Summary of drinking water and wastewater comparative trials between sand and AFM

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Drinking water

Data summary from tests conducted on drinking water treatment, locations include a facility in Scotland, and second in England and the treatment of waste water in the middle east to produce drinking water from a single pass AFM pressure filter. Systems operated in Spain on waste water treatment are also presented.

Trials in Scotland

The trials were conducted on two parrallel pressure filters, operational flowrate 10m/hr one filter with a high quality sand and the second with AFM active filter media.

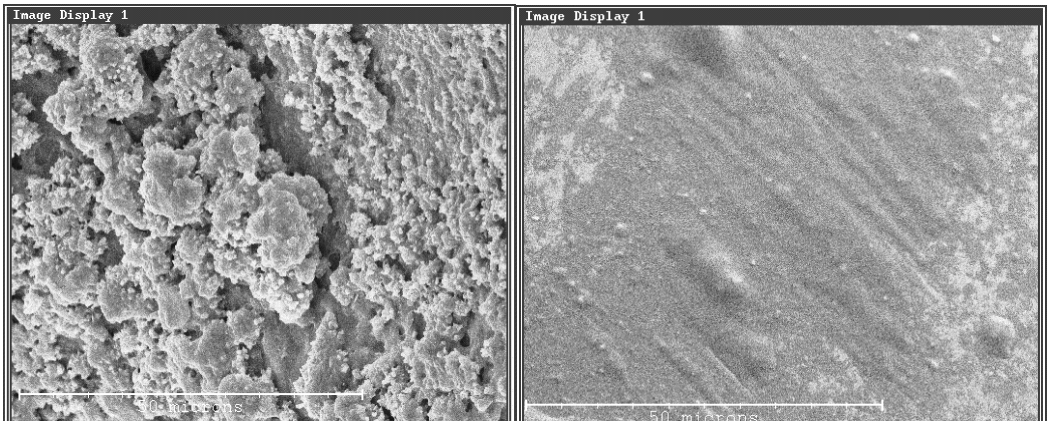
The filters were operated by the water company, and all samples were collected and analysed by the same water company.

Trend line information for the data confirms a 50% performance improvement using AFM over sand running under identical conditions with no pre-coagulation or flocculation. AFM will remove particles down to approx 5 microns and sand will remove particles down to10 microns. However the main difference is due to the bio-mechanical instability of sand filters.

AFM carries a surface negative charge, when the water is pre-treated by anionic coagulents and flocculents at the correct application rate, the zeta potential of the solids is shifted to the positive side. Large particles above 5 microns will be mechanically removed by AFM, smaller particles with a +ve charge will be adsorb on to the –ve charged surface of AFM. While AFM does not provide absolute filtration, when combined with pre-coagulation and flocculation it will remove most particles down to 1 micron, and many sub-micon particles as well as dissolved organics. AFM approaches the mechanical performance of ultra filtration (UF), but will remove smaller particles as well as a dissolved components that can not be removed by UF. AFM is certified under Reg 31 and is a direct replacement for sand in rapid gravity or pressure sand filters.

