AFM®

ACTIVATED FILTER MEDIA

DRYDEN AQUA DISTRIBUTION

SUSTAINABLE WATER QUALITY

THE BEST **FILTRATION** MEDIA

FACTSHEET FOR PUBLIC POOLS

ABOUT **DRYDEN AQUA**

OUR **FACTORIES**

Dryden Aqua Distribution
Büsserach, Switzerland

Dryden Aqua Technology
Bonnyrigg, Scotland

OUR **OFFICES**

Dryden Aqua Germany
Weimar, Germany

Dryden Aqua North America
Dallas, TX, U.S.A

Dryden Aqua Asia
Shanghai, China

Dryden Aqua is one of the largest manufacturers of glass filtration media in the world. As marine biologists, we have a unique knowledge combination and detailed understanding of the biological, as well as, the physio-chemical reactions in water. This has enabled us to develop and manufacture a highly innovative range of products, **such as the Activated Filter Media, AFM®**. We are proud to provide **sustainable and cost-effective solutions** for the drinking & waste water industry, for aquaria and aquatic life support systems as well as for swimming pools worldwide.

"Our mission is to provide products and solutions that have a positive environmental impact on our ecosystem.
We help to make this world a better place - a non-toxic environment for all"

WHAT IS AFM® ?

AFM® (Activated Filter Media)

Made from pure recycled green and brown glass, AFM® is a direct replacement for sand and can be installed in all types of sand filters without additionnal investments in infrastructure.

AFM® is verified to, at least, double the performance of sand filters, thereby, significantly reducing operating costs and outlasts all other filter media.

Most importantly, AFM® was developped by Dr. Howard Dryden to prevent the formation of harmful disinfection by-products (DBP's), such as Trichloramines and THM's, to provide the best air quality and safest environment for all public pool guests and employees.

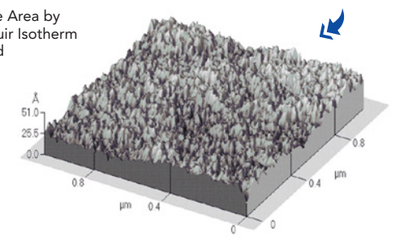
AFM® Unique features

AFM® is exposed to a unique 3-step chemical and thermal activation process to become self-sterilising and, to enhance filtration properties. **During the activation, the structure and the chemistry of the glass is modified.**

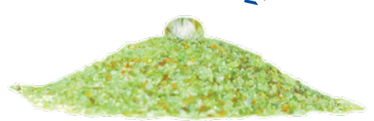
AFM® Grade 1 = 50.000 m² / 1'000 kg *
Sand 0.4 - 0.8mm = 3.000 m² / 1'000 kg

* Surface Area by Langmuir Isotherm Method

Mesoporous structure



Self-sterilising hydrophobic surface



Self-sterilising surface resistant to bacterial growth

Increased surface area for superior filtration properties

Hydrophobic surface for the adsorption of organics

AFM® **CERTIFICATIONS**

- ISO 9001:2015, ISO 14001:2015 and 45001:2018.
- NSF 50 & 61 certified for swimming pools and drinking water treatment.
- DWI (UK) Regulation 31 certification for potable water use.
- European Water Directive (98/83/EC) & (80/778/EEC) compliant.
- HACCP certified for use in food & beverage production.
- EN-12902 and EN-12904 compliant.
- IFTS (Institute of Filtration and Techniques of Separation) independently tested and verified filtration performance.

100% BIO-RESISTANT FILTER MEDIA

- **No biofilm**
  No pathogens
- **No clusters**
  No channeling
- **50% - 80%**
  less Trichloramines
- **Stable & reliable**
  performance

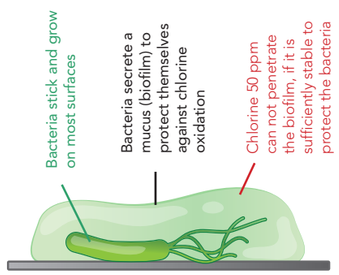
How do bacteria survive in a swimming pool ?

Within just a few days, bacteria will colonise all surfaces in contact with water. **The largest surface in contact with water, in a swimming pool, is the quartz sand in the filter.** 1 m^3 of quartz sand has a surface of 3000m^2 and it is an ideal breeding ground for bacteria. Bacteria will attach to the surface of the sand grains and, within seconds, will form a biofilm that protects them from oxidants. In this protective biofilm, bacteria can grow and multiply. Even high chlorine concentrations and good backwashing cannot stop this development completely.

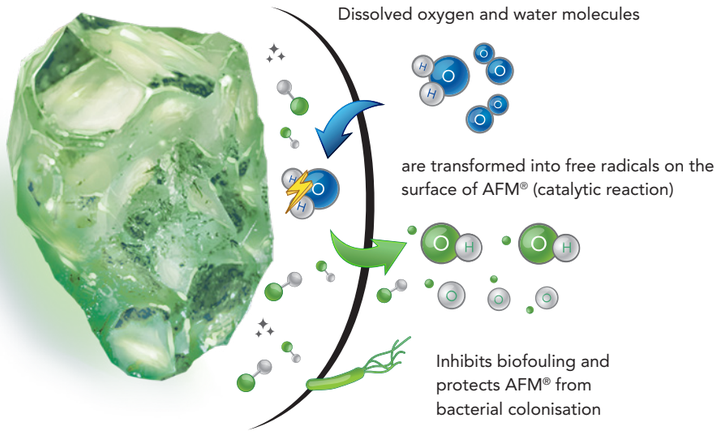
UNIQUE SELF-STERILISING SURFACE
RESISTANT TO BACTERIAL GROWTH

Our approach:
Prevent the growth of bacteria rather than kill them!

One of the main differences between AFM® and other filter media such as sand and crushed glass is its bio-resistance. When in contact with water, a small amount of free radicals ($O^{\cdot}$ and $OH^{\cdot}$) are formed on the surface of the grains. **Thanks to their strong oxidation potential, free radicals protect AFM® from colonisation by bacteria and fully prevent the formation of biofilm.**



Bacteria cling to surfaces (walls, floor, piping systems and especially in the filter media)



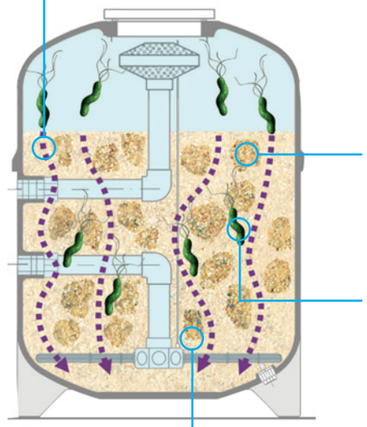
- Does not support bacterial growth, eliminates clumping, channeling and passage of unfiltered water.
- Prevents the biological conversion of urea to ammonia responsible for the formation of trichloramines.
- Provides predictable, repeatable and consistent filtration performance.
- Will consistently evacuate >95% of all retained particles during backwash.

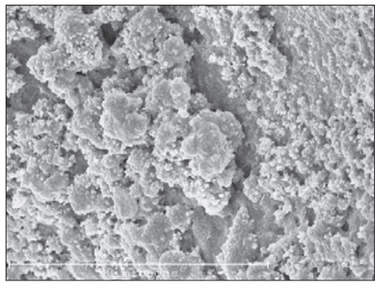
THE 3 MAIN **PROBLEMS OF BIOFILM**

INCONSISTANT AND UNRELIABLE FILTRATION 1

After 6 – 12 months, biofilm on the sand has developed to a degree where the grains stick together, forming clumps and causing channelling of the filter bed that reduces mechanical filtration performance and allows unfiltered water to reach the swimmers.

AFM® filters work at constant high filtration and backwash efficiency and each filtration and backwash phase will show the same performance. There is also no possibility of unfiltered water reaching the pool.



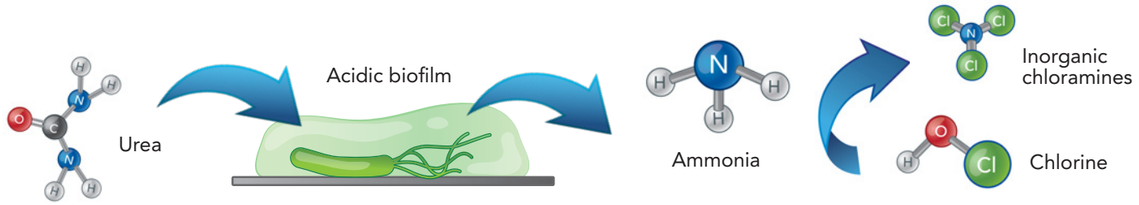


2 PATHOGENS

The filter develops into a breeding ground for pathogens, such as legionella and pseudomonas. Periodically, bacteria flocs will break through the filter. **AFM® prevents the growth and the transmission of these pathogens. Pool water is therefore much safer.**

TRICHLORAMINE - CHLORINE SMELL 3

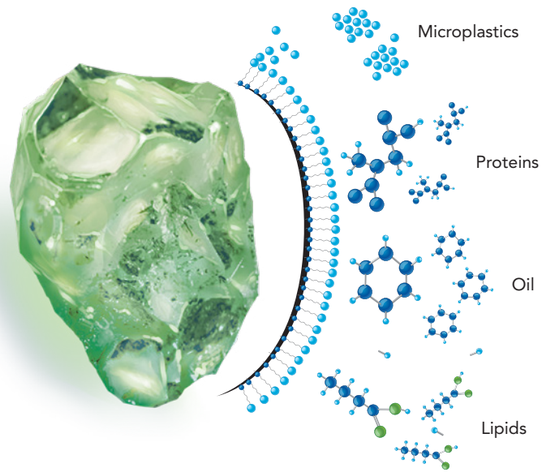
Pool users introduce sweat and urine into the pool water. These consist of 80% urea. Bacteria in the biofilm convert this urea into ammonia which then reacts with chlorine to form inorganic chloramines (mono-, di- and tri-chloramine). Trichloramine (NCl_3) is very volatile and is responsible for the unpleasant chlorine smell. It is also a severe health hazard causing skin, eye and lung irritation and will cause corrosion of buildings and installations. **With AFM®, there is no biological conversion from urea to ammonia in the filter bed: No biofilm ▶ No trichloramine ▶ No chlorine smell !**



SUPERIOR FILTRATION PROPERTIES

1 MICRON	↓ NTU	↓ Cl	↓ THMs
Filtration to 1 micron	Exceptional water clarity	Reduced chemical consumption	The best air quality

ADVANCED ADSORPTION **OF ORGANICS**



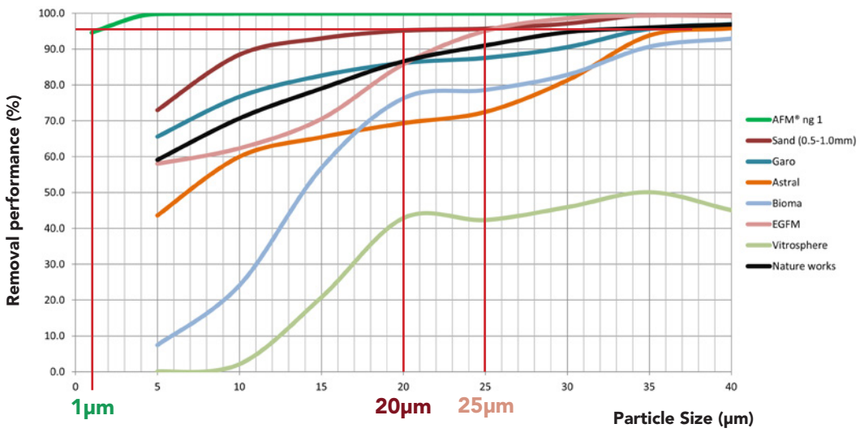
Organic substances like oil and fats are more difficult to dissolve into water and tend to float or to be adsorbed onto a non polar hydrophobic surface.

Thanks to its very large hydrophobic surface, AFM®ng filters ≈ 50% more organic substances from water than quartz and glass sand.

This can be confirmed by measuring the TOC (total organic content) or $KMnO_4$ consumption.

STABLE **FILTRATION DOWN TO 1 MICRON**

AFM® filters much finer than quartz or glass sand. The independent and best-known European laboratory for filtration tests IFTS (www.ifts-sls.com) has tested AFM®, quartz sand and various glass sands. The tests were conducted **with fresh filter media without any biofilm,** a 20m/h filtration velocity, and without the addition of flocculants. The following results were achieved:



Independently verified by

IFTS is a leading independent accredited laboratory, in France, specializing in water filtration

Sand filters 95% of all particles down to **20 microns.**

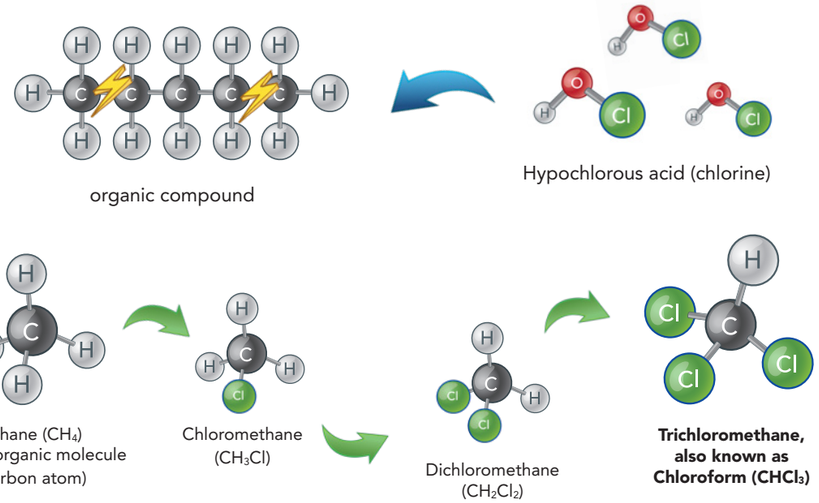
Glass sand filters 95% of all particles down to **25 microns.**

AFM® ng filters 95% of all particles down to **1 micron.**

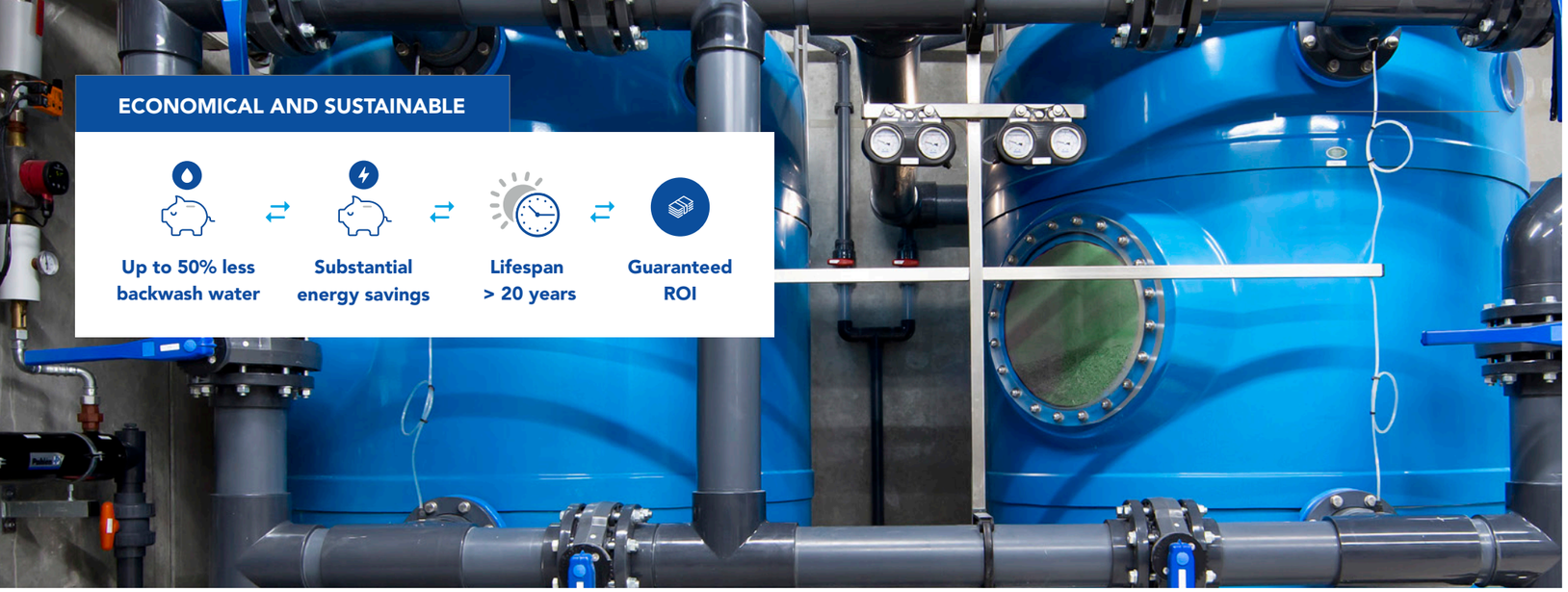
UP TO **50% LESS THMs !**

Less organics
= Less THMs

Trihalomethanes (THMs), including Chloroform, are very **toxic volatile by-products** formed when organic substances are not fully oxidised and react with chlorine in the water. Reducing the organic load will reduce the potential of their production. This is how AFM® reduces THM concentration by up to 50%, to provide **the best and cleanest air quality for all pool users and staff!**



Chloroform ($CHCl_3$) is one of the 4 trihalomethanes (THM's). It is dangerous for humans because it passes through lung tissue to enter the bloodstream where it can damage the nerves system. Chloroform is one of the oldest known anesthetics and it is now suspected to be carcinogenic. Babies and pregnant women are vulnerable and should not be exposed to chloroform or other THM's in high concentrations. In Switzerland, the limit for THMs in indoor pools has been set at < 20 µg/L.
Scan the QR code to watch our webinar about disinfection by-products in swimming pools.



ECONOMICAL AND SUSTAINABLE

- Up to 50% less backwash water
- Substantial energy savings
- Lifespan > 20 years
- Guaranteed ROI

RECOMMENDED **FILTRATION & BACKWASH SPEEDS**

Filtration speed : 15 to 30 m/h
Example: 20 m/h x filter surface (m^2)
= Filtration flowrate (m^3/h)

Backwash speed : 40 to 50 m/h
Example: 40 m/h x filter surface (m^2)
= Backwash flowrate (m^3/h)

More information in our AFM® installation and commissioning manual

THE LOWEST **OPERATING & MAINTENANCE COSTS**

▸ Up to 50% less backwash water

Sand needs - according to DIN standards - to be backwashed at >60m/h for 5 minutes or longer. AFM® only needs >40 m/h backwash velocity. The backwash efficiency is higher - and no air scouring is required - because no biofilm is coagulating the grains. With AFM® a backwash duration of 4 minutes is enough to remove all particles.

As a result, approx. 50% of the backwash water can be saved. Water costs are approx 2€/m^3 for water and 3€/m^3 for heating and treatment.

For the best results, use AFM® with a frequency controlled pump and set your pump's speeds using a flowmeter

Frequency controlled pump

▸ Less chemicals

What is filtered out does not need to be oxidised. The greater filtration efficiency of AFM® therefore saves chlorine and acid. **Chemical savings are approximately 20 - 30%.**

▸ Filter maintenance and life expectancy

A major cost factor is the cost of replacing the media (removal, disposal and filling with new media). These costs are the same for AFM® and sand, but the life expectancy of AFM® is much higher than sand. Due to its bio-resistance and hardness, **AFM® will last for over 20 years if the filters are backwashed properly.**

The payback for the incremental cost of AFM® is usually less than 2 years for indoor pools and 5 years for outdoor pools! Scan the QR code to download some of our AFM® case studies.

AFM® **GRADES & LAYERING**

AFM® (1,250 kg/m^3) is 15% lighter than sand (1,500 kg/m^3).
In order to replace 24 tons of sand, you will need 20 tons of AFM®.
Quantity of sand x 0.85 = Quantity of AFM®

AFM® ng Grade 1 is our main filtration grade. AFM® ng removes 95% of all particles down to 1µm.

AFM® ng Grade 2 acts as a support and filtration layer removing particles down to 5 µm.

AFM® Grade 3 is a support layer used to cover the laterals of a filter to ensure proper flow distribution during filtration and backwash.

- 50 % ng **GRADE 1** 0.4 - 0.8 mm
- 25 % ng **GRADE 2** 0.7 - 2.0 mm
- 25 % **GRADE 3** 2.0 - 4.0 mm

AFM® **PACKAGING**

AFM® is supplied in 21 kg and 25kg bags or 1000 kg big bags

40 bags on CP1 pallet

24 pallets/truck or 20 pallets/20' FCL

Take a virtual tour of our newest factory in Switzerland and learn how AFM® is produced

THE MOST SOPHISTICATED & SUSTAINABLE **GLASS PROCESSING FACTORIES IN THE WORLD**

Green manufacturing can be done by all, and even small changes can make a huge difference for the environment ! Sustainability in factories is based on 4 areas : Sourcing, energy, water, and waste.

Made from 100% recycled glass

AFM® is manufactured from 100% recycled bottle glass sourced locally, a raw material that already exists and needs to be reused. Sand is a finite raw material that is being used for many different applications, for example the construction industry. When mining sand, landscapes are destroyed and entire ecosystems disappear. Processing and transport are energy inefficient.

Self-sufficient production

Our production process is 100% energy self-sufficient, using up to 850,000 kWh self-generated solar power per year. Moreover, AFM® is cleaned and washed using **100% rainwater** from a closed-loop filtration system, before being sterilised to become the cleanest glass filter media on the market. AFM® has a loose **organic contamination of 5 g/ton.** Normal glass sand has up to 20,000 g/ton.

Zero waste

Waste (metal, paper, plastic) and non-target product (flint glass, CSP, fines) are separated and recycled or used in other industries. Sludge is responsibly disposed of or sold to biogas companies to produce green electricity.

The most advanced colour sorters

We only use green and brown glass in the manufacture of AFM® because white glass does not contain the metal oxides needed to make the media self-sterilising. That is why we have invested 1.5 million euros in the most modern colour sorting machines in the world. **AFM® contains more than 98% green and brown glass.**

Perfect size and shape

We use special soft-crushers to break the glass gently and achieve the desired particle shape while ensuring it has no sharp edges that can injure you or damage the filter. One of the largest sieving machines in the world ensures perfect sieving to get a **precise and consistent particle size and shape.**

Unique activation process

The raw AFM® goes through a **unique three-step chemical and thermal activation process.** The Activation is the reason for its bio-resistance and superior filtration properties. Dr. Howard Dryden researched the provenance of chlorine disinfection by-products at university more than 30 years ago and developed this unique process to stop their development at source.

DRYDEN AQUA
SUSTAINABLE WATER QUALITY

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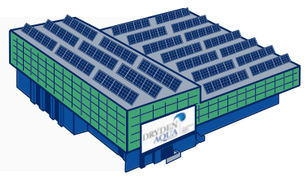
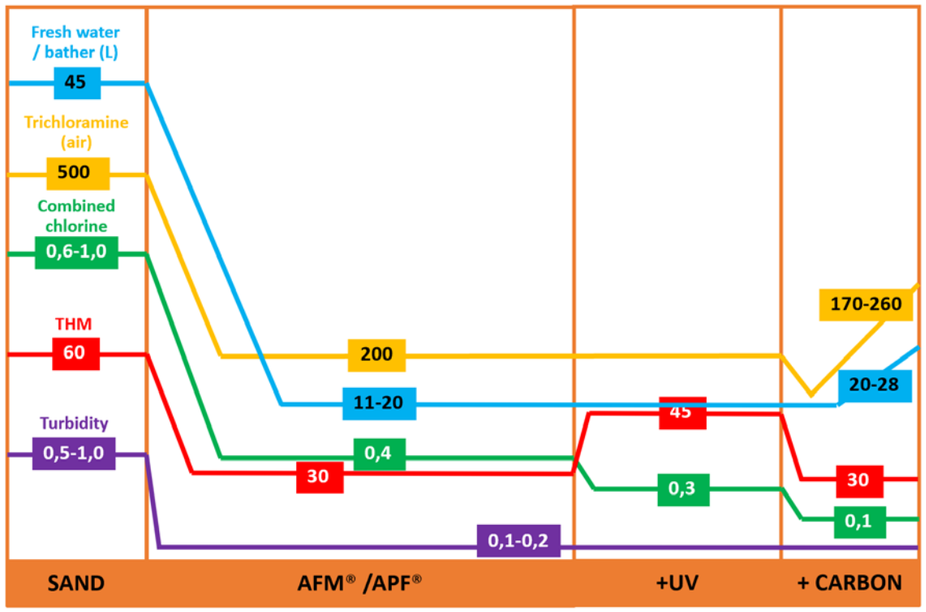


PROJECT DATA "BAD HESSELINGEN"

Pool:	Public indoor pool
Location:	Hesselingen, NL
Size:	25 x 15m
Filter:	1 piece - ø 2700mm
Visitors:	≈ 5'500 per week
Testing laboratory:	C-Mark
Testing period:	2015 - 2017

BAD HESSELINGEN
MAJOR PERFORMANCE TEST

A performance test has been conducted at an existing indoor swimming pool in the Netherlands. The pool has high bather loads and testing was conducted **an 18-month period**. On a monthly basis, 36 different chemical and biological parameters were tested for comparative reasons to show changes in water quality over the period. The tests were also taken on the same day of the week and same time of the day to ensure consistency. C-Mark was the chosen lab for testing as they are the largest in the Nertherlands, with recognised international testing procedures. All test protocols can be made available in Dutch. **The graph below summarises the most important parameters:**



Phase 0: Sand + Flocculation
Phase 1: AFM® + APF® (Flocculant) – no carbon
Phase 2: AFM® + APF® + UV
Phase 3: AFM® + APF® + 10 cm of activated carbon (coconut shell)

RESULTS & COMMENTS

▸ Water savings and return on investment

At 45 m/h backwash velocity, the water quality was dramatically improved and they now consume only 15L of fresh water / guest instead of 45L previously. Significant amount of water (≈ 40K / year) and electricity (≈ 2.000 kWh / month) are now being saved. **The return on investment (ROI) with this project was less than 2 years**. The savings in chlorine and acid were not included in this calculation – only water and heating costs!

▸ Water and air quality

Water and air quality has significantly improved (with 50% less fresh water). The water looks clearer with **much lower turbidity (< 0.2 NTU)**. Even after very high bather load, the water stays in perfect condition and chlorine smell is gone.

- **Trichloramines in the air were reduced by 60%** from 500 µg/m³ to less than 200 µg/m³.
- **THMs were reduced by half** from 60 µg/L to 30 µg/L or less.

▸ Total combined chlorine

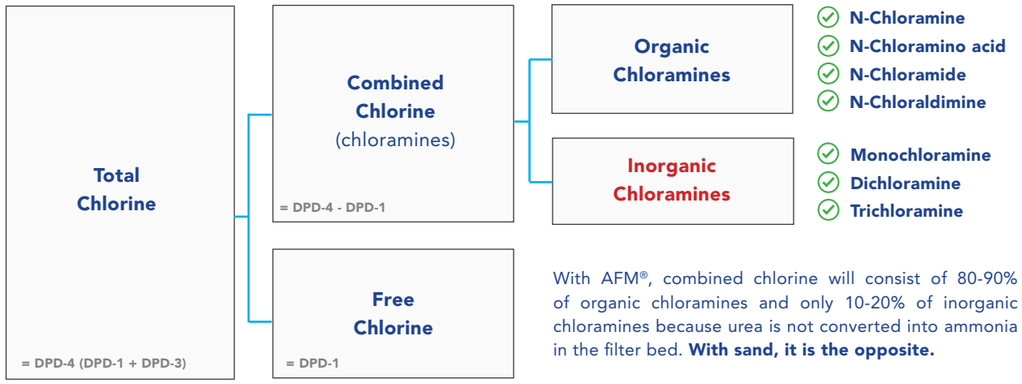
Combined chlorine is now low and steady. The maximum allowable level of combined chlorine in the Netherlands is 0.6 mg/l. In order to reach a value of 0.2 mg/l or less, a 5 – 10 cm layer of activated carbon (coconut shell) on top of AFM® was required and was the best solution.

Important note: While UV systems are effective at reducing combined chlorine, they also have unwanted side effects. The number one reason we do not recommend using UV to reduce combined chlorine in swimming pools is because they only partially break down large organic molecules. These smaller components then react with chlorine in the water to form THMs (chloroform). In Bad Hesselingen, THMs jumped from 30 µg/L to 45 µg/L after the installation of the UV system (phase 2), and went back down after stopping it (phase 3) - see red curve.

Our recommendations to keep combined chlorine below 0.2 mg/l on pages 14-15

COMBINED CHLORINE < 0.2 PPM
IN PUBLIC POOLS

AFM® will not form less combined chlorine (chloramines). However, the level of **inorganic chloramines (Mono-, Di- and Trichloramine) will be 2 to 5 times lower than with sand, while the level of organic chloramines will be slightly higher.** Organic chloramines are not volatile, slowly build up in the water and are non-toxic compared to Trichloramines.

