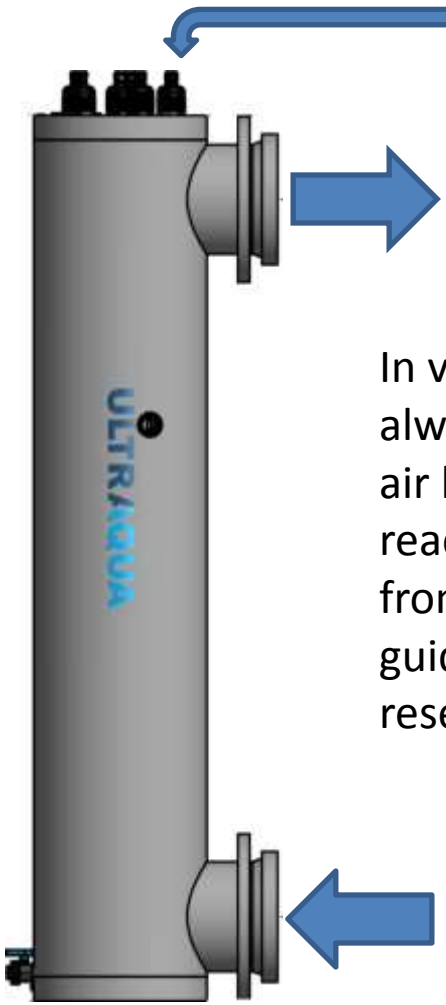
It is recommended to install the unit horizontally with inlet/outlet connections pointing upwards. This is to avoid accumulation of air accumulation in the reactor.

Always check that air does not accumulate as a result of up- or downstream piping layout.



# CLOSED PRESSURIZED REACTOR INSTALLATION

*vertical*




1⁄4” plug in reactor top
For air bleeding

In vertical installation reactor always requires continuous air bleeding. Use 1⁄4” plug in reactor top. If possible, water from air bleeding should be guided back to an open reservoir upstream the pump.

**General checklist:**

- Reactor chamber can be emptied for service work
- UV-lamps and quartz-sleeves can be replaced.
- Necessary precautions are taken in the event of flooding due to quartz sleeve breakage.
- Reactor chamber must be properly supported to avoid possible vibration during the operation
- Use UV-resistant materials for up and down stream piping (PP,PE,SS)
- If PVC is used, it is highly likely that the PVC will discolour and may become brittle in the areas of the connections

# OPEN CHANNEL UV SYSTEMS - VARIOUS INSTALLATION PRINCIPLES IN OPEN CHANNELS

A) Solution for 1-3 frames
Shown:
· 1 MonoRay SS channel unit
· 1 wall mount plate
· 1 flow guide plate

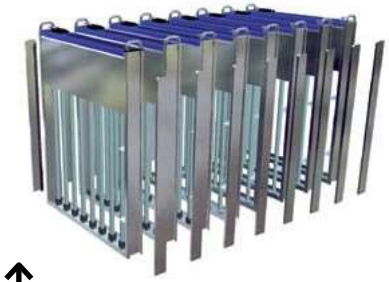
A Flow is guided along lamps to ensure even exposure to UV

B) Solution for 1-3 frames
Shown:
· 2 MonoRay SS channel units
· 2 sets of side mounting rails
· 3 flow guide plates

B Flow is guided along lamps to ensure even exposure to UV

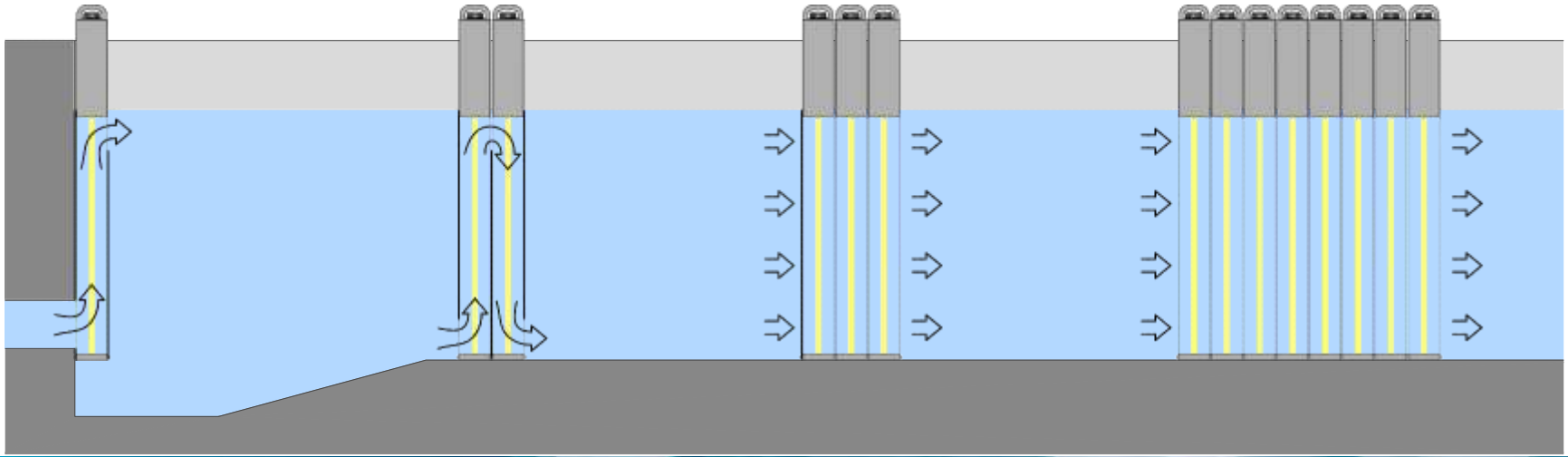
C) Solution for 2-5 frames
Shown:
· 3 MonoRay SS channel units
· 2 sets of side mounting rails
· 1 perforated plate

