WE TAKE CARE OF YOUR WATER
We take care of you…

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Who is Borman?

- Borman Italiana s.r.l. was established in **1961**

- The production plant and annexed warehouse, offices and analytical and research laboratories are located in Settimo Milanese (Milano)
- Borman's target is Research and Development, Production and Sale of **chemical products for industrial and municipal water treatment with related technologies.**
- Borman is certified according to the International Standard UNI EN ISO 9001:2015 and ISO 14001:2015

Industrial and civil areas where Borman is present

Wide diversification of application areas. Borman is currently present in:

Steelworks / Iron and steel industry
Automotive industry
Chemistry
Food
Pharmaceutical
Power Generation
Paper Production
Textile
Glassworks
Hospitals / Large buildings
Municipalities

Main Customers:

Steelworks:

- Arvedi Terni (ex Thyssen Krupp Group)
- ILVA Group
- Interpipe Steel (Ukraine)
- Ferriera Valsider (Metinvest Group - Ukraine)
- Ferriere Nord
- Marcegaglia Group
- Acciaieria Valsugana
- Olifer
- Nunki Steel

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Main Customers:

Others:

- Burgo Group (Paper)
- Lucart (Paper)
- Georgia Pacific (Paper)
- Fiat Group (Automotive)
- IMS (Foundry)
- PPG (Paintings)
- Bormioli Group (Glasswork)
- Enel (Power)
- EDISON (Power)

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Main Customers:

Others:

- Erbil (Iraq) (Refinery - through Distributor)
- Pentaclean (Hungary) (Distributor)
- Brenntag S.p.A. (Distributor)
- Mentani Detergenti S.r.L. (Hospitals - Distributor)
- Labromare S.r.L. (Land and Sea environmental Remediation)
- DANIELI & C. OFF.MECC. (Engineering company)
- CAP HOLDING (Management of integrated water service of Milan – Italy – metropolitan city)
- ECO center (Integrated water service – sewage and depuration)

Main Customers:

Others:

- E.O.N (Power)
- SALOV (Edible oil refinery)
- NESTLE' (Food)
- AMSA (Incinerator)
- PFIZER (Pharma)
- SANOFI AVENTIS (Pharma)
- KEDRION BIOPHARMA (Pharma)

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What does Industrial Water Treatment mean?

When using water the following problems can occur:

SCALING

Increase in MAINTENANCE COSTS

and reduction of EFFICIENCY

What does Industrial Water Treatment mean?

When using water the following problems can occur:

CORROSION

Significant increase in MAINTENANCE COSTS and risk of PLANT SHUTDOWN

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What does Industrial Water Treatment mean?

When using water the following problems can occur:
UNCONTROLLED MICROBIOLOGICAL GROWTH

Increase in MAINTENANCE COSTS and reduction of EFFICIENCY

Where do these problems occur?

Cooling Water Systems

Steam Generators

Reverse Osmosis

What do we provide to solve these problems?

Cooling Systems

Hyperline & Biogreen product lines

- Corrosion inhibitors
- Antiscales
- Dispersants
- Biocides

Boilers / Steam Generators

Bormaclean, Bormavis & Bormine product lines

- Oxygen Scavengers
- Alkalizing amines for condensate
- Internal dispersant treatment

Reverse Osmosis

Revos & Roclean product lines

- Antifoulants
- Biocides
- Membrane Cleaning

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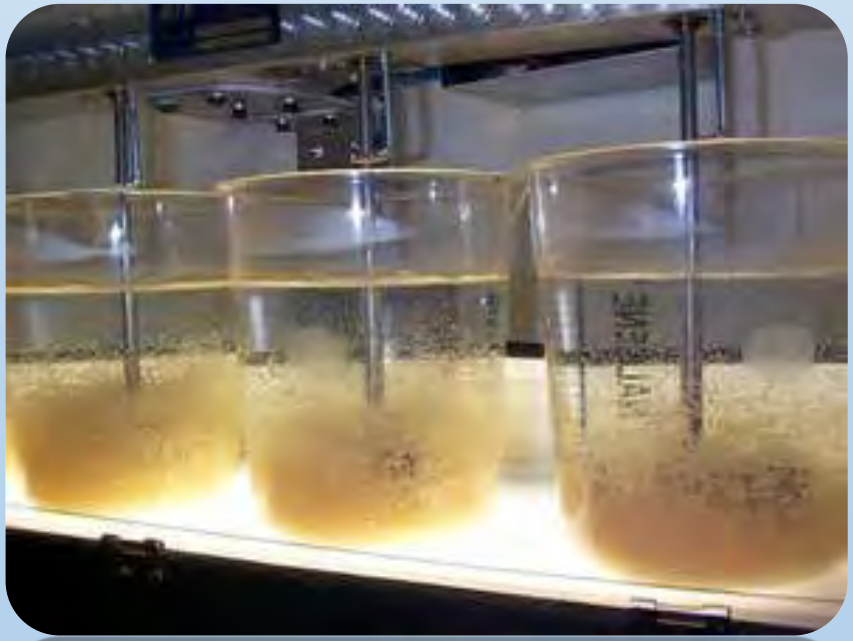
Water clarification product line – Borman solutions

Products and technologies to clarify inlet feed water and outlet wastewater plants (polluted wastewater) and for their reuse (Water Reuse). Sludge dewatering.



- **Tailor-made mixed-organic Coagulants**
- **Polyelectrolytes (powder and water/oