

TO WHOM IT MAY CONCERN

Magnago, June 2022.

Subject: fusio-technik FASER WOR system.

Here are some information related to the **faser FIBET-T**, **FIBER-COND** and **FIBER-LIGHT WOR** (Whire Oxidation Resistance) pipes of the **PP fusio-technik system**, produced by Aquatechnik Group SpA:

- multilayer pipe PP-RCT WOR/PP-RF/PP-R for potable hot and cold water, with fiber reinforced middle layer and internal layer made with PP-RCT WOR (White Oxidation Resistance), internal and external layers are white;
- all the articles of the fusio-technik system are produced in Polypropylene, therefore they are perfectly weldable with each other using different appropriate welding techniques for Polypropylen articles.
- the polymeric material which the pipes are made of, shows a high chemical resistance (depending on the application) and it is not subject to corrosion.

The polymeric materials are subject to degradation. The material degradation, implies the reduction of the mechanical resistance by degradation.



The causes of this degradation are different:

- heat;
- UV-Vis/IR rays;
- combined action between mechanical stress and chemical reaction (stress cracking);
- Oxygen action;
- ionizing radiations (eg. Gamma ray);
- biological cause (fungi and bacteria);
- metal ions;
- chemical oxydation (eg. Chlorine).

The pipes for potable water or for water used for disinfection, are exposed to multiple causes of degradation previously shown:

- heat;
- stress cracking;
- chemical Chlorine oxidation.

In time, the shortage of water resources, forced the operators to use water treated with potability treatments and/or the necessity of constant disinfection to prevent illnesses (eg: anti-legionella treatments).

Therefore, the necessity to produce materials more and more resistant to disinfectant agents for water increased.

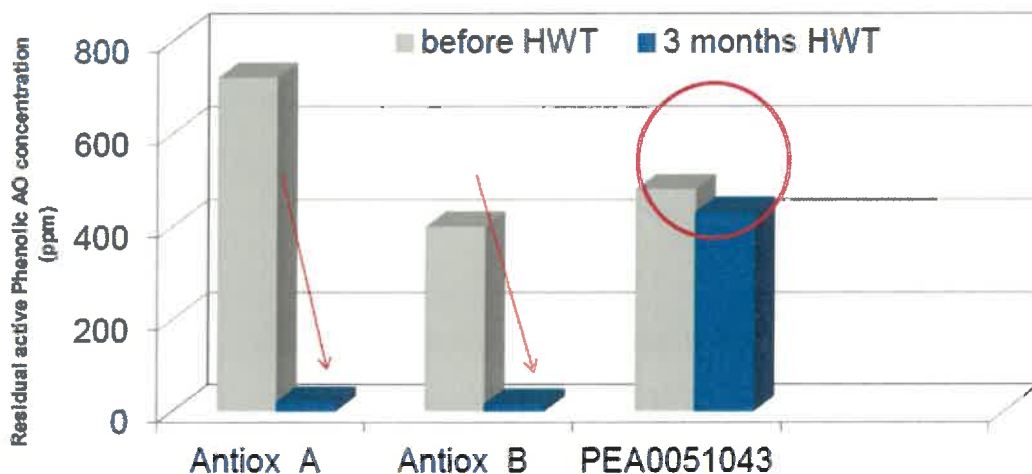
Based on the experience matured in the North American market (through Aquatechnik NA) where disinfectant treatments for water are particularly aggressive, Acquatechnik Group s.p.a. decided to extend the usage of the specific white “masterbatch” to the Italian and European production as well: therefore, this “masterbatch” has been refined and improved in terms of efficiency and resistance of the polymer to the oxidative- thermal stress.

This master shows the most technologically evolved system in terms of resistance to the oxidant agents, and together with the PP-RCT, the most resistant Polypropylene to Chlorine, it confers significant efficiency and Chlorine resistance to the internal layer, bigger than the one the previous system had.

To prove what's been said so far, some of the data related to the additive and to the **fusio-technik faser** pipe are reported.

The tests have been performed on the additives (additive comparison) and on the sample pipes (different Fusio system pipes comparison) produced foreseeing, for the internal layer, the combined usage of PP-RCT and these latest generation additives: this combination between polymer and additives has been called WOR.

ADDITIVE COMPARISON



This histogram shows a comparison of the efficiency between the different stabilization systems.

“Antiox A” and “Antiox B” are additive systems of the previous generation, “PE0051043” is the latest generation additive used for the WOR pipe.

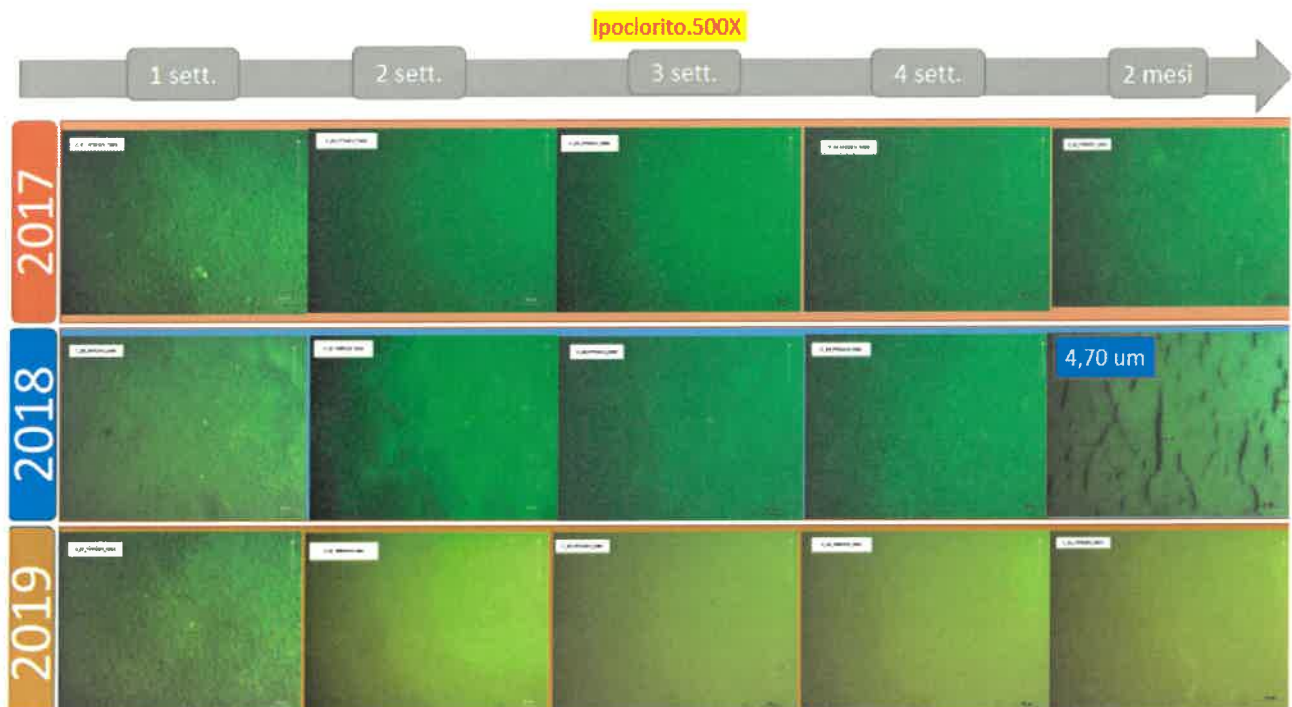
You can see that, after the treatment of the polymeric material, added with different stabilization systems to the action of the oxidants such as Chlorine in these conditions:

- water at 80°C;
- Chlorine concentration=5ppm;
- Treatment duration= 3 mesi;

the additive shows the same efficiency it had at the start.

Therefore, Chlorine resistance is way higher than the one guaranteed by the previous generation additives.

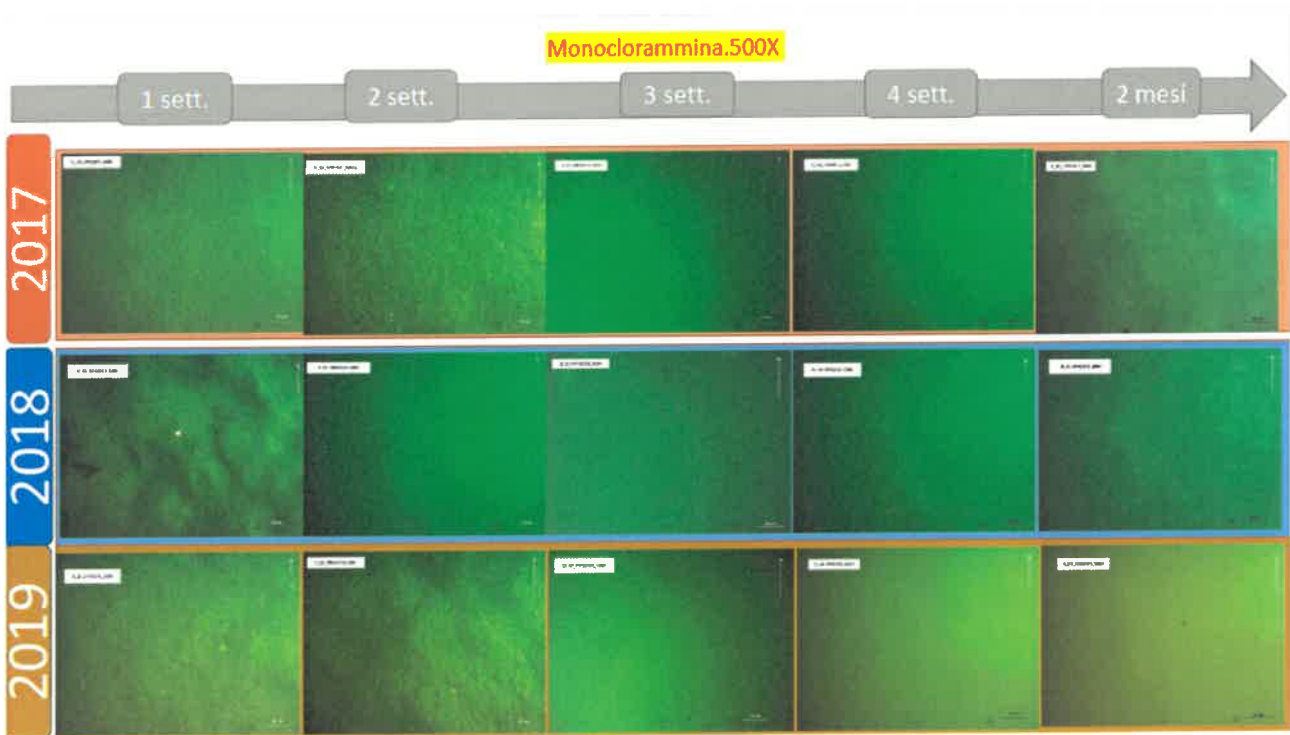
OPTICAL MICROSCOPY MORPHOLOGICAL TEST free Chlorine by Hypoclorite



Note: the green color is due to the chromatic effect from the polarized light. In reality, the surfaces are: green for the 2017 sample, white for the 2018 and 2019 samples.

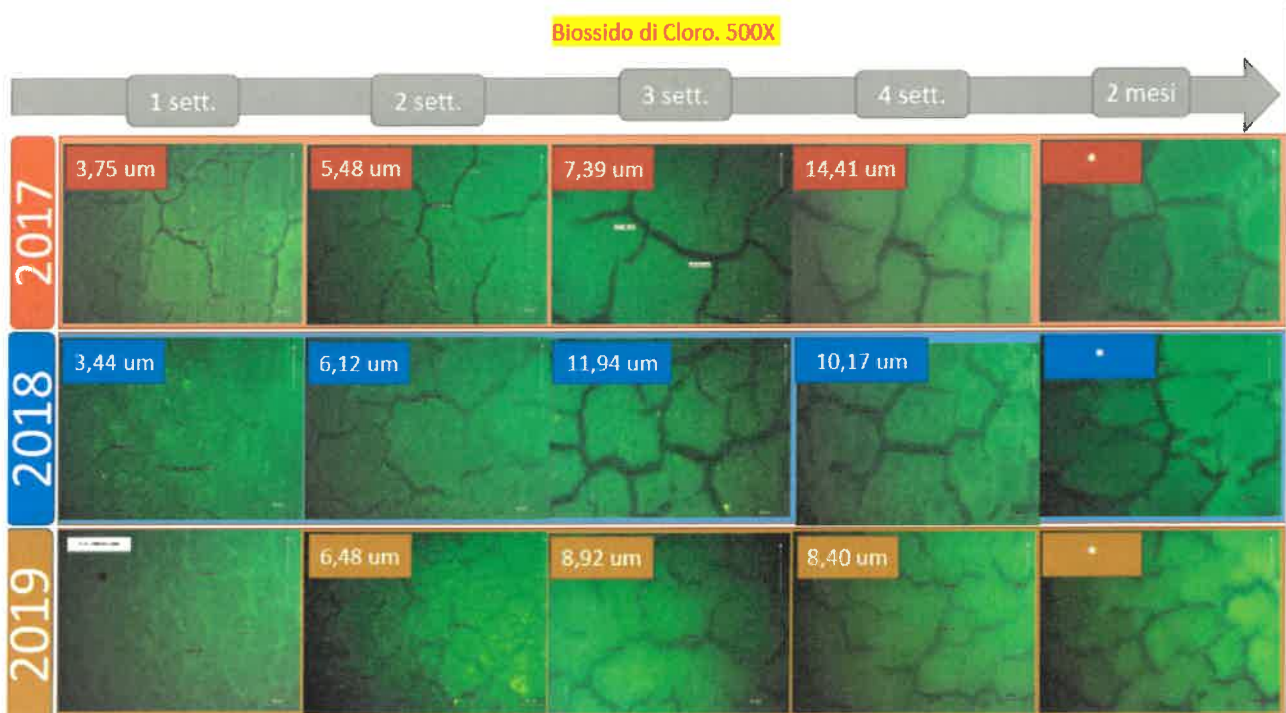
The morphological evaluation of the internal surfaces of the pipe that are in contact with different disinfectant Chlorine based agents, show a higher WOR 2019 pipe resistance. Particularly, using Chlorine Dioxide, the 2019 pipe shows the presence of “fractures” after some weeks, the dimensions of these fractures are stable during the test and they are smaller compared to the other sample pipes.

OPTICAL MICROSCOPY MORPHOLOGICAL TEST Monochloramine




Test results:

OPTICAL MICROSCOPY MORPHOLOGICAL TEST Chlorine Dioxide



DIFFERENT FUSIO PIPES COMPARISONS

We analyzed n°3 different types of FUSIO pipes:

- pipe 2019= pipe faser Fiber-T SDR 7,4 green/white WOR Ø25mm;
- pipe 2018= pipe faser Fiber-T SDR 7,4 green/green Ø25mm;
- pipe 2017= pipe fusio-technik SDR 6 green Ø25mm.

Test conditions:

Biossido di Cloro

$[\text{ClO}_2] = 1 \text{ ppm}$
T= 70 °C
p= 5 bar
v= 0,5 m/s

Monoclorammina

$[\text{NH}_2\text{Cl}] = 4 \text{ ppm}$
T= 70 °C
p= 5 bar
v= 0,5 m/s

Cloro Libero

$[\text{ClO}^-] = 4 \text{ ppm}$
T= 95 °C
p= 5 bar
v= 0,5 m/s

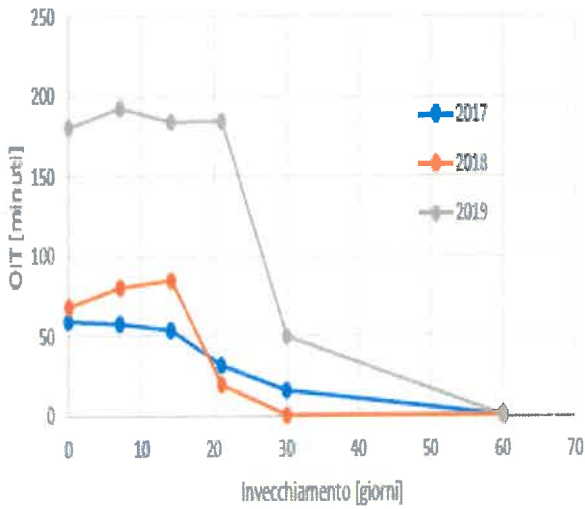
Length:

- 1 week;
- 2 weeks;
- 3 weeks;
- 4 weeks;
- 2 months.

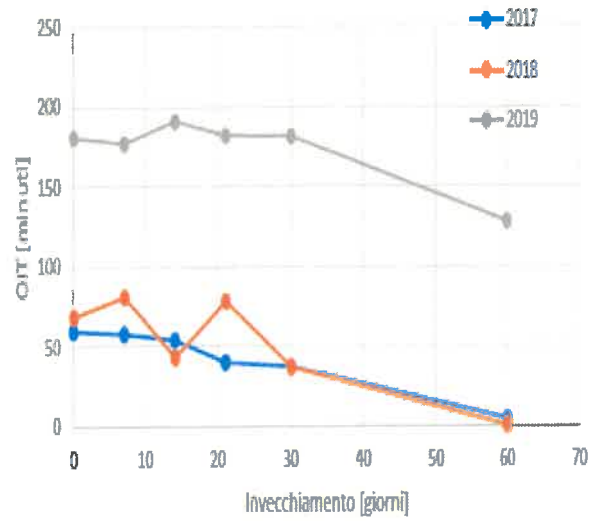
DIFFERENTIAL SCANNING CALORIMETRY (DSC):
OXYDATION INDUCTION TIME (OIT)

OIT a 200°C
 Campionatura: 0,35±0,70 mm dalla superficie interna

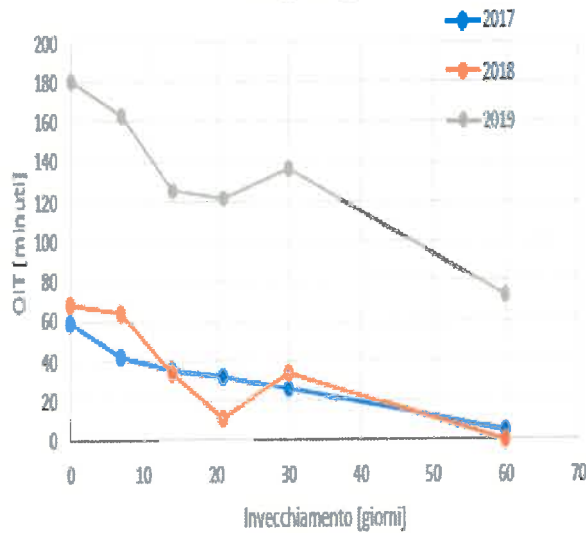
Biossido di Cloro



Monoclorammina



Cloro libero




This test allows to determine the capability of the material to overcome the degradation (thermo-oxydative): the higher is the OIT measured time, the higher is the resistance of the material.

The results of the previous graphs, show the resistance of the WOR 2019 pipe which is generally 30/40 times higher than the other tested pipes.

This chart shows data and OIT measures registered in the past:

SAMPLE	OIT (minutes) external layer
New 2018 FIBER-T Aquatechnik PP pipe	75
Fusio-technik Ø25 Aquatechnik PP pipe after 20000 hours at 5bar/ 70°C with 1 ppm ClO ₂	7
Single layered PP pipe from competitor broken after 5 years of usage	1
New single layered white Aquatechnik PP fitting	32

The comparison between these data and the one registered on the WOR pipe analysis, show that the OIT times that reach the 200 minutes represent the high resistance of the WOR pipes to degradation.

ANALISI SPETTROFOTOMETRICA FT-IR

Ipoclorito, 2 mesi, superficie



This analysis is made on the internal layer of the pipes in contact with disinfectant agents, and it shows the chemical alteration on the polymeric chains of the Polypropylene, due to the Chlorine attack.

The red circle shows different peaks of the carbonyl group: the higher is the breadth of that peak ($1700/1750 \text{ cm}^{-1}$), the higher is the chemical alteration on the polymeric chains.

This measure shows the high resistance of the WOR pipe to Chlorine.

CONCLUSIONS

Considering previous experimental data registered from Aquatechnik's Research Center, it shows that the synergie between the raw material (PP-RCT), the last generation additives and the modality of production, allowed the manufacture of some fusio-technik FASER WOR articles with better characteristics for what concerns resistance to the thermo-oxidative degradation, typical of the potable water sanification agents, like Chlorine treatments.

For what concerns some other characteristics, it's possible to quantify this improvement in 30/40 times.

This brings us to believe that the fusio-technik FASER WOR articles are significantly better than the older ones, in terms of resistance to potable water sanification agents. Our Technical Office is at disposal for every information needed, so that the given support to the designers will lead to an efficient design of the system, since the correlation between a good system design and product quality is the most important thing for the installation of safe, reliable and long-lasting systems.

Technical management



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