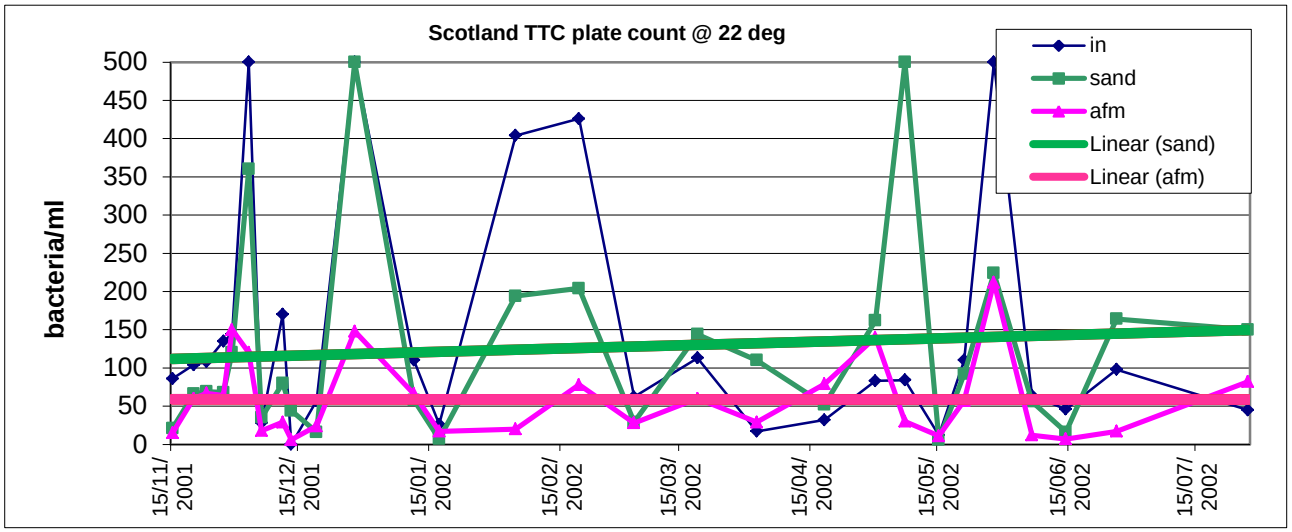
Bio-mechancial instablity of sand filtration

Sand will deteriorate with time due to an ecological natural succession of bacteria species that colonize the sand surface, this leads to bio-mechanical instability and variable performance. AFM does suffer from bio-mechanical instability, performance is stable and predictable over many years, indeed AFM should last for the life of the filter.



The above electron micrographs are of the surface of sand and AFM, sand is an excellent substrate for the growth of bacteria, and irrespective of the back-wash velocities a biofilm will develop on every grain of sand over a period of 7 days. The bacteria stick themselves on to the surface of sand using an alginate, the alginate will eventually causes coagulation of the sand grains and this is when worm-hole channelling starts to develop. The worm hole channels are usually transient and may only appear for a few minutes to several hours. When a sand filter channels, the solids collected on top of the filter bed may be discharged into the product water. The solids load will increase, heavy metals will increase and any bacteria or parasite such as crypto or giardia may be discharge into the product water.

AFM is manufactured from glass as a raw material, glass is an alumino-slicate with a similar chemical composition to sand. The properties of glass depend upon the chemical composition of the glass and how the material is treated. Self-cleaning glass windows use titanium dioxide films to create a hydrophobic surface with photo-catalytic properties. AFM glass is treated to provide a hydrophilic surface with catalytic properties. The catalytic reactions are activated by the presence of oxygen in the water. The activation process develops a permanent surface negative charge and high surface oxidation potential. If there is some oxygen in the water, AFM will not biofoul, the AFM particles will not coagulate and the filter bed will not experience worm-hole channelling.



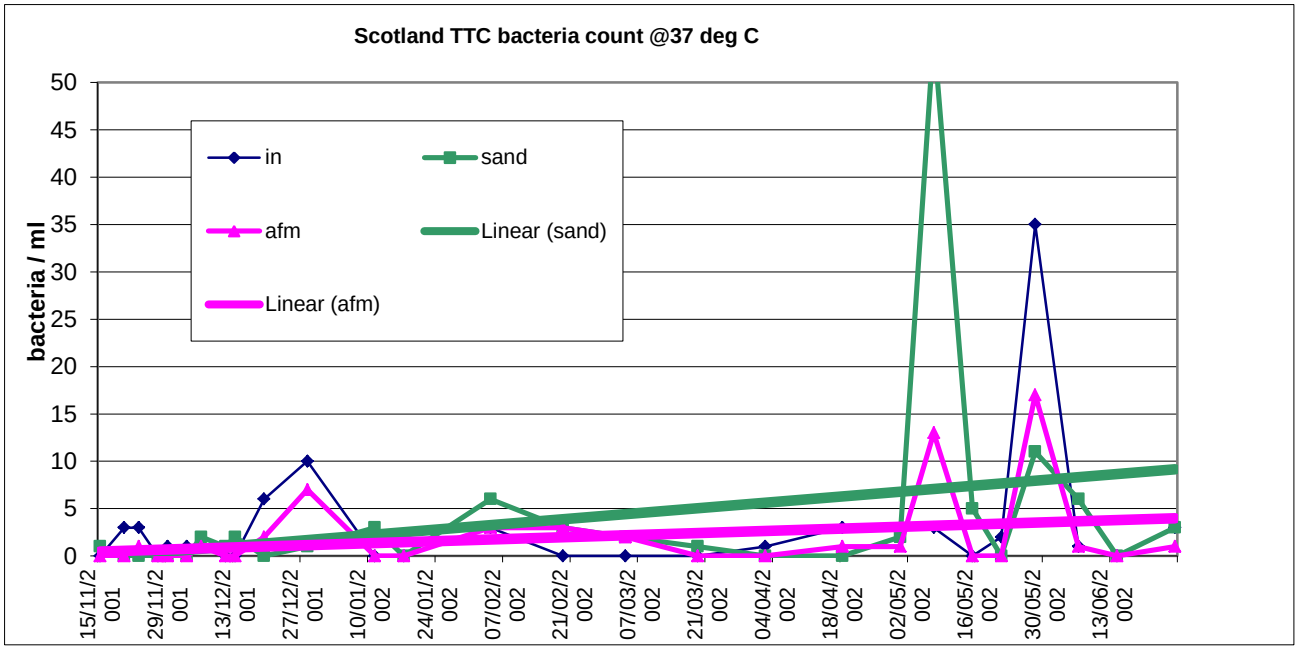
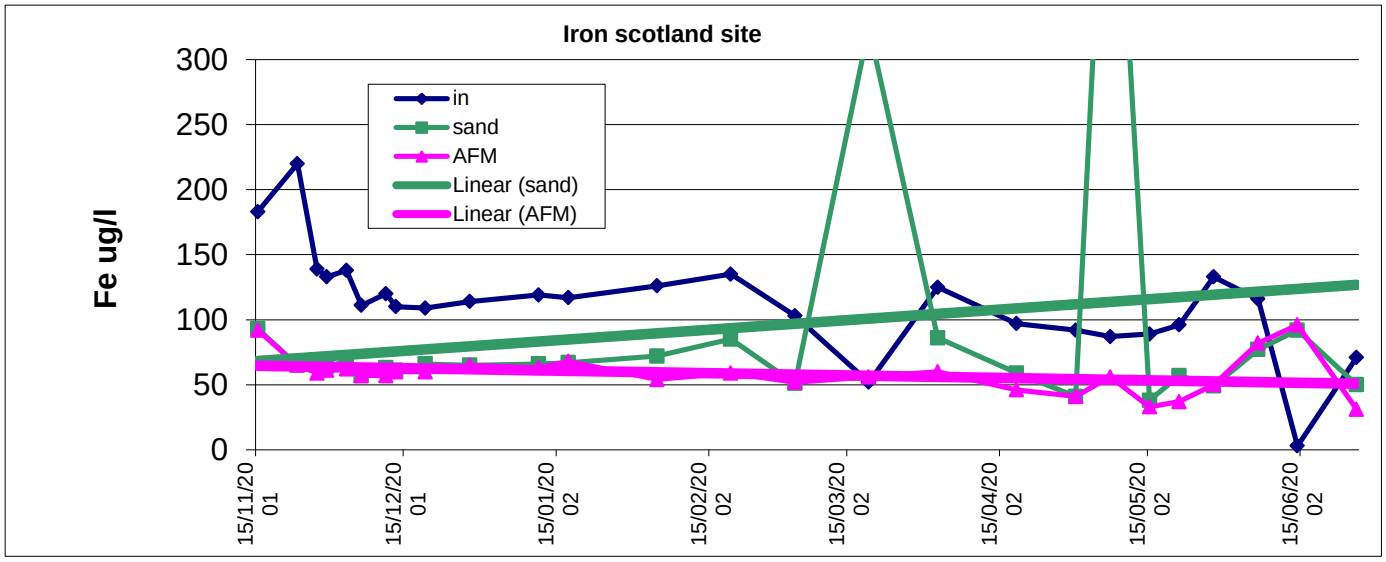
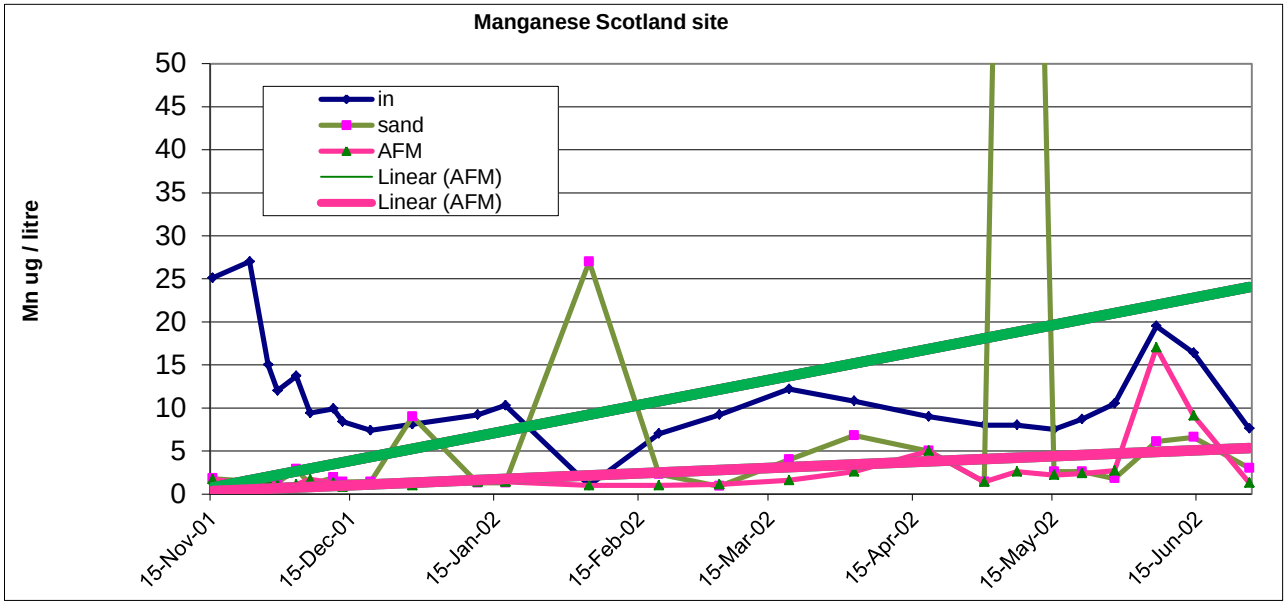


Plate count at 22 degC and at 37 degC. linear trend line at the end of the test period confirms AFM was removing twice as much as the sand. The linear trend lines are skewed due to high break-through concentration of bacteria into the product water, however this did not happen with AFM to the same frequency or magnitude.

A similar set of results on the same samples of water were observed for iron and manganese.





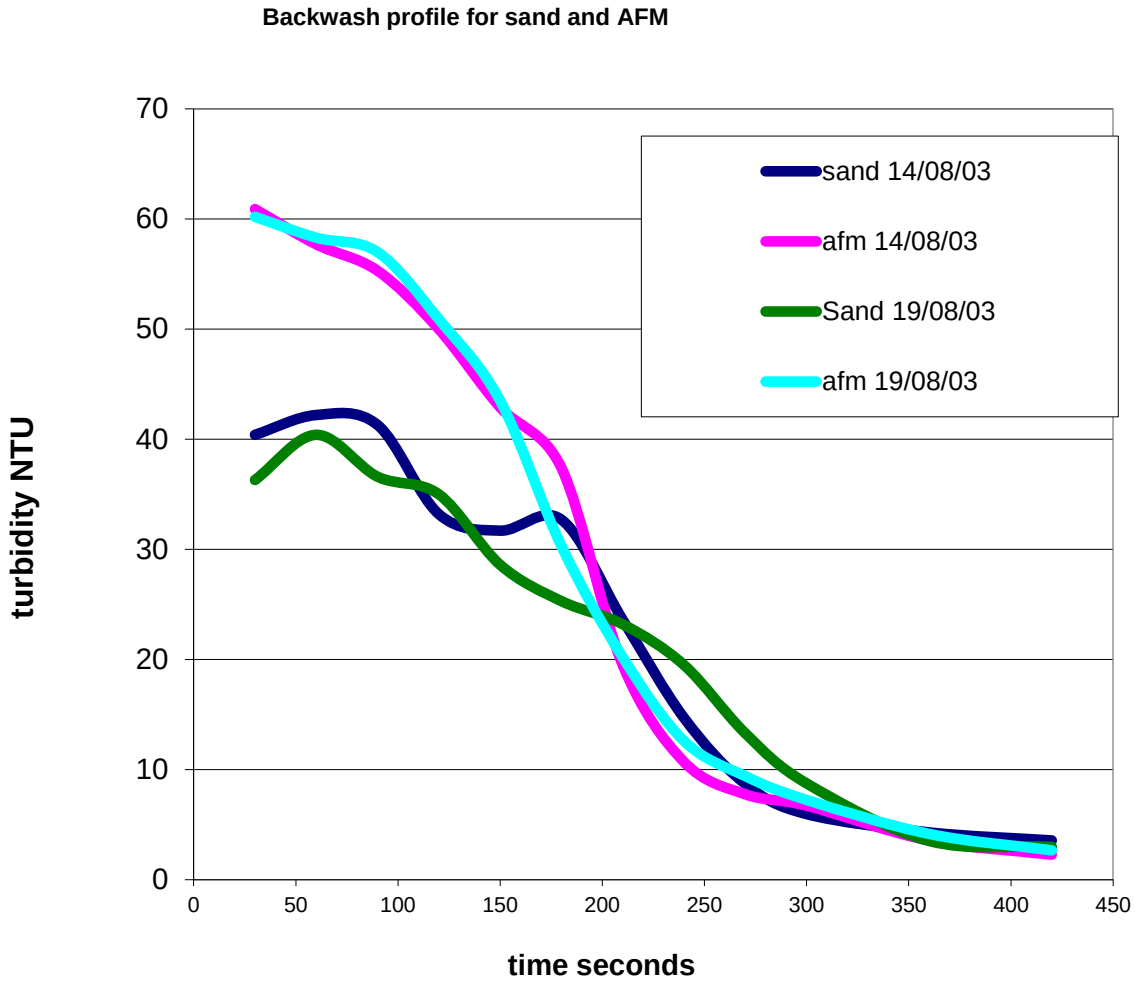
The results are skewed by the spikes of iron and manganese entering the discharge water from the sand filter. The results show the instability of sand filtration in relation to an identical filter on AFM.

Back wash Profiles, drinking water treatment

What goes into a filter must come back-out

Two pairs of filters with pre-coagulation and flocculation were operated on a surface water system, one with sand and the second pair with AFM by a water company in England.

Back-wash profiles for the filters were measured and integration of the area under the profile confirms 30% more solids are back-washed out of AFM filter bed. The data relates to 4 filters that had been in service for 10 weeks. AFM back-wash profile stays the same, sand deteriorates with time, after 6 months the difference was closer to 50%.



Tertiary treatment after activated sludge

Treated effluent from large waste water treatment plants in the Middle East are often stored in large lagoons / lakes for subsequent treatment and reuse. Sand anthracite filters are used to treat this water in order to provide irrigation water.

The quality of the irrigation water will dictate the application; class 1 irrigation water may be used to irrigate produce for direct human consumption, such as tomatoes and cucumbers. Class 2 irrigation water is an inferior quality and can only be used for produce not directly consumed, for example produce with a skin such as bananas or avocados.

AFM systems have been compared directly against sand anthracite systems operating in polluted water at high temperatures. The water was chlorinated, flocculated and then filtered, the data below gives the results.

The results confirm that on a single pass system AFM could produce class 1 irrigation water from treated waste water.

Parameter	Influent waste water	After sand / anthracite filter	After AFM
Turbidity ntu	65	5	0.8
BOD mg/l	35	8	2
TSS mg/l	40	5	5
VSS mg/l	38	5	2
CFU (100ml)	60000	10	0

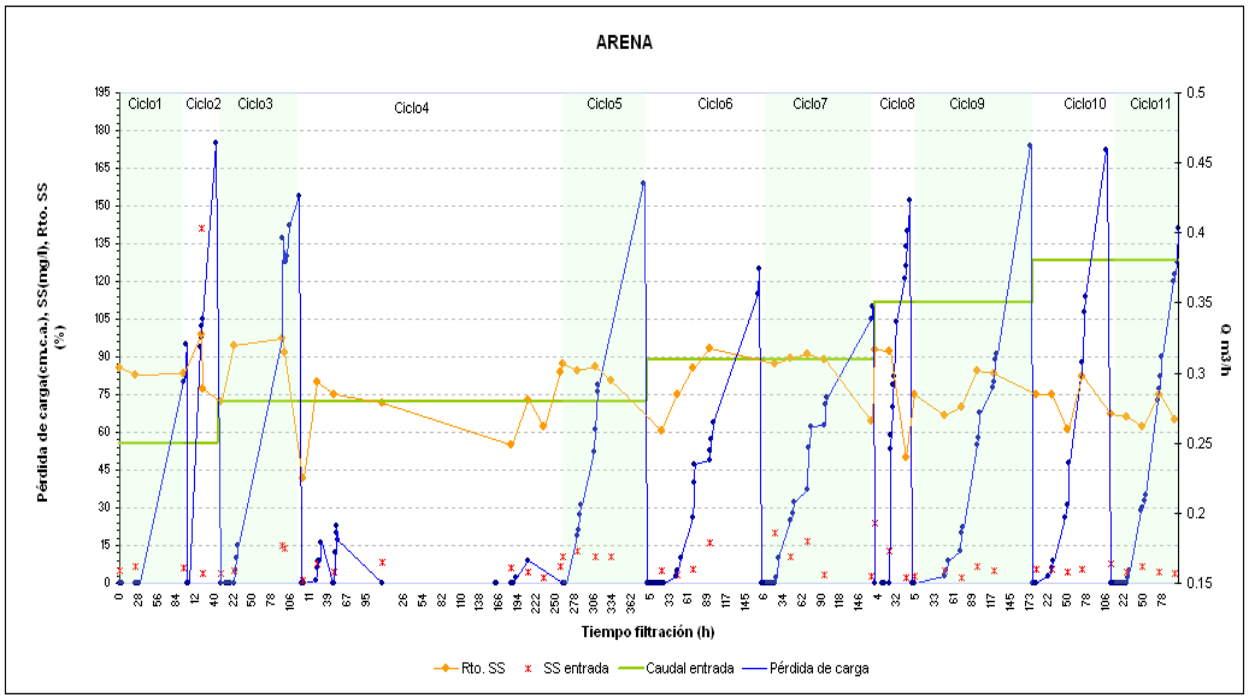
The tertiary treatment of waste water

A comparative evaluation against AFM in a pressure filter and other technologies

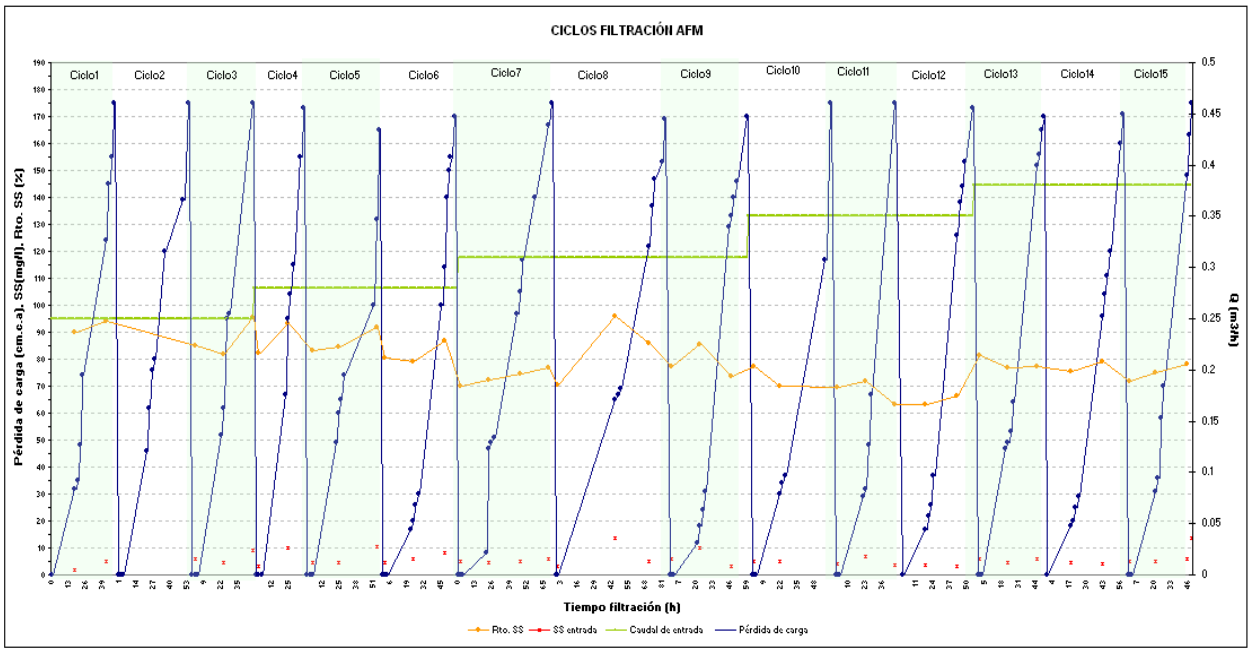
TYPE OF FILTER	SS. (mg/l)		Performance %	Turbidity ntu		Performance %	bacteria		Performance %	Velocity
	inlet	outlet		inlet	outlet		inlet	outlet		m3/m2/h
RGF sand filter with sand	7.14	2.2	69	3.5	2.23	36	23120.0	12300.0	46	1.2
Pressure filter with sand	8.18	3.82	53	5.87	4.76	18	22311	18023	19	4.96
Moving bed sand filter with sand	7.08	3.82	46	2.13	1.79	16	14067	10307	26	5.4
Drum filter 10 micron	14.66	7.33	50	7.16	3.88	45	56712	38460	32	3.23
Disc Filter 10 micron	5.6	3.1	44	2.22	2.06	7	30450	21138	30	2.12
Ring Filter 10 micron	7.41	3.98	46	3.01	3.17		9447	7761	17	2.5
AFM® Pressure filter	10.60	0.89	96%	2.98	0.24	92 %	23000	10000	58 %	3.59

NOTE : The results presented are published in the Spanish magazine " Technology del Agua" in December 2009, page 47. The AFM results correspond to a test made at a water treatment works by and independent water company in a working effluent plant near Valencia 11/12/2009. The test bed is shown on the right.

Trials with a sand filter and identical AFM filter continued in order to evaluate the performance of sand and AFM for the treatment of waste water.



Back-wash cycles for a rapid gravity sand filter, note the varying time difference between backwash cycles and variable magnitude. Between hours 95 to 166 the bed was channelling hence the reason for the low pressure differential. Channelling happens to varying degrees on each run phase cycle.



The AFM filter above shows almost exactly the same time interval between back-washes and the same performance on each cycle. The is no evidence of any channelling of water through the filter bed. AFM systems in pressure filters have now been in use on waste water treatment plants for over 10 years and are still giving the same performance.

The data demonstrates the stability, predictability and high performance of AFM filtration system.