DRYDEN AQUA DISTRIBUTION
SUSTAINABLE WATER QUALITY

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

10 HIGH-LEVEL TRAINING SESSIONS

Live Zoom

Dryden Pool Academy
SESSION 9

PATHOGENS IN SWIMMING POOLS

1

AGENDA

zoom

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

1. What are the most common pathogens found in swimming pools?
2. How to prevent the growth of pathogens
3. What to do when pathogens are present

Case studies

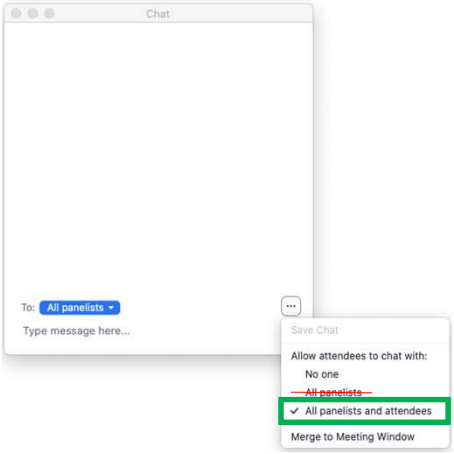
Q&A : Questions / Answers

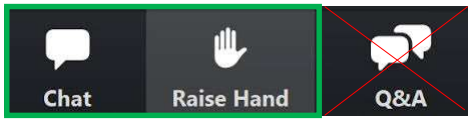
2

2

Questions & Answers

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





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Dryden Pool Academy : Now on YouTube !

Find all the sessions on our YouTube channel

Chapters SESSION 1

0:00 - Intro
1:35 - Presentation of Dryden Aqua
8:24 - The pyramid of pool water treatment
14:13 - Turnover-rates principles
21:58 - Turnover rates in private pools
27:00 - Turnover rates in public pools
30:10 - Pressure losses & selection of the right pump
40:20 - Even water distribution in the pool
43:52 - Number of inlets, skimmers and floor drains
50:50 - The importance of flow meters
54:39 - Case study

4

DRYDEN AQUA DISTRIBUTION SUSTAINABLE WATER QUALITY

3 simple steps!

SESSION 8

DRYDEN POOL ACADEMY KNOWLEDGE IS POWER!

1

AFM®ng and DAISY® will reduce :

a) Chloroform and other THMs in all swimming pools by <50%

b) Inorganic chloramines by 2 to 5 times <u>but not organic chloramines</u>

=> Total combined chlorine with DAISY®
Public outdoor pools : < 0.2 ppm
Public indoor pools : 0.3 – 0.4 ppm

2

To reach a total combined chlorine level below 0.2 ppm in public indoor pools

- Use 10cm of activated carbon on top of AFM®

- UV medium pressure will lower total combined chlorine but <u>will increase THMs</u>

- Ozone will bring good results but is <u>by far the most expensive solution</u>

3 Advanox™

ADVANCED OXIDATION

<u>The best solution</u>

Advanox in combination with DAISY®

Total combined chlorine < 0.2 ppm
Lowest THMs levels
<u>No loss of chlorine in the process</u>

Much lower running costs compared to UV medium pressure and ozone

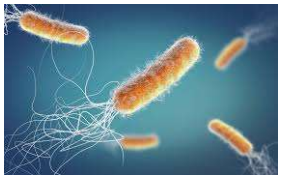
5

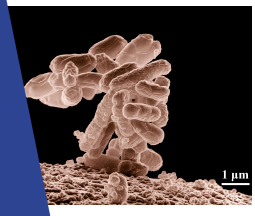
DRYDEN AQUA DISTRIBUTION SUSTAINABLE WATER QUALITY

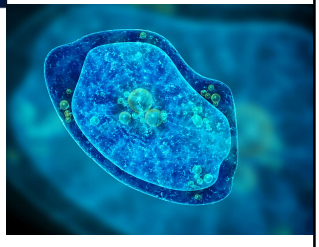
DRYDEN POOL ACADEMY KNOWLEDGE IS POWER!

DRYDEN POOL ACADEMY

The most common pathogens in swimming pools







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Pathogens in pools: SIA 385/9 (Switzerland)

Parameter	Unit	Pool water max. values	
Microbiological requirements		**TARGET**	**MAX.**
Aerobic mesophilic germs	CFU/ml	0	1'000
Escherichia coli (E. coli)	CFU/ 100 ml	0	0
Pseudomonas aeruginosa	CFU/ 100 ml	0	0
Legionella spp. In pool water	CFU/ 100 ml	0	1

Cryptosporidia: Mainly in USA and UK)

***CFU= Colony Forming Unit**

7

Total number of germs – total plate count

The number of **aerobic mesophilic germs** is often referred to as the "total plate count."

It provides information on the number of microorganisms that multiply optimally under aerobic conditions in a temperature range between 30 and 40 degrees Celsius.

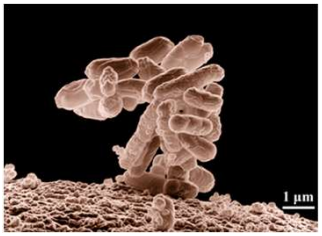
- Can be used to assess overall sanitary quality
- General microbial contamination indicator
- Makes no specific distinction

«Houston we have a problem»

8

Escherichia coli (E. coli)

E. coli are bacteria of fecal origin and belong to the opportunistic pathogens (optional pathogenic)



- Approx. 2 microns in size
- Indicate fecal contamination
- Proof according to ISO 9308-1

They can form toxins and cause severe diarrhea, stomach cramping, pain, nausea and vomiting

9

Pseudomonas aeroginosa

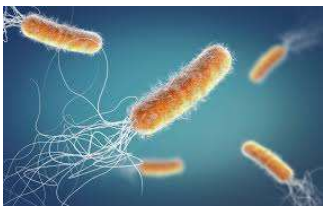
Pseudomonads are bacteria measuring 0.5-3.0 micron in size.

They are the builders, the pioneers of biofilms.

They colonize all wet areas quickly and efficiently and multiply very quickly under ideal conditions (warm and sufficient sewing materials). P. aeruginosa is a facultative anaerobe.

Planktonically (alone) they are easy to oxidize – but they are well protected in biofilms.

The ability of this bacterium to interact with other microorganisms and produce biofilms makes it difficult to control their growth.



Consequences: Otitis (ear infection) and skin infection

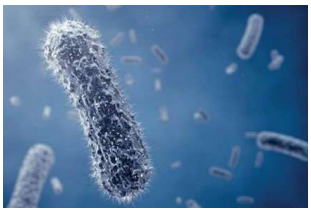
10

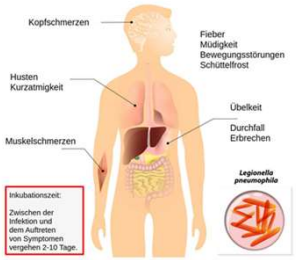
Legionella

Legionella are bar-shaped bacteria about 6 microns in length that live in water. Currently, about 57 different species of Legionella are known.

Legionella is a bacteria that includes the species L. pneumophila, causing legionellosis (all illnesses caused by Legionella) including a pneumonia-type illness called Legionnaires' disease or Pontiac fever

Infection can occur when inhaling Legionella-containing aerosols.





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Legionella

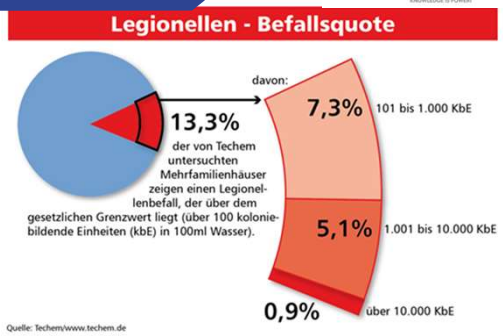
Legionella reproduce mainly in a temperature range between 25 and 45 °C.

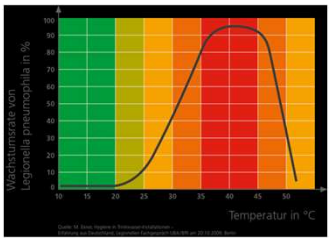
They can be brought into the pool through tap water.

They multiply especially well if there is insufficient disinfection and backwash of the filter.

If Legionella is detected directly in the pool water, it is most likely because the filter has bio-fouled and the water is contaminated as a result.

(Source: SIA 385/9)





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Ameoba

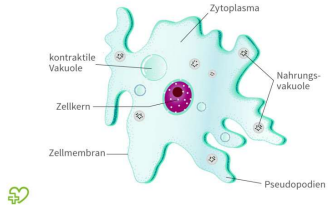
Amoebas are single-cell organisms that have no cell walls and therefore can alter their shape, primarily by extending and retracting their pseudopods (temporary, arm-like projections) to move and feed.

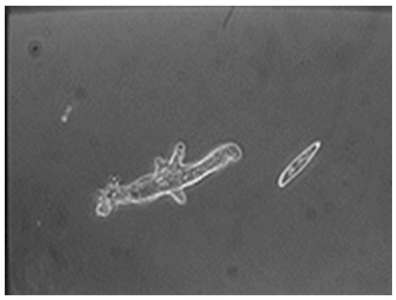
An amoeba is between 100 – 1000 micros in size.

Amoebas typically ingest their food by extending their pseudopods to encircle and encapsulate live prey or particles of scavenged material.

Many amoebas are pathogenic, some of which can also cause serious diseases in humans, for example a severe gastrointestinal disease.

More importantly, many amoeba species harbor pathogenic bacteria such as legionella.





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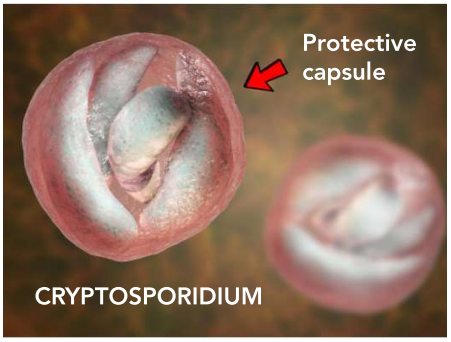
Cryptosporidium

Cryptos are pathogens (of faecal origin) that are ingested orally a… severe diarrhea => cryptosporidiosis is a serious intestinal disease

The only way to remove them ⇒ FILTRATION



Cryptos can survive at 5 ppm chlorine for 5000 hours. They are resistant to chlorine.

Cryptos are 3 to 6 microns in size and can be filtered with very good filtration

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DRYDEN AQUA

Biology in sand filters

SESSION 4

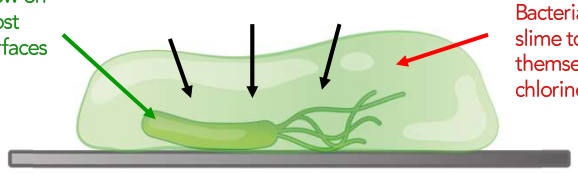
DRYDEN POOL ACADEMY

How do bacteria survive in a swimming pool?

Bacteria stick and grow on most surfaces

Chlorine 50ppm
cannot fully oxidise the biofilm, if it is sufficiently stable to protect the bacteria

Bacteria secrete a slime to protect themselves against chlorine oxidation



Biofilm can develop on walls, floor, pipework and especially in the filter media

The filter media represents approx. 90% of the total pool surface
1m³ of sand has a surface of 3.000 m²

15

15

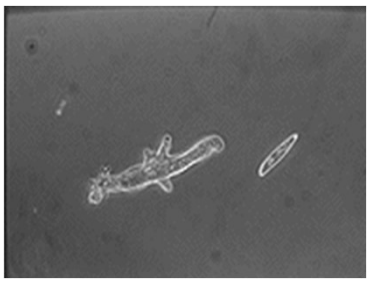
Biofilm is a «home» for growing pathogens

DRYDEN POOL ACADEMY

In the biofilm live entire communities of bacteria and other pathogens – including Legionella, amoebae, crypto, pseudomonas…

At 30°C water temperature, they can double in mass every 30 min.

Even the highest chlorine concentrations and the most aggressive backwashing can't stop this development!

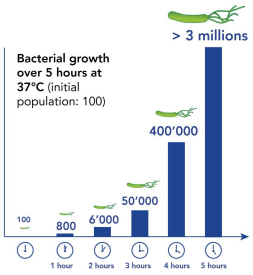


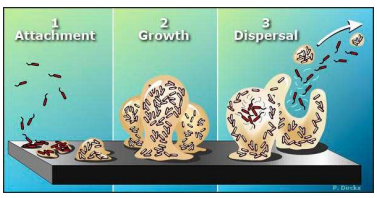
NO biofilm

↓

No bacteria, viruses and other pathogens

Food and temperature make a huge difference!





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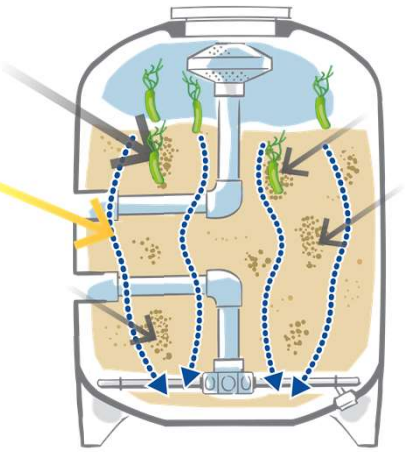
The main problems of biofilm: 1. Channeling and coagulation of sand

- Biofilm leads to coagulation of sand and the formation of channels
- Inconsistent and unreliable filtration

Clumps

Channels

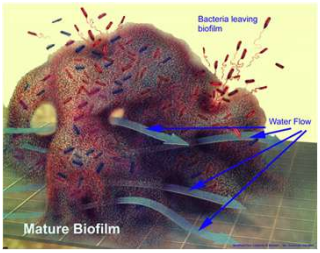
Bacterial flocs discharged into pool



Turbidity increases

Chlorine consumption increases

Filtration is no longer reliable



NO biofilm

→ No clumping

→ No channeling

→ Reliable filtration

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DRYDEN POOL ACADEMY

How to prevent the growth of pathogens ?

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Filtration with AFM®

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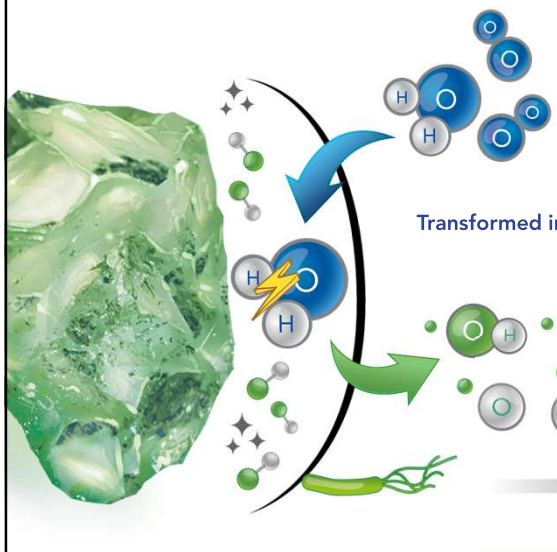
Fully prevents the formation of biofilm in the filter bed



Water molecules and dissolved oxygen

Transformed into free radicals on the surface of AFM® (catalytic reaction)

Fully prevent bio fouling and protect AFM® from bacterial colonisation. Free radicals oxidise dissolved organic matter and heavy metals.

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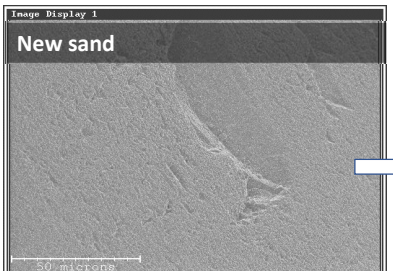
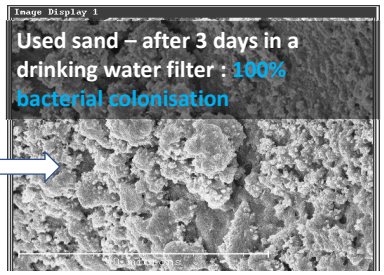
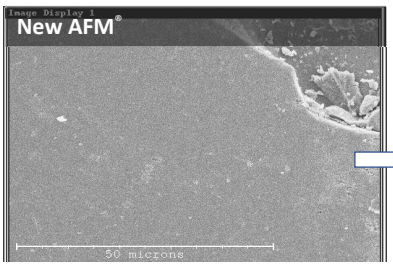
AFM® after 5 years…





Bacterial count in 5 g of filter media at a water temperature of 37°C	
AFM	18
Sand	3,600,000



Samples were taken after backwash

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Significantly improves filtration

Test identification

Test date : 03/10/2019	Operator : ML	IFTS n. : ECH_00031256

Customer reference

Filter ref. : AFM 21 ng (0,4 - 0,8mm) Sample 2

Test parameters

Test fluid : Filtered water	Test dust : ISO CTD	Batch n. : 13388C

Test results

Parameters		Contaminant injection				Particle counting			
Test flow rate (m3/h)	0,37	Flow rate (L/h)	Concentration (mg/L)			Counter	Sensor	Flow rate (mL/min)	Volume (mL)
Temperature (°C)	23,4		Initial	Final	Average				
Concentration (mg/L)	5,2	10,02	202	181	191,5	PAMAS 2132	WaterViewer	25	25
Test duration (min)	362								

Initial cleanliness (#/mL)

Particle number/mL	Sizes (µm)	> 1	> 2	> 4	> 6	> 8	> 10	> 20	> 25
	Upstream	110,52	75,64	33,6	12,96	7,48	5,68	2,4	1,76
	Downstream	42	23,84	10,16	5,12	4,08	3,88	3,32	2,92

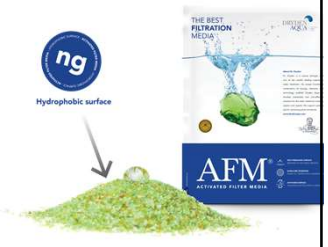
Filtration efficiency and Particle number (#/mL)

Sizes (µm)		> 1		> 2		> 4		> 6		> 8		> 10		> 20		> 25	
Upstream	E (%)	12702	94,6	8737	96,9	3359	99,3	1338	99,9	559	99,9	274	99,9	20	99	8	98,9
Downstream		684		270		25		2		0		0		0		0	

AFM®ng removes 94,6% of >1 micron particles at 20m/h

1 MICRON

Certified 1 micron filtration



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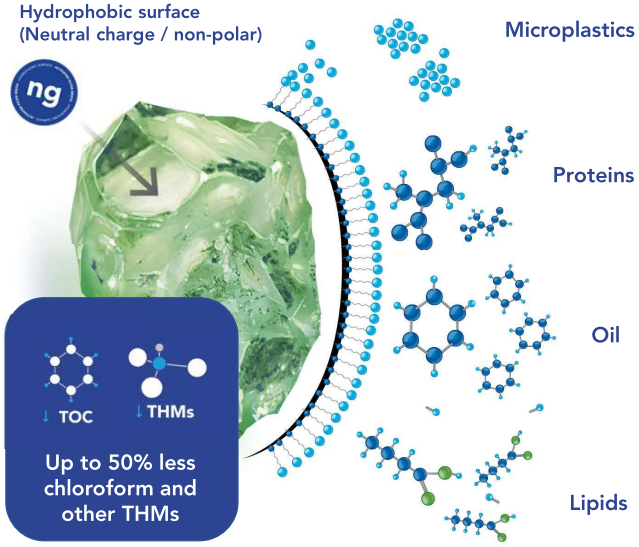
AFM® ACTIVATED FILTER MEDIA — Filters 50% more organics than sand

DRYDEN POOL ACADEMY

Hydrophobic surface
(Neutral charge / non-polar)



Most organic substances like oils, lipids, fats and amino acids are non-polar and tend to be adsorbed onto a hydrophobic surface.

Organic matters are the precursor for the formation of THMs in chlorination.

Chloroform will pass the lungs to reach the bloodstream and circulatory system.

Less organics = less potential to form THMs

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Coagulation & flocculation with APF®

DRYDEN POOL ACADEMY

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Why use APF®?

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

OPTIMAL SAFETY

REMOVAL OF DISSOLVED POLLUTANTS AND CHLORINE RESISTANT PATHOGENS (e.g CRYPTO)

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DRYDEN AQUA DISTRIBUTION
SUSTAINABLE WATER QUALITY

NoPhos

SESSION 6

THE BIOLOGICAL SOLUTION TO PREVENT ALGAE AND BACTERIA

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

26

Phosphate is a vital nutrient for algae and bacteria

In the absence of phosphates……

there may be plenty of food but, it can't be metabolized!

Phosphates are responsible for nutrient transport across cell membranes.

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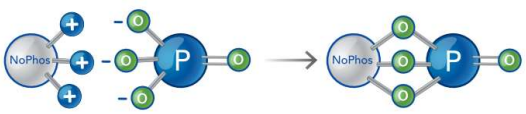
No food => no growth

NO ALGAE AND BACTERIA

REMOVAL OF DISSOLVED PHOSPHATES (PO4)

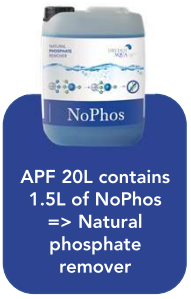
PHOSPHATE IS A VITAL NUTRIENT FOR ALGAE AND BACTERIA



NoPhos has a 3+ charge

Phosphate has a 3- charge

To precipitate phosphate out of solution



APF 20L contains 1.5L of NoPhos => Natural phosphate remover

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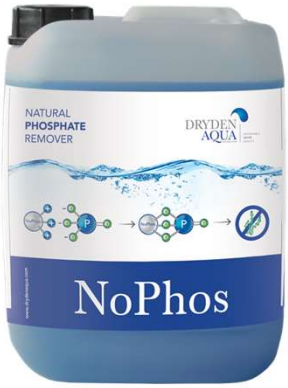
Algae and bacteria are a problem for all swimmers…



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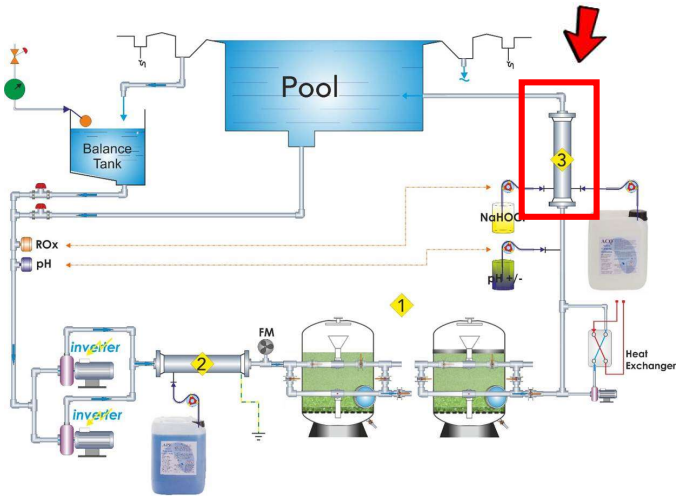
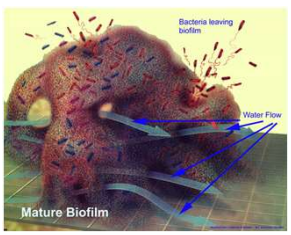
ZPM after the filter: Cavitation-reactions smash biofilm and Crypto



Smashing Crypto
Smashing biofilm



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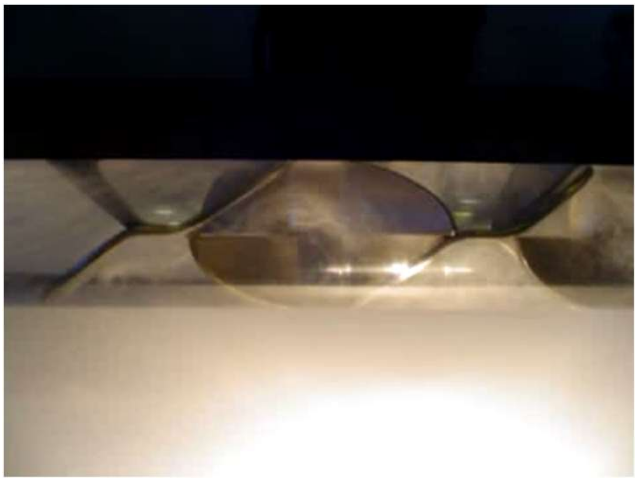
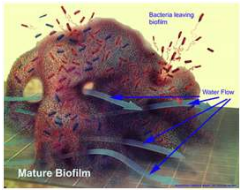
ZPM after the filter: Cavitation-reactions smash biofilm and Crypto



Smashing Crypto
Smashing biofilm



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DRYDEN AQUA DISTRIBUTION SUSTAINABLE WATER QUALITY

DRYDEN POOL ACADEMY

What to do when pathogens are present!

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Pool analysis results and measures

DRYDEN AQUA

Art des Auftrages: Badewasseruntersuchung
Auftragsnummer: B15-01820
Kundennummer: B71693
Tagebuchnummern: PB15-05463 - PB15-05466
Entnahmeorte / -stellen: Siehe unten
Probenahme / -nehmer: 01.07.2015 / 09:20-09:55 Uhr Jaborsky Mario Dr. / Eurofins Institut Jäger
Probeneingang: 01.07.2015
Untersuchungsbeginn: 02.07.2015 **Untersuchungsende:** 13.07.2015

ERGEBNISSE

Tagebuchnummer: PB15-05463			**Auftragsnummer :** B15-01820	
Wasserkörper/Objekt: Schwimmbecken				
Entnahmestelle: Filtrat				
Parameter	**Einheit**	**Prüfergebnis**	**Höchstwert**	**Prüfverfahren**
Mikrobiologische Untersuchung (Filtrat)				
Wassertemperatur bei PN	℃	29,4		DIN 38404-4 (C 4)
Koloniezahl 36 ℃	KBE/1 ml	0	100	TrinkwV Anl. 5 Teil I d) bb)
Escherichia coli	MPN/100 ml	0	0	Colilert 18/Quanti Tray
Pseudomonas aeruginosa	KBE/100 ml	0	0	DIN EN ISO 16266 (K11)
Legionella species	KBE/100 ml	**10 !**	0	UBA-Methode/ISO 11731/DIN EN ISO 11731-2

PN = Probenahme

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What to do if pathogens are present

DRYDEN AQUA

DRYDEN POOL ACADEMY

1-10 CFU/100 ml

- Backwash filter with highly chlorinated water (> 20 mg / 1)
- Check water treatment for any functional defects
- Make new analysis after 4 weeks

10-1000 CFU /100 ml

- Turn off aerosol-generating devices
- Backwash filter with highly chlorinated rinse water (> 20 mg / 1)
- Empty, clean and disinfect the spa
- New analysis of the pool water and also the filtrate (the water after the filter - before disinfection) after 10 days

>1000 CFU /100 ml

- Close the pool to swimmers
- Find the source of contamination
- Clean and disinfect piping, valves, channels, balance tank
- Check filtration and backwash
- Eliminate the source of contamination
- Re-commission

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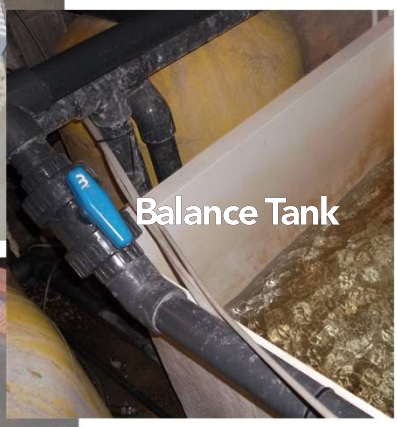
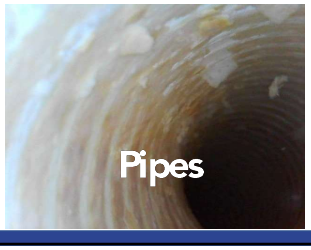
Pathogens in swimming pools
The places to target...





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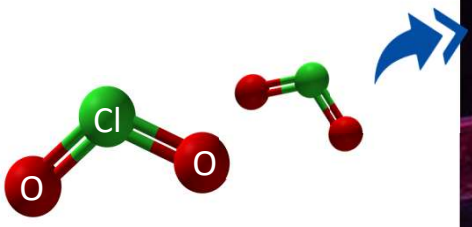
How to remove biofilm

Remove biofilm



with Chlorine Dioxide (ClO_2)

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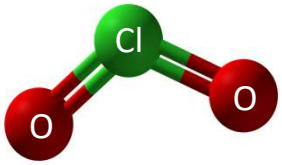
Chlorine Dioxide (ClO_2)

Chlorine dioxide is a chemical compound with the formula ClO_2. It is a radical with oxidizing properties.

It is often used instead of chlorine because it forms less toxic DBP's (THM's etc.)

It is more effective than chlorine (1.57eV vs 1.35eV) and, unlike chlorine, also effective against viruses and many protozoa.

Chlorine dioxide is a soluble gas and it can penetrate biofilms. This is why it is much more effective in the removal of biofilms.



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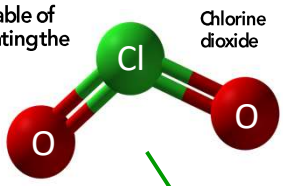
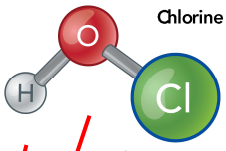
Chlorine Dioxide > unique properties

Chlorine dioxide passes through the biofilm - not chlorine!

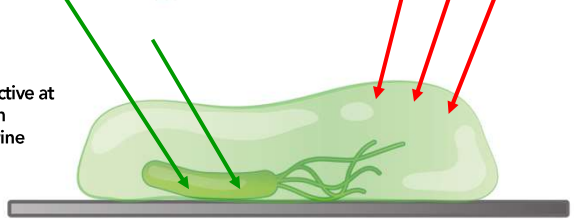
DryOx

Chlorine dioxide is a soluble gas capable of directly penetrating the biofilm





It is 10x more effective at eliminating biofilm compared to chlorine



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Disinfection of the filters with DryOx

1. Fill the balance tank to the top
2. Add 4 DryOx tablets for 10 m3 of pool volume to the balance tank
   Ex: Pool 100m3 => 40 tablets of 1g => 0.4ppm ClO2
3. Stop the pumps for 5 minutes and let the tablets dissolve completely
4. Turn the pumps on for 5 minutes to bring the "DryOx-water" into the filter. Then turn the pump off for 1 hour and let DryOx work (concentration x time)
5. Finally, backwash the filter before restarting

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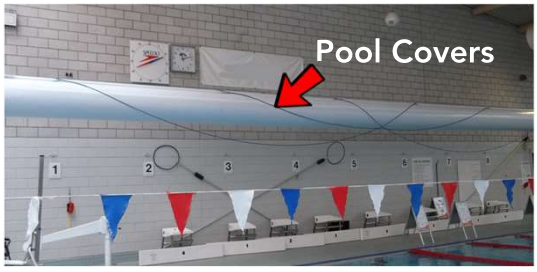
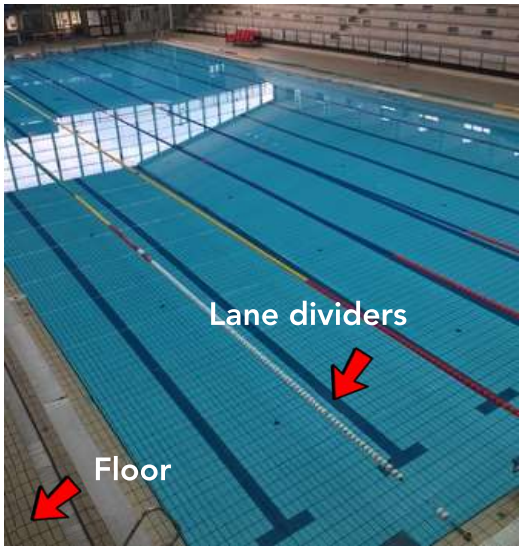
Also check and clean the following
2 DryOx tablets dissolved in 50-100 litres of water





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In spas and hot tubs

1. Add 4 tablets per 1000 l water volume (ClO2 concentration 4g/m3)
2. Turn on the filter and massage system for 1 hour. Do not use the pool during this time
3. Completely drain the pool water, rinse and refill with fresh water. Repeat this treatment at least every 3 months.

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Pipes before and after DryOx

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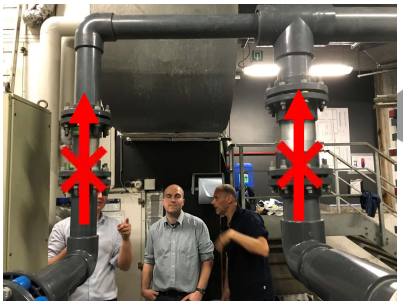
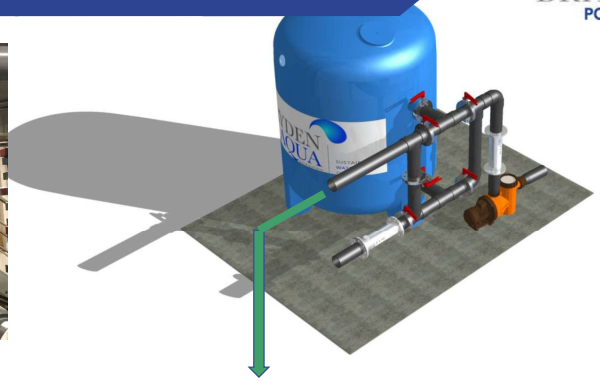
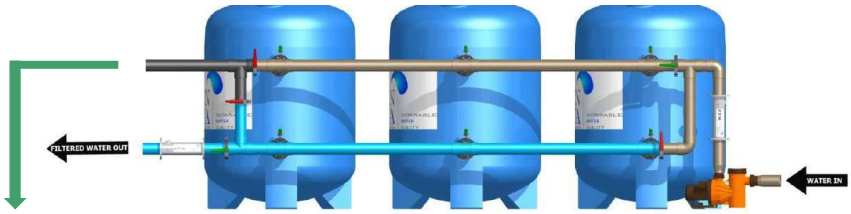
Biofouling of the filter bed as a result of insufficient backwash







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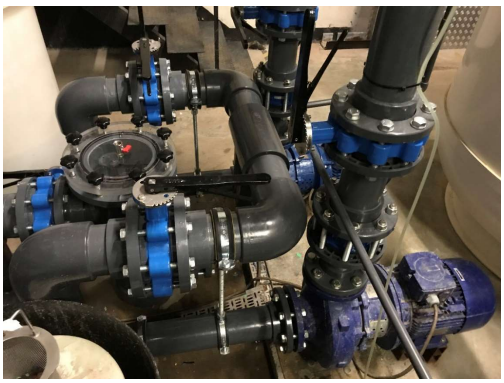
Wrong pipe diameter – no FlowVis => No efficient backwash => problem

SESSION 3

2 pumps 5.5kW
2 x 60m3/h

Filter d1600mm: 2m2
Piping DN100/d110mm
Speed @ 100m3/h =4m/s



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DRYDEN AQUA DISTRIBUTION SUSTAINABLE WATER QUALITY

DRYDEN POOL ACADEMY

CASE STUDIES

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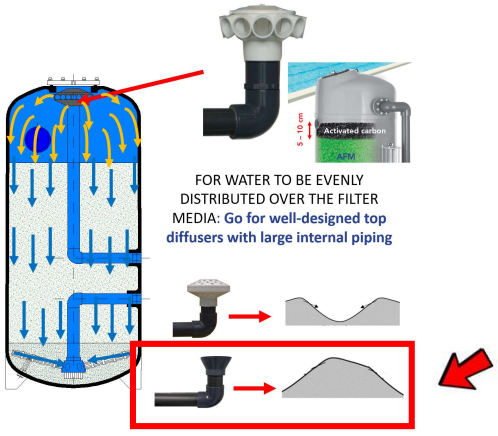
DRYDEN AQUA DISTRIBUTION SUSTAINABLE WATER QUALITY

Dinslaken – Germany 2014:

DRYDEN POOL ACADEMY KNOWLEDGE IS POWER!