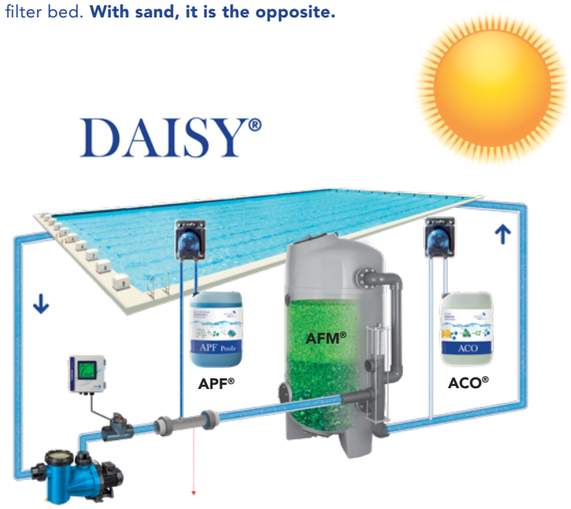


With AFM®, combined chlorine will consist of 80-90% of organic chloramines and only 10-20% of inorganic chloramines because urea is not converted into ammonia in the filter bed. **With sand, it is the opposite.**

▸ Outdoor pools

Thanks to the sun, outdoor pools usually have less of an issue with chloramines. In this case, a properly sized DAISY® System (AFM® + APF®) will be enough to reach a combined chlorine below 0.2 mg/l.

For the best results use ACO® which will amplify the natural disinfection power of the sun and reduce combined chlorine by 30 – 50%. Chlorine consumption will also be reduced.



▸ Indoor pools

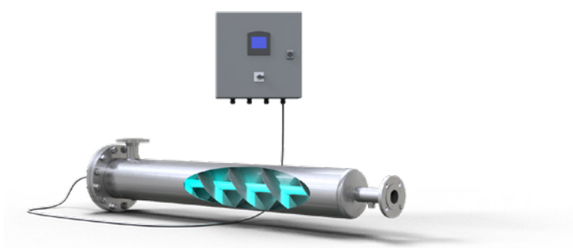
In public indoor pools, a properly sized DAISY® System will provide a stable combined chlorine level of ≈ 0.3 - 0.4 mg/l. To reach a value of less than 0.2 mg/l we recommend the following 2 solutions :

1. Activated carbon (GAC)

5-10 cm of Activated Carbon (coconut shell) can be added on top of the AFM® filter bed. This small layer will avoid microbial contamination of the activated carbon while adsorbing organic chloramines leading to a maximum level of 0.2 mg/l of combined chlorine – even under heavy bather load.

2. Advanced oxidation with Advanox™!

Advanox™ is a state-of-the-art water treatment system designed to **reduce organic substances and organic chloramines in water** by oxidation reactions with powerful hydroxyl radicals ($OH^{\cdot}$). When DAISY® is used in combination with Advanox™, the lowest combined chlorine concentration of < 0.2 ppm and the lowest THMs levels can be achieved. Unlike medium pressure UV systems, Advanox™ does not produce harmful THMs, consumes less energy and offers significantly lower operating costs!



Advanox™ represents a much more effective & healthier solution than UV Medium pressure systems. It is also a perfect alternative to ozone with much lower CAPEX and OPEX! Scan for more information.

ACTIVATED CARBON VS ANTHRACITE - MAKE THE RIGHT CHOICE!

Activated carbon (GAC)

- **GAC** is very efficient for removal of combined chlorine with low contamination risk if the layer remains below 10 cm.
  - Has a very high surface (BET) : 900 - 1200 m^2/g.
  - Does not contain iron.

Anthracite H & N

- **Anthracite H** will remove combined chlorine, however:
  - Surface (BET) is 3x lower than GAC : 300 m^2/g.
  - Requires 3x more depth than GAC (30 cm).
  - Can contain iron!
- **Anthracite N** is not efficient for removal of combined chlorine. It is not activated and has no adsorption capacities.

10 HIGH LEVEL TRAINING SESSIONS

YouTube

DRYDEN POOL ACADEMY

DOWNLOAD **SECTION**

LinkedIn

Dr. Dryden is a marine biologist specialising in swimming pool water treatment. His mission is to eliminate toxic disinfection by-products and provide the best air and water quality on the market. For over 35 years, Dr. Dryden has been working with chlorinated systems for Dolphins and other aquatic mammals before successfully introducing his technology to the pool industry. Today, as a testament to the performance, safety and benefits of his water treatment solutions, over 500'000 swimming pools worlwide are using Dryden Aqua products.