

DRYDEN AQUA
DISTRIBUTION | SUSTAINABLE WATER QUALITY

Dryden Pool Academy
SESSION 8

PUBLIC POOLS

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

10 HIGH-LEVEL TRAINING SESSIONS

Zoom Live

DAISY+ : Dryden Aqua Integrated System

KNOW THE FLOW!

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AGENDA 9:30 – 10:30


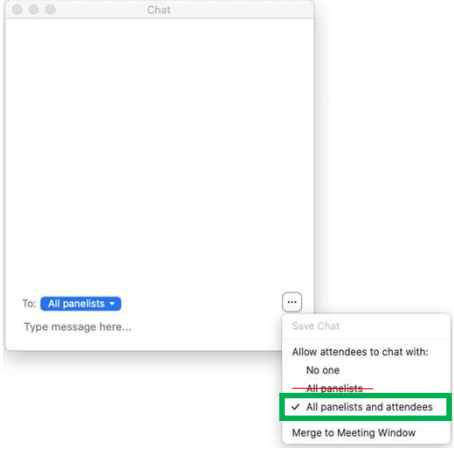
DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

SESSION 8


- Combined chlorine and THMs
- 4 ways to treat water in public swimming pools
- UV medium pressure systems
- DAISY® + Advanox: The best solution for reducing combined chlorine and pharmaceuticals
- Q&A : Questions / Answers


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Questions & Answers

Prepare and send us your questions during the meeting using the chat!

 Chat

 Raise Hand

 Q&A

3

Dryden Pool Academy presentations and replays







www.drydenaqua.com


Replay available for 7 days after each session (EN, DE, FR, US)

PDF Presentation available for download 24 hr before each session (every Thursday)

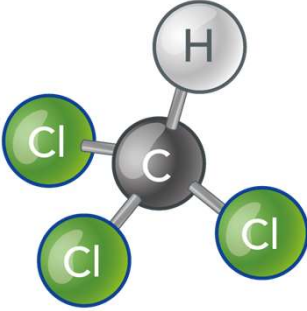



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Chloroform

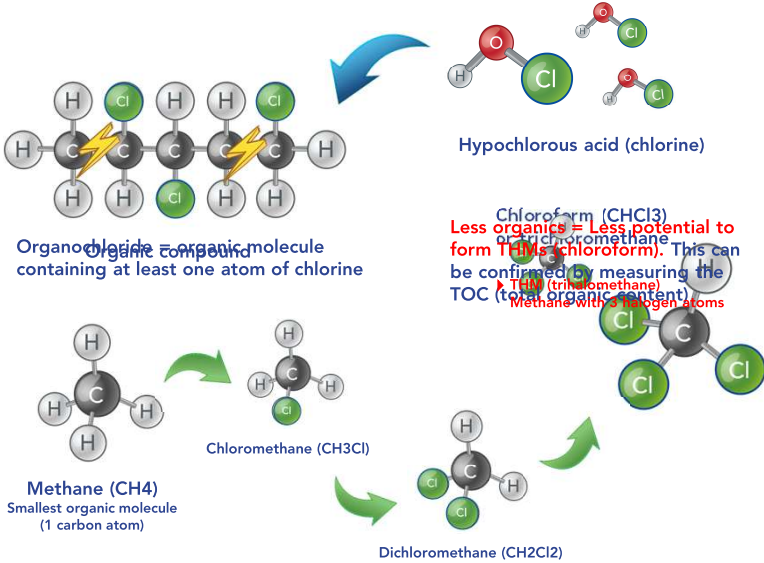


CHCl₃

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Chloroform (THMs) is formed in water when chlorine reacts with organics





Organic compound

Hypochlorous acid (chlorine)

Chloromethane (CH₃Cl)

Methane (CH₄)
Smallest organic molecule (1 carbon atom)

Dichloromethane (CH₂Cl₂)

Chloroform (CHCl₃)

Less organics = Less potential to form THMs (chloroform). This can be confirmed by measuring the TOC (total organic content) with organic content.

THM (trichloromethane)
Methane with 3 chlorine atoms

Organic compounds are composed of mainly carbon and hydrogen.

Chlorine oxidize organic molecules such as oil, lipids or protein to form **organo-chloride**


Chlorine keeps breaking down the molecule into smaller parts

Chloroform (CHCl₃) is a very volatile toxic by-products.


Chloroform passes the lungs to reach the bloodstream and nerve system.

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Biofilm is responsible for the formation of trichloramines



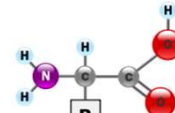
50 ml urine



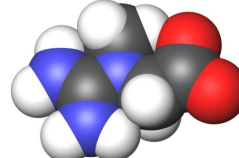
200 ml sweat




In two hours in the water, an athlete can secrete up to 1 l of sweat and 80 ml of urine.




Amino acid



Creatine



ammonium
about 10%

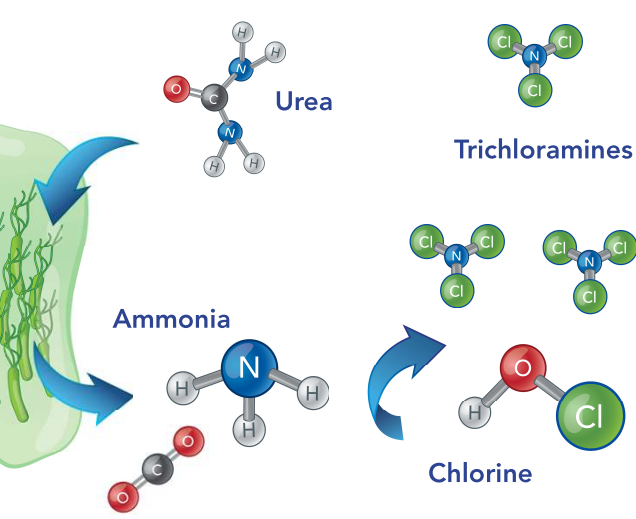


urea
about 80%

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Biofilm is responsible for the formation of Trichloramines



Urea


Ammonia

Chlorine

Trichloramines

- 1 Urea and other nutrients brought by bathers feed bacteria in the biofilm
- 2 Urea is converted by bacterial enzymes (urease) to ammonia (NH₃)
- 3 Ammonia reacts with chlorine in acidic biofilm to form mono-di-trichloramines
- 4 Trichloramine gas is discharged into the air : Chlorine smell, eye and lung irritation

NO biofilm

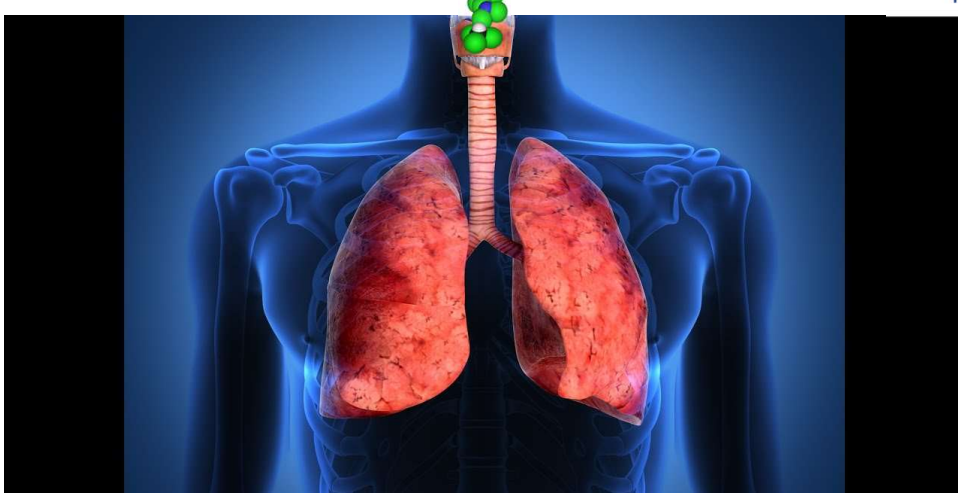


→ No or significantly less trichloramines

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Trichloramines and chloroform are volatil and therefore toxic



Disinfection by-products => If they are volatile – They are toxic

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Disinfection by-products => If they are volatile – They are toxic




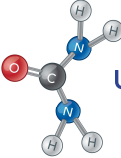
Volatile chlorine by-products are especially dangerous for small children less than 2 years old, because their blood-brain barrier is not yet fully developed.



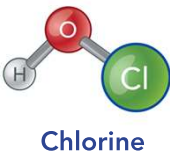
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Total combined chlorine : organic + inorganic chloramines






Urea



Chlorine



Organic chloramines

DPD-1 + DPD-3 = DPD-4

Total Chlorine

Combined Chlorine

Free Chlorine

Inorganic Chloramine

- Monochloramine
- Dichloramine
- Trichloramine

Organic Chloramine

- N-Chloramine
- N-Chloramine acid
- N-Chloramide
- N-Chloraldimine


AFM® → 10-20% inorganic chloramines
90-80% organic chloramines

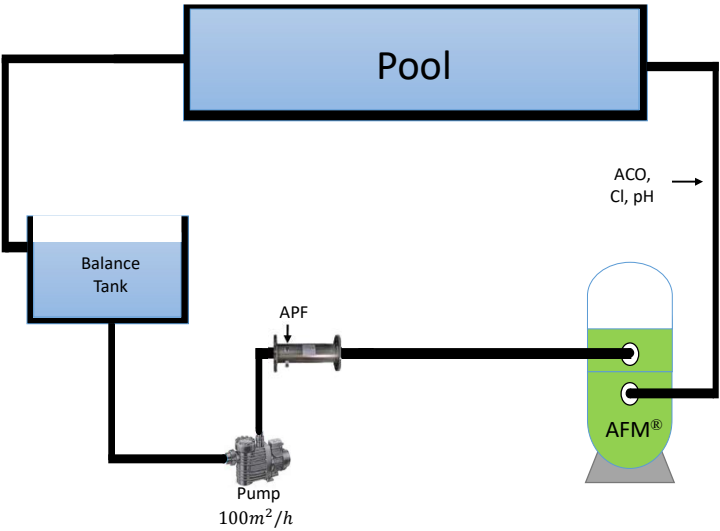
Sand → 80-90% inorganic chloramines
20-10% organic chloramines

DPD-1

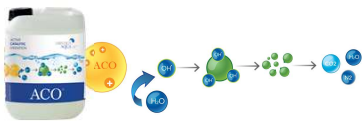
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DAISY® – public outdoor pool





- ▶ Coagulation & flocculation with APF® (and ZPM)
- ▶ Filtration with AFM®
- ▶ Injection of ACO®



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Outdoor pool Heiden, Switzerland - 5 years old - 30 tons of AFM, APF & ACO



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Outdoor pool Heiden, Switzerland



- The values for combined chlorine are between 0.01 - 0.1 mg / l
- THMs at 25 µg / l (0.025mg/l).
- Even in hot conditions such as summer 2018 – water temperatures up to 27° - we had these excellent values (see analysis below).
- The water has never been so clear before. Turbidity below 0.1 NTU
- Chlorine consumption has been reduced by approx. 25%.
- There is no smell of chlorine.

Auszug aus den Untersuchungsergebnissen

Feldparameter

Parameter	Einheit	HW	RW	EW	I1155	I1156	I1157
Chlor, frei	mg/L	0.80			0.34	0.13	0.29
Chlor, gebunden	mg/L	0.20			<0.05	0.09	<0.05
pH-Wert		7.60			7.60	7.80	7.40
Temperatur	°C				25.8	26.2	26.2
Leitfähigkeit (25°C)	µS/cm				1042	1038	836

Mikrobiologische Befunde

Parameter	Einheit	HW	RW	EW	I1155	I1156	I1157
amK, 30 °C	CFU/mL	1'000			1	0	16
E. coli	CFU/100 mL	n.n.			n.n.	n.n.	n.n.
Enterokokken	CFU/100 mL				n.n.	n.n.	n.n.
P. aeruginosa	CFU/100 mL	n.n.			n.n.	n.n.	n.n.

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Outdoor pool Heiden, Switzerland



Fazit: Wir sind mit Dryden Aqua's Konzept DA-SY (AFM, APF und ACO) sehr zufrieden und empfehlen es anstelle von Sand einzusetzen. Die bescheidenen Mehrkosten sind durch die wesentlich bessere Wasserqualität gerechtfertigt.

«We are very happy with DAISY»

Ueli Frigg

Ueli Frigg, Badmeister in Heiden: 29.8.2018

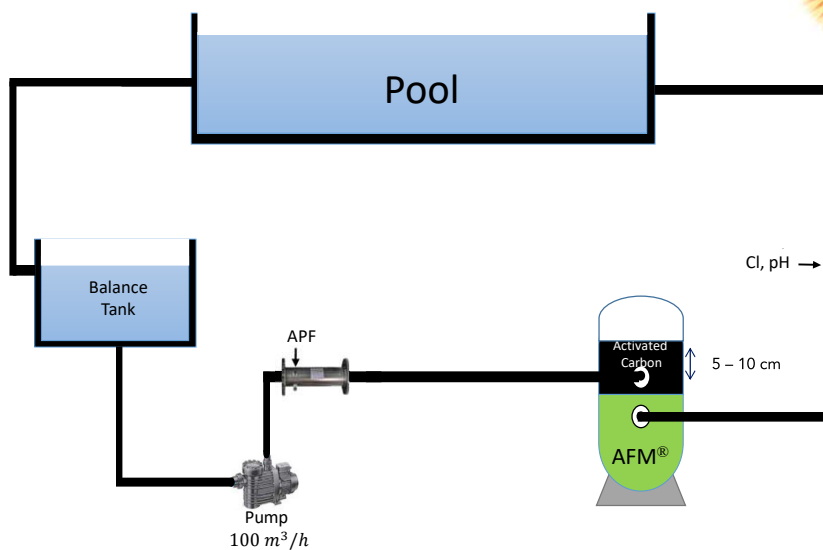


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DAISY® – Public Indoor Pool




▶ Coagulation & flocculation with APF®
You will get to 0.4mg/l of total combined chlorine


▶ Filtration with AFM®
+ 10 cm of activated carbon
To reach combined chlorine < 0.2 mg/l

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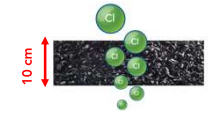
DAISY® – Public Indoor Pool





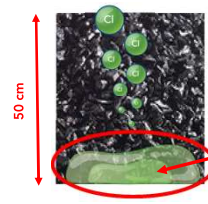
10 cm activated carbon on top of the filter bed in replacement of AFM

Stay under 10 cm of layer to prevent biofouling of the carbon




10 cm

Chlorine should go through all the way




50 cm


All chlorine is adsorbed
Bottom starts to be biofouled




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What about anthracite? Anthracite N vs H





NOT INTERESTING FOR POOLS

Anthracite N


Spec. weight 720kg/m³
Grain sizes: 0.8 – 1.6 or 1.4 – 2.5mm
Based is stone coal

It is not thermal activated

Has no adsorption capacity

Surface is not porous

Is only used for room filtration



NEEDS 3x MORE DEPTH THAN ACTIVATED

Anthracite H


Spec. weight 500kg/m³
Grain sizes: 0.8 – 1.6 and 1.4 – 2.5mm
Based on brown coal - thermal activated

Surface (BET) 300m²/g (3x lower vs Activated carbon)


Dechlorination half-life length: 30cm @ 30 m/h filtration velocity

Is used for THM and combined chlorine reduction

Can contain iron!!!




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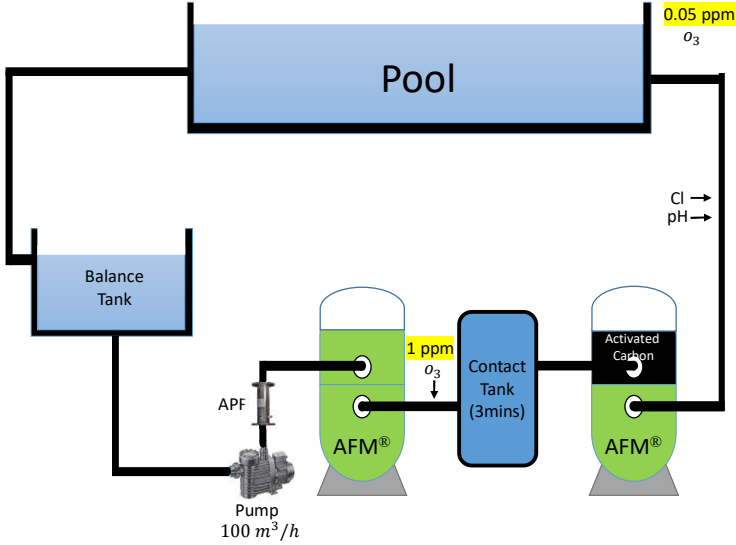


DRYDEN AQUA
SUSTAINABLE WATER QUALITY

DAISY® – Public Indoor Pool with O₃




DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER



- ▶ Coagulation & flocculation with APF® (and ZPM)
- ▶ Filtration with AFM®
- ▶ Injection of 1g/m³ O₃ + contact tank (>3 minutes)
- ▶ AFM + activated carbon filter


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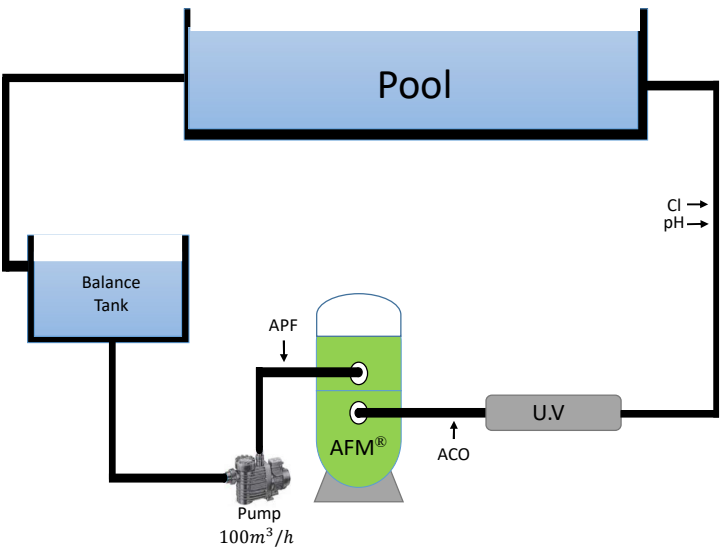


DRYDEN AQUA
SUSTAINABLE WATER QUALITY

DAISY® – Public Indoor Pool with UV medium pressure



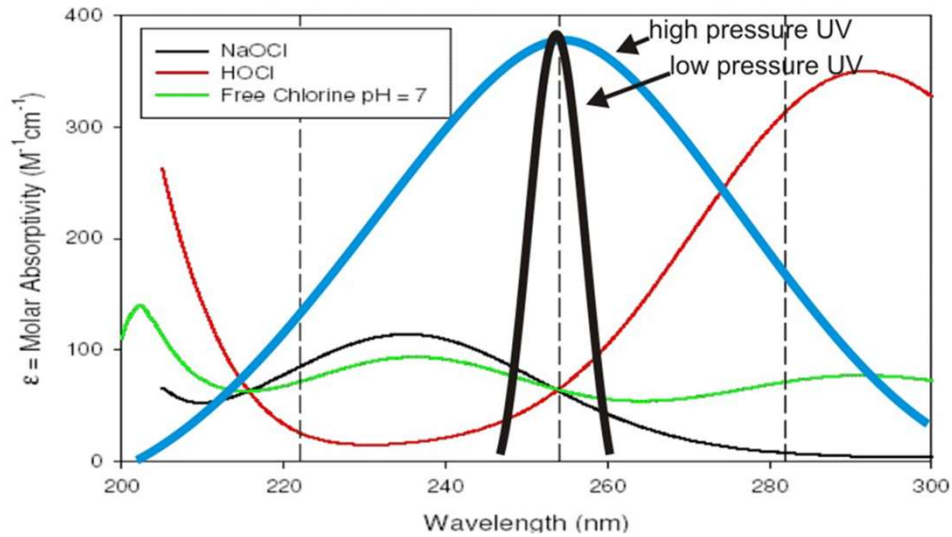
DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER



- ▶ Coagulation & flocculation with APF® (and ZPM)
- ▶ Filtration with AFM®
- ▶ Medium pressure UV system
Ideally with ACO® injection

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Reduction of combined chlorine with UV medium pressure

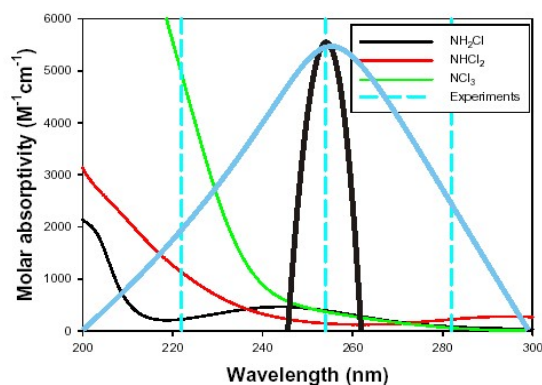


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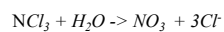
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UV medium pressure reduces inorganic combined chlorine

1. Medium pressure UV reduces inorganic combined chlorine by photolysis
2. Mono-, di- und trichloramine will be oxidised to nitrate (NO_3)
3. Nitrate is a food source for algae and bacteria



Low pressure UV (250 bis 260nm) are not effective in reducing inorganic combined chlorine. Medium pressure UV with a wave length down to 200nm is far more effective in reducing inorganic combined chlorine.



But: In this process you increase THM's ($CHCl_3$)

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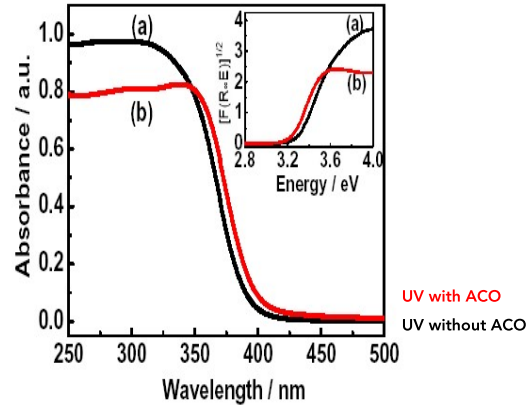
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UV adsorption spectrum

ACO works as a "sunblocker". Wavelengths below 350nm are deflected into a longer wavelength. The energy released in the process forms free radicals (OH. and O.).

Short wavelengths break organic compounds into smaller components. This is called photolysis. Each of the smaller components then react again to form DBPs like chloroform.

Thanks to ACO, free radicals are formed which further oxidize contaminants to CO₂, N₂ and H₂O



The high absorbance figures below 350nm wavelength shows ACO prevents short wavelength UV light penetration of the water.

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UV medium pressure and ACO

- UV medium pressure lamps cause the photolysis of chlorine, chloramines and organic substances.
- The short wavelengths break down organic molecules into smaller components. Each of these components will react with chlorine to form chloroform.
- Inorganic chloramines such as mono-, di- and trichloramines are oxidized to nitrate (NO₃) as the end product. Nitrate concentrations can rise up to 100mg / l. Nitrate is a fertilizer and increases the growth of algae and bacteria.
- ACO absorbs the short-wave UV light to produce more free radicals. These completely oxidize ingredients. What remains is CO₂, H₂O and N₂.
- We are against UV medium pressure lamps in connection with chlorine. If so, ACO should also be used.

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DAISY® : Case Study BAD HESSELINGEN (Holland)



BAD HESSELINGEN
MEPPEL



- Competition pool, 25x15m (850 m³)
- 5500 visitors/week
- 1 filter Ø 2700, 2 pumps with variable speed controller
- FS: 23 m/h / BS: 45 m/h

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BAD HESSELINGEN – Test protocol



- **STAGE 0** : old situation (sand filtration)
- **STAGE 1** : AFM + APF
- **STAGE 2** : UV (Low pressure)
- **STAGE 3** : 10cm Active Carbon

2 months
7 months
4 months
6 months


Test 1x per month by Eurofins/C-Mark
Always the same day
Always at the same time

**Tested Parameters:**

- Turbidity, pH, Free Chlorine, Total Chlorine, Combined Chlorine, KMnO₄, Urea, Aerob, Temperature
- Pseudomonas aeruginosa, intestinale enterococci, clostridia, Staphylococcus, Legionella, Bromate, Chlorate, THM's, Chloride, Nitrate, Trichloramine in air
- Aluminium, Calcium, Magnesia, Kalium, Barium, Carbonate, DOC, AOX

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BAD HESSELINGEN – Results



Parameters (according to law)	STAGE 0		STAGE 1				STAGE 2			STAGE 3		
	Date	12-03	07-04	19-05	14-07	08-09	03-11	29-12	23-02	24-04	12-07	09-08
Visibility	botto m	botto m	botto m	botto m	botto m	botto m	botto m	botto m	botto m	botto m	botto m	Botto m
pH	7,1	7,3	7,2	7,3	7,4	7,3	7,5	7,4	7,3	7,2	7,4	
Free Chlorine (mg/L)	0,7	0,9	1,0	1,0	0,8	1,0	1,1	1,2	1,0	0,9	0,8	
Total Chlorine (mg/L)	1,4	1,4	2,0	1,4	1,2	1,4	1,4	1,5	1,3	1,0	0,9	
Combined Chlorine (mg/L)	0,7	0,5	1,0	0,4	0,4	0,4	0,3	0,3	0,3	0,1	0,1	😊
KMnO4-usage (mg/L)	8,3	12,0	16,0	6,2	4,9	6,3	5,4	6,4	4,2	4,1	4,8	😊
Urea (mg/L)	0,5	0,5	0,8	0,8	0,8	0,8	0,6	0,8	0,6	0,5	0,5	
Aerob colony forming 36°C (kve/mL)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 4	< 1	< 1	< 1	
Temperature (°C)	27,1	27,0	22,0	22,0	22,1	22,1	22,0	22,5	22,0	22,0	22,0	
	SAND		AFM/APF				DAISY+UV			DAISY+AC		

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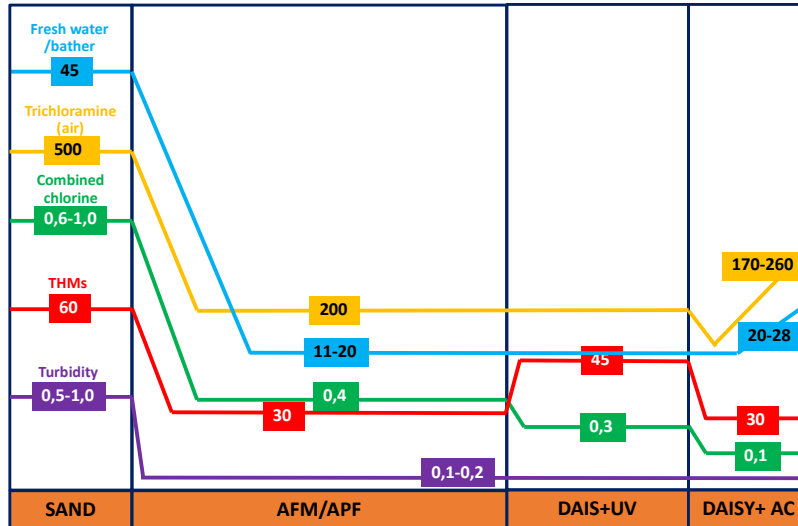
BAD HESSELINGEN – Results



Parameters (additional)	STAGE 0		STAGE 1				STAGE 2			STAGE 3		
	Date	12-03	07-04	19-05	14-07	08-09	03-11	29-12	23-02	24-04	12-07	09-08
Turbidity	0,5	0,5	0,5	0,11	0,16	0,12	0,27	0,15	0,09	0,20	0,21	😊
Sum THM's	46	56	61	33	24	27	45	43	-	30	25	😊
Trichloramine (air)		495	515	226		192	174	230		165	261	😊
Fresh water per bather	45	46	23	23	15	12	18	12	15	19	28	😊
	SAND		AFM/APF				DAISY+UV			DAISY+ AC		

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BAD HESSELINGEN – Results



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BAD HESSELINGEN – Results after 15 months


RESULTS after 15 months:

- **Crystal clear** (turbidity <0,2)
- Even after very high bather load – the water **stays in perfect condition**
- **No smell**
- **Combined chlorine very low** and steady
- **THM's decreased** (60 µg/L → 25 µg/L)
- **Trichloramines in the air decreased** (500 µg/m³ → < 200)

And.....

- Better water quality with **only 15L fresh water/visitor** (was 45 L)
- This means they are **saving on water (about 40K / year), heating, chemicals and electricity (about 2000 kW/h / month)**
- The managing director of Bad Hesselingen **has become an ambassador** who tells everybody that changing to AFM was their best decision. We take advantage of that.

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**DRYDEN
AQUA**
DISTRIBUTION

SUSTAINABLE
WATER
QUALITY

ADVANCED OXIDATION FOR PUBLIC POOLS

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**DRYDEN AQUA + VAN REMMEN
TOGETHER THE BEST => COMBINED STRENGTHS**

“Provide modern technology that combines cost saving with sustainable, cleaner water”

**DRYDEN
AQUA**
DISTRIBUTION

SUSTAINABLE
WATER
QUALITY

**DRYDEN
AQUA**
DISTRIBUTION

SUSTAINABLE
WATER
QUALITY

EXPERTS IN FILTRATION &
WATER CHEMISTRY
(POOLS, WT, AQUACULTURE)

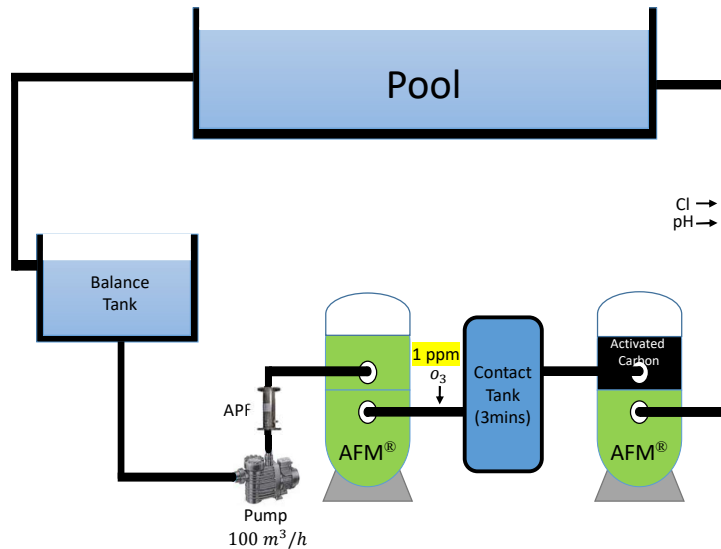
**VAN
REMMEN**
UV Technology

MANUFACTURES
STATE-OF-ART UV SYSTEMS
LOW ENERGY CONSUMPTION

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Public Indoor Pool with O₃

DAISY + Advanox: the cost effective alternative to Ozone



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Advanced oxidation for indoor public pools



What is advanced oxidation?

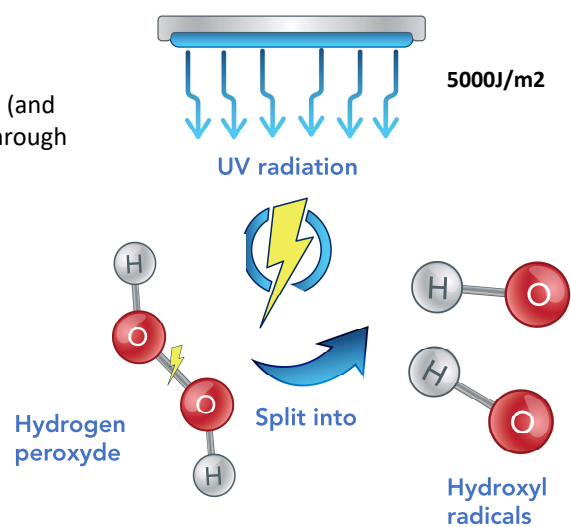
Chemical treatment process designed to remove organic (and sometime inorganic) material from water by oxidation through reaction with hydroxyl radicals ($\cdot\text{OH}$).

Hydroxyl radicals are one of the **most powerful** oxidants and **do not form harmful disinfection by-products**.

Hydroxyl radicals are produced during UV-dissociations of H₂O₂

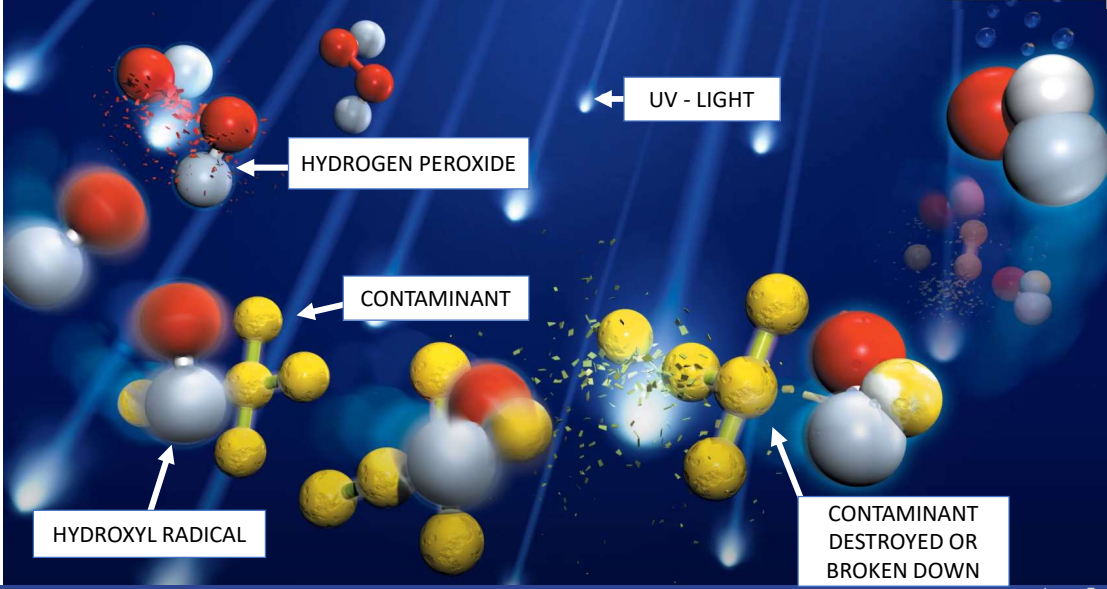
In other words:

- UV-radiation chops up the H₂O₂ molecule into
OH• OH•



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Advanced oxidation for indoor public pools



The diagram illustrates the advanced oxidation process. On the left, a hydrogen peroxide molecule (two red spheres and two white spheres) and a hydroxyl radical (one red and one white sphere) are shown. In the center, a contaminant molecule (yellow and white spheres) is depicted. On the right, the contaminant is shown being destroyed or broken down into smaller particles. The process is initiated by UV light, indicated by blue beams and a label 'UV - LIGHT'.

Labels in the diagram: HYDROGEN PEROXIDE, CONTAMINANT, HYDROXYL RADICAL, UV - LIGHT, CONTAMINANT DESTROYED OR BROKEN DOWN.

Image: TroianUV



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ADVANOX: ADVANced OXidation



The image shows the Advanox UV reactor unit, a cylindrical stainless steel device with a control panel on top. Two close-up views show the internal UV lamps glowing with a bright blue light.

Logos: DRYDEN AQUA SUSTAINABLE WATER QUALITY, VAN REMMEN UV Technology

Advanox™

ADVANCED OXIDATION

powered by **VAN REMMEN** UV Technology

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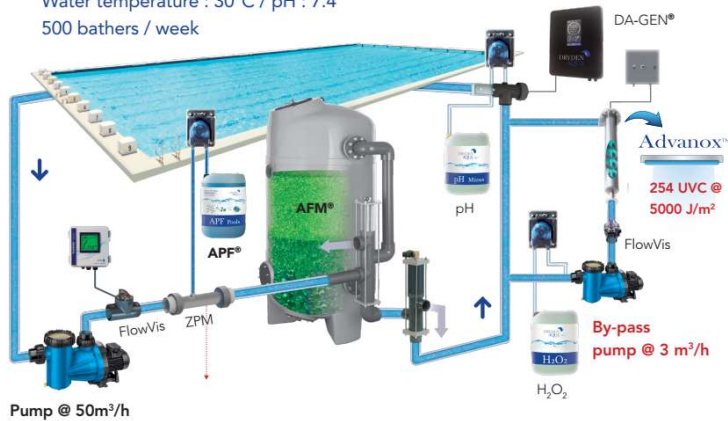
ADVANOX CASE STUDY

Public pool Breitenbach Switzerland



Example: 180m³ swimming pool

Water temperature : 30°C / pH : 7.4
500 bathers / week



Advanox:

- Install a by-pass on the return line
- **Turnover: Pass your pool volume every 2 - 3 days through Advanox**
- **Divide your pool volume by 60 (48 - 72 hours)**
- **Ex: Pool 180m³ / 60h => 3m³/h (every 2.5 days)**

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ADVANOX CASE STUDY

Public pool Breitenbach Switzerland



Example: 180m³ swimming pool

Water temperature : 30°C / pH : 7.4
500 bathers / week





Why only 1 pass every 2 - 3 days:

- Thanks to DAISY we have 80% organo-chloramine and only a very small amount of inorganic combined chlorine (mono-, di and trichloramine)
- Organo-chloramines are building up slowly
- => 1 pass every 2 - 3 days is enough
- **Example Breitenbach: 180m³ / 60h = 3m³/h**


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ADVANOX CASE STUDY

Public pool Breitenbach Switzerland

Example: 180m³ swimming pool
 Water temperature : 30°C / pH : 7.4
 500 bathers / week



Dose H₂O₂ - Approximate dosage:



- a) concentration H₂O₂ 35%: approx. 10ml per m³/h
- b) concentration H₂O₂ 12%: approx. 30ml per m³/h

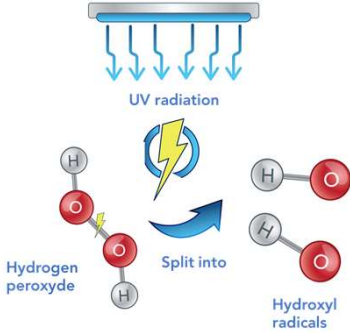
Example Breitenbach: 3m³/h => 30ml of 35% H₂O₂

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ADVANOX

Very special reaction chamber

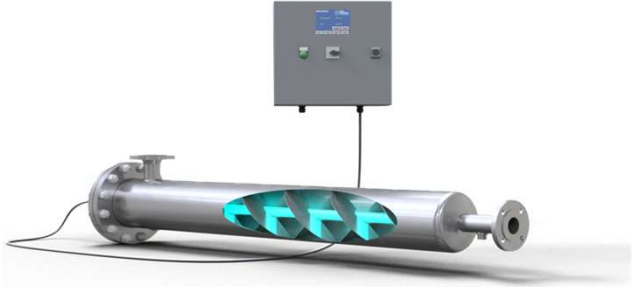


Hydrogen peroxide

UV radiation

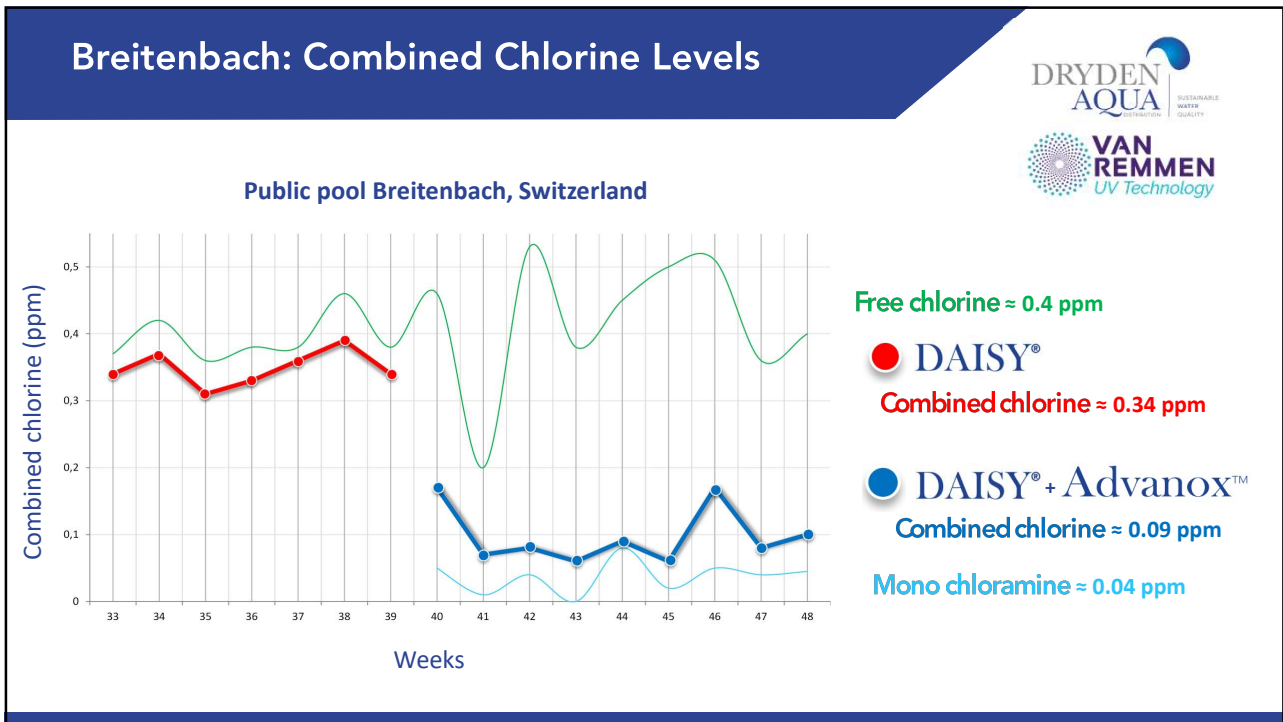
Split into

Hydroxyl radicals

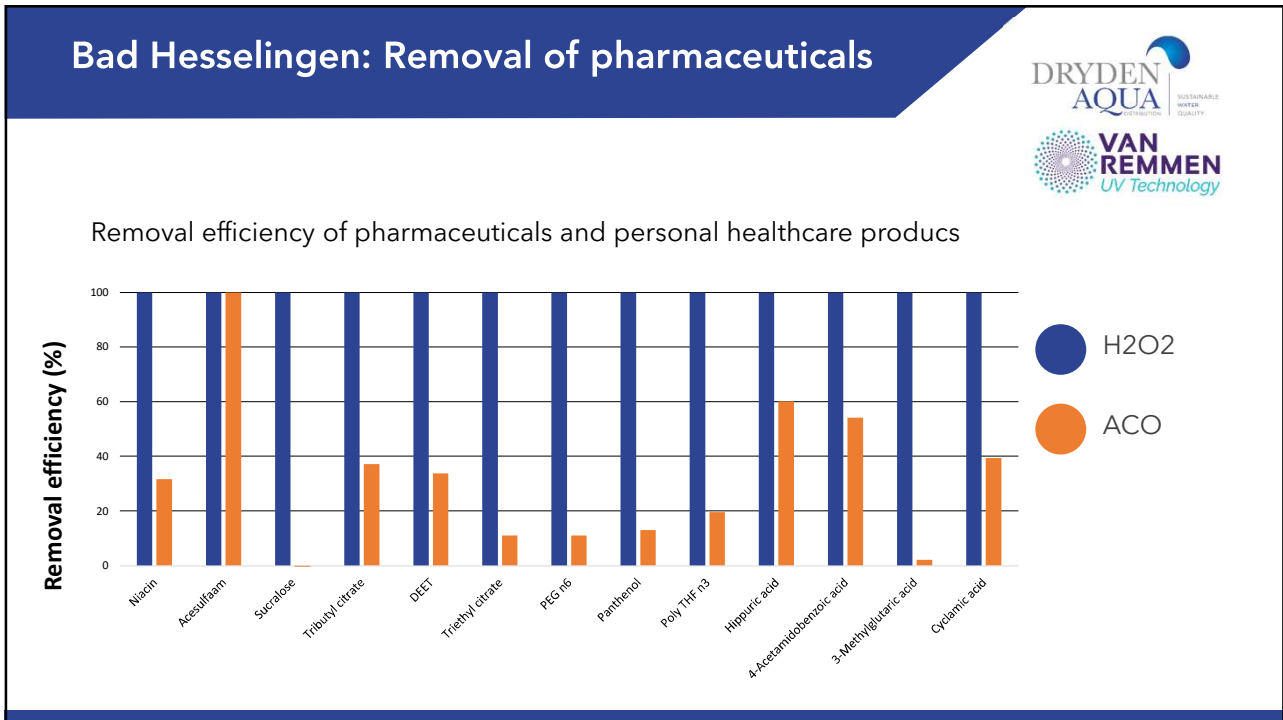


For best performance of the process

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Advanox for public pools



Why is Advanox better than UV-medium pressure?

- UV-medium pressure are generating THMs and consumes 50% of chlorine
- UV-medium pressure are expensive in CAPEX and OPEX:
 - Higher power consumption
 - More heat => more scaling
 - Shorter lifetime of the lamps

Advantages Advanox vs AFM + 100mm activated carbon?

- No loss of chlorine
- GAC can create some black dust – rinsing is needed
- Works also when the filterbed is not flat

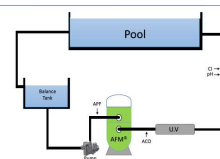
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Advanox: The best solution



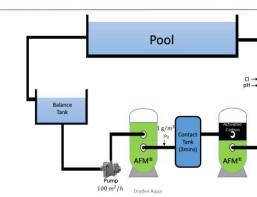
Much better and healthier than

DAISY public – indoor with U.V



As good as

DAISY public – indoor with O₃



But at much less costs

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Advanox : Best performace at the lowest costs



50016



90019



AS-034112

Item No	Description	List Price € excl VAT
ADVANOX: ADVANCED OXIDATION FOR POOLS		
92100	Advanox™: Advanced Oxidation Pool AOP 80, for <80m³ size pools	6'200.00
92250	Advanox™: Advanced Oxidation Pool AOP 250, for <250m³ size pools	8'750.00
92500	Advanox™: Advanced Oxidation Pool AOP 500, for <500m³ size pools	9'500.00
50016	Dryden aqua flocc-dos-pump 3.2 - 240 ml/h for H ₂ O ₂ dosing	450.00
90019	FlowVis Flow meter d25mm inside/32mm outside / 1,2 - 5,4m³/h	87.00
AS-034112	Speck Badu Alpha Eco Soft Pumpe 0,50kW 230V	890.00
92000	Replacement lamp Advanox, UV-C lamp - 350W LL, 12'000h life expectancy	590.00
92001	Replacement lamp Advanox, UV-C lamp - 600W LL, 12'000h life expectancy	750.00
92002	Quarts sleeve (every 4 years)	350.00

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ADVANOX ALWAYS IN COMBINAISON WITH DAISY® => BEST SOLUTION TO REMOVE COMBINED CHLORINE!



DAISY®

Reduces oxidation demand
Reduces THMs
Reduces operating costs
Reduces inorganic chloramines



Total combined chlorine
< 0.2 ppm
Lowest THMs levels
No loss of chlorine
Safest & purest water



Advanox™

ADVANCED OXIDATION

Strong oxidation without by-products
Reduces THMs
No loss of chlorine
Low power consumption, longer lifespan
Removes cosmetics, pharmaceuticals & toxins
Reduces organic chloramines

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Dryden Pool Academy SESSION 9

PATHOGENS IN SWIMMING POOLS



10
HIGH-LEVEL
TRAINING
SESSIONS




Zoom



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AGENDA

zoom



What are the most common pathogens found in swimming pools?

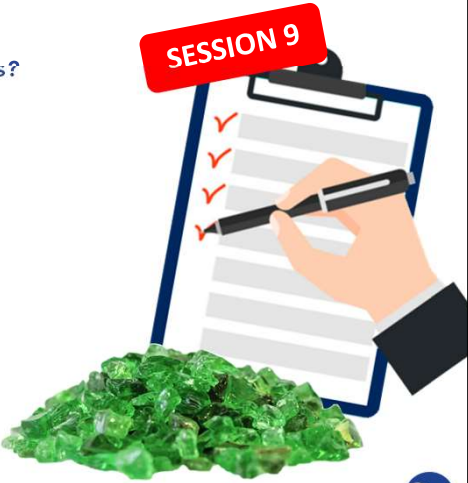
Legionella, crypto, pseudomonas


How to prevent the growth of pathogens

What to check if you have pathogens

DryOx : The best solution to remove biofilm

Q&A : Questions / Answers





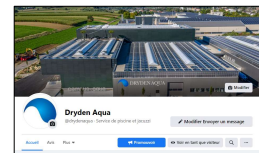
48



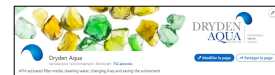
Question / Answers



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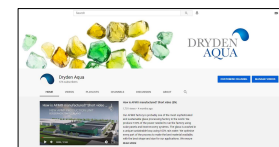


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