Problems:

1. Combined chlorine
2. Chlorates too high
3. Legionella



FOR WATER TO BE EVENLY DISTRIBUTED OVER THE FILTER MEDIA: **Go for well-designed top diffusers with large internal piping**

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Dinslaken – Germany 2014

SESSIONS 2&3

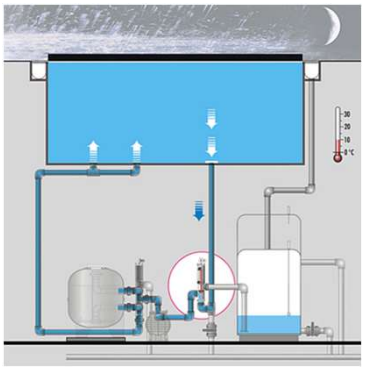
Filter d1200mm = 1.2 m2
Backwash volume needed: 4000l

Balance tank only 3000l (gross) and 2000l (net)

Can only backwash for 2 minutes

Problem: Biofouling of the filter and combined chlorine

Solution: backwash directly from the pool



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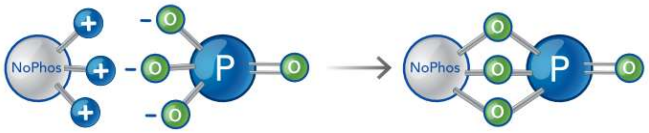
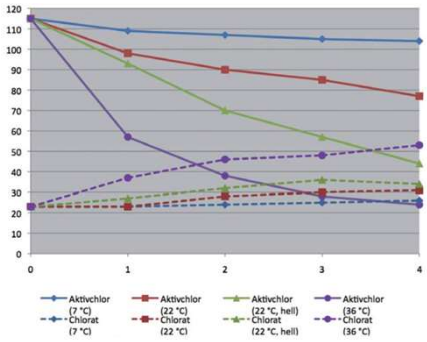
Dinslaken – Germany 2014

Legionella: Tap water had 4.0mg/l phosphate



Chlorates: 3 pallets of chlorine bleach (due to price) stored at room temperatures of 35°

72 x



SESSION 4

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San Sebastian – Spain 2018:

Problems: Pseudomonas

Actions: Change to AFM-S - nothing else

- Piping ok but valves to small – no flow meters
- No APF - no ZPM - No GAC
- The system is running with UV medium pressure

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San Sebastian – Spain 2018:

Actual situation 15.3.21:

Problems with pseudomonas GONE

Chlorine consumption aprox 25% lower

Small algae problems in the pool in a small área

Solution: APF, Stenner, Injection before the pump

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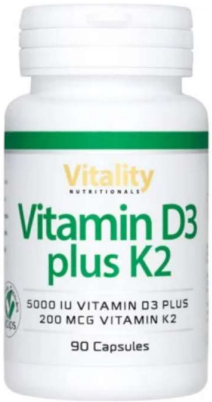
Vitamin D



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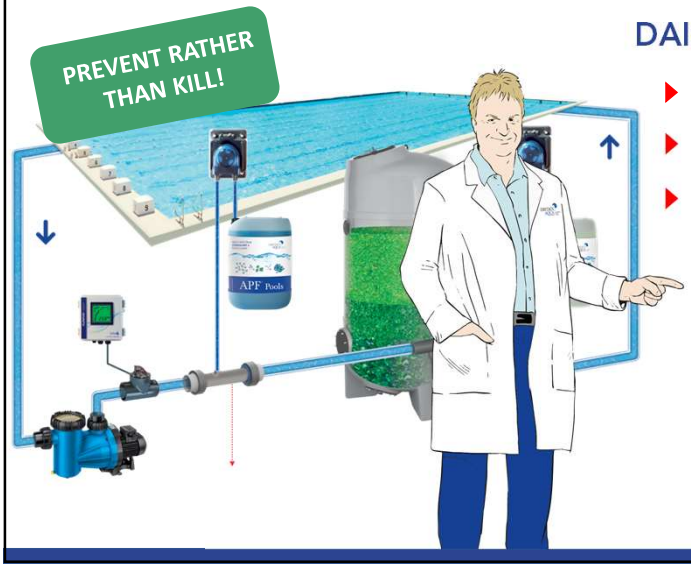
DAISY® : The vitamin D for your pool !



DAISY® RESULTS:

- Best filtration down to 0.1 micron
- Oxidation demand reduced by up to 80%
- Less disinfectants = less toxic DBP's

WHAT WE STAND FOR:

- The safest & clearest water
- The best air quality
- The lowest chemical consumption and operating costs

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DRYDEN AQUA

DAISY® competition pool Greece

50m visibility – If operated the right way – The perfect solution

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

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DRYDEN AQUA
DISTRIBUTION
SUSTAINABLE WATER QUALITY

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

Dryden Pool Academy
SESSION 10

SUMMARY & TEST

10 HIGH-LEVEL TRAINING SESSIONS

Live Zoom

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DRYDEN AQUA

Questions / Answers

DRYDEN POOL ACADEMY
KNOWLEDGE IS POWER!

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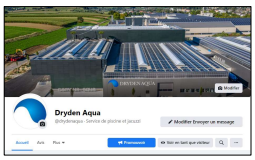
POOL ACADEMY
KNOWLEDGE IS POWER!



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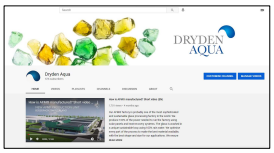
drydenaqua.com/downloads



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