C Perforated plate creates mixing to ensure even exposure to UV



D) Solution for > 4 frames
Shown:
· 8 MonoRay SS channel units
· 8 sets of side mounting rails

D With more than four frames even exposure to UV is ensured by unit design



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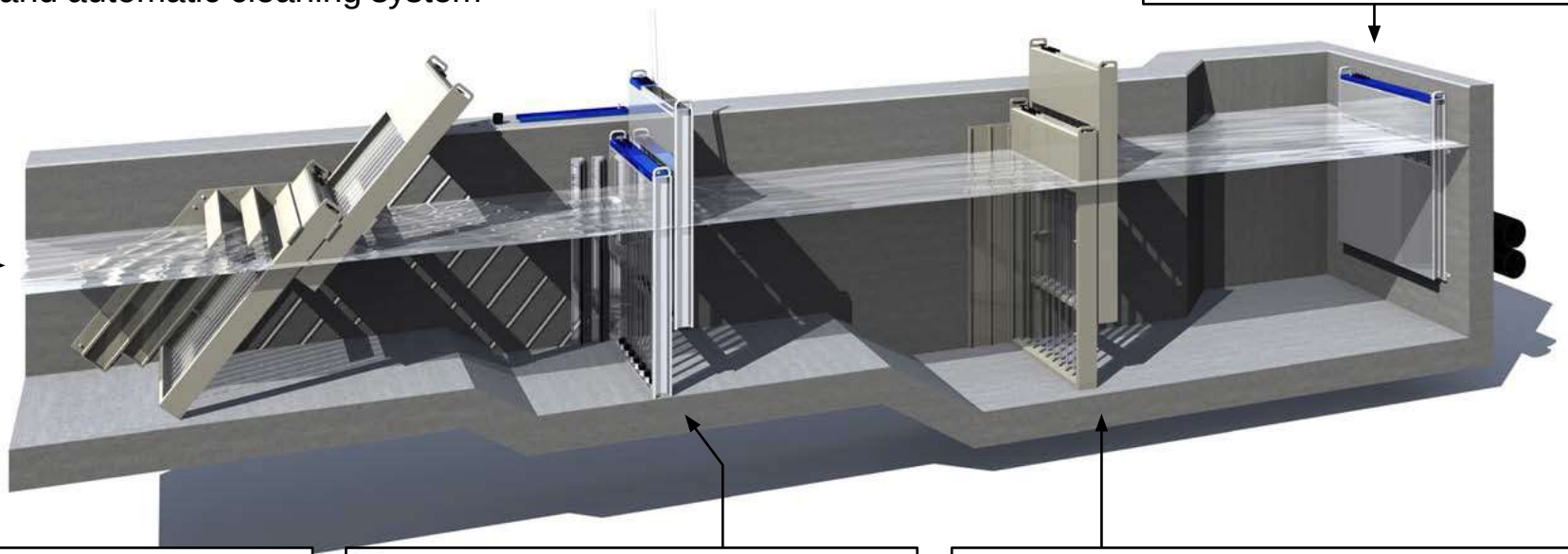
# HIGH FLOW RATES IN OPEN CHANNELS

## - OPEN CHANNELS AND RESERVOIRS

***Widely used in aquaculture systems***

- ☑ Modular concept to fit any geometry and flow rate
- ☑ AISI316L Stainless steel or heavy wall polypropylene reactors
- ☑ Accepts large water level variations
- ☑ Extremely low headloss
- ☑ UV monitoring and automatic cleaning system

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# STAINLESS STEEL CLOSED REACTOR SYSTEMS

## - OPTIMIZED FOR DISINFECTION

***ULTRAAQUA stainless steel reactors:***

- ☑ Material AISI316L
- ☑ Electro-Polished inside and outside
- ☑ Large DIN/ANSI flanges for low head loss
- ☑ Fully automatic cleaning system
- ☑ UV monitoring ACC. to ÖNORM-DVGW standards


MR8-220SS, 200m³/h
Lonnaval, Australia


MR16-350SS VAL, 350m³/h
Belsvik, Norway

***Ultratherm lamps - Market leading performance:***

- ☑ Life time 16.000 hours guaranteed
- ☑ All lamps are made in Germany

MR14-440SS, 2x 750m³/h
Puerto Varas, Chile

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# SMALL FLOW PP & SS REACTOR SYSTEMS

**Small flow rate UV systems in both stainless steel and PVC-C or PE material.**

MR1-75PVC-C, 5m³/h
Hirtshals, Denmark

- ☑ Ideal for flows <10m³/h
- ☑ Multicolor digital display
- ☑ Temperature protection Simple
- ☑ or advanced controller
- ☑ UV monitoring with advanced controller
- ☑ Plastic or steel (316L) enclosure


75 Series, One lamp reactor

| | MR1-75SS | MR1-75PVC-C |
|---|---|---|
| Max flow m³/h | 8 | 6 |
| Power | 0,08kW | 0,08kW |
| Inlet / Outlet | 1½" BSP | 2" BSP |

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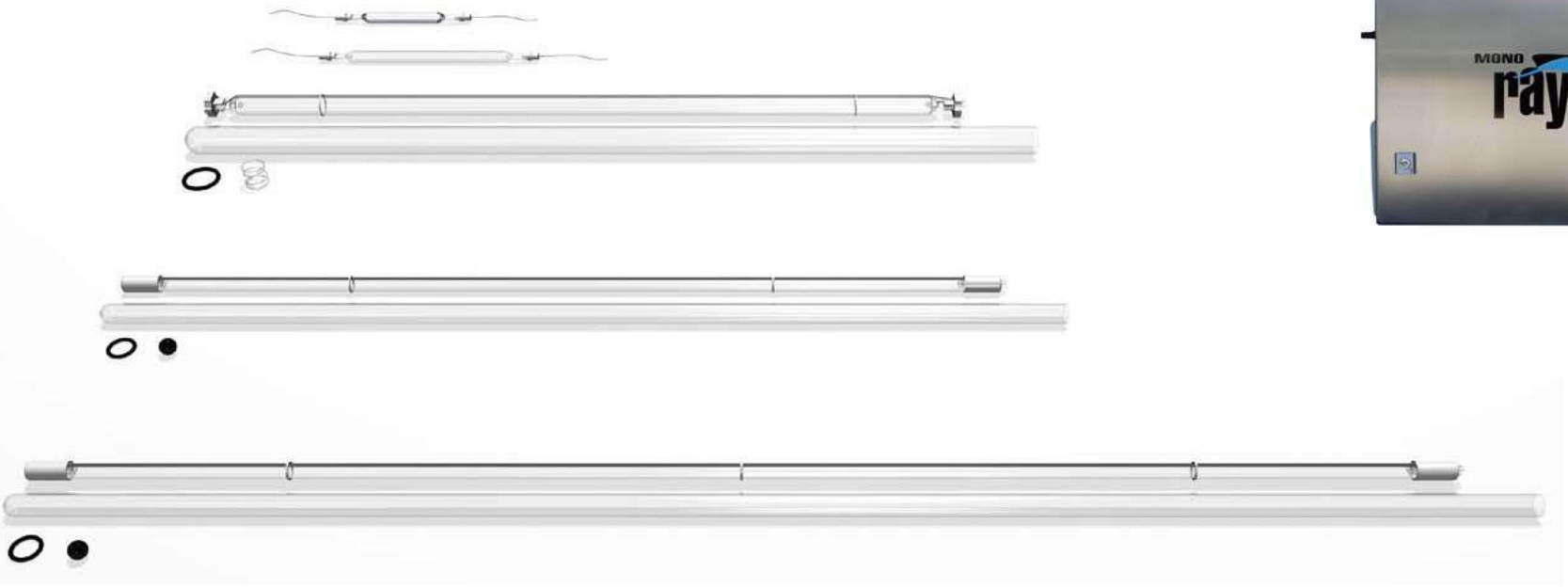
- **ULTRATHERM® Long-life coated LPHO UV lamps with 16.000 hours lamp lifetime (EOLL 80%-85%)**
- **Lamp UV efficiency 36%**
- **Intelligent electronic ULTRATHERM® lamp drivers**

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# EASY MAINTENANCE

## - NO TOOLS REQUIRED

***Maintenance is very simply***

- ☑ Efficient degradation of chloramines
- ☑ Efficient inactivation of all kinds of microorganisms
- ☑ Very low footprint
- ☑ Ideal for retrofit
- ☑ Advanced high frequency electronic lamp driver

Polypropylene reactors use similar sealing components as SS reactors.

- Replacement of UV lamps with reactor fully pressurized
- Hand operated quartz sleeve nut
- Shock absorber to protect quartz sleeve if lamp is dropped

# AUTOMATIC CLEANING SYSTEM

## - EXTRA SAFETY

***Build to last also in complex wastewater***

- ☑ Long life PTFE wiper rings
- ☑ High quality servomotor
- ☑ Very few components
- ☑ Fits 220, 350 and 440 closed reactor or open channel

**Please note:**

- Medium pressure systems are supplied with manual cleaning device as standard.
- Low-pressure UV systems are supplied without cleaning system as standard
- Validated low-pressure UV systems are always supplied with automatic cleaning system

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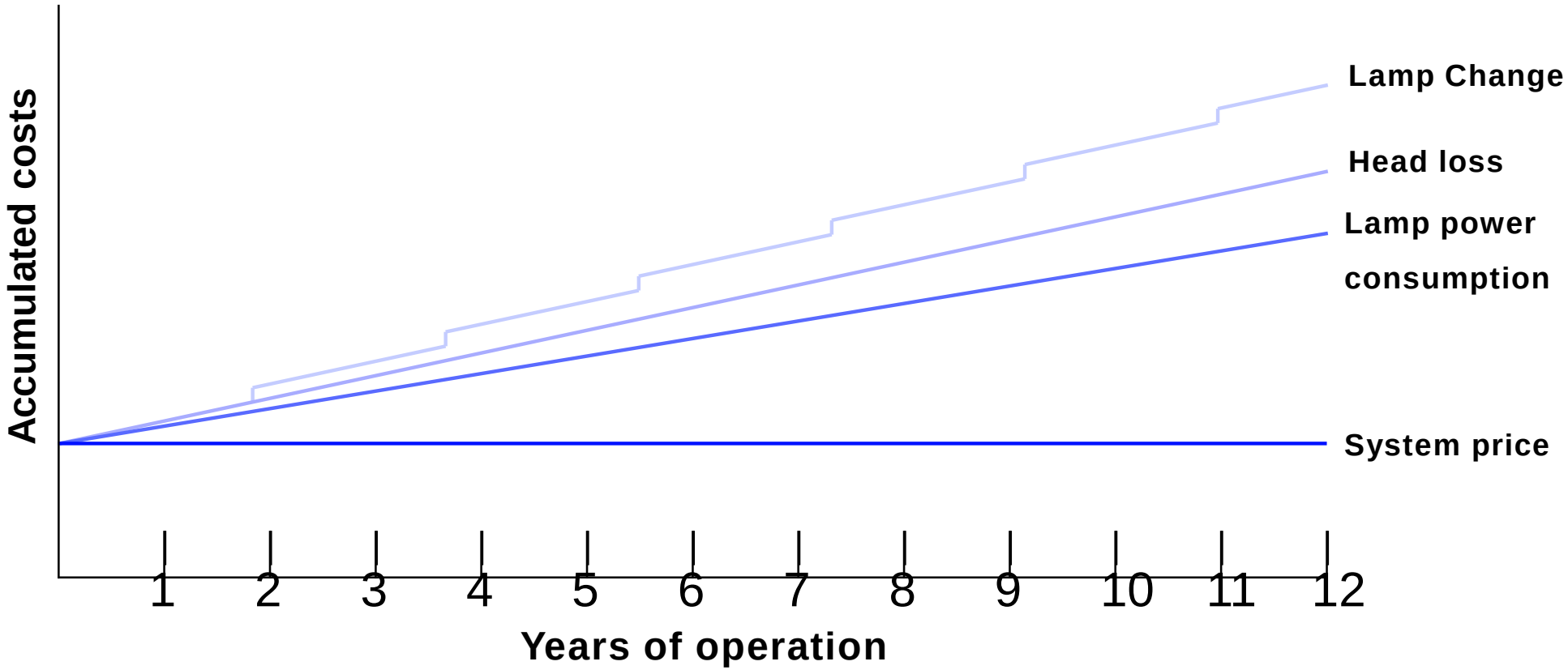
# UV SYSTEM LIFETIME ECONOMY



# Summary

1. Microscreens and UV are complimentary, scalable and proven water treatment processes in aquaculture. < 100 gpm - > 10,000 gpm.
2. Both technologies work with gravity or pump.
3. Both Microscreens and UV are Low Head! Each requires < 1 ft. of Head!
4. Main Applications = Intake, RAS and Effluent.

**Questions ?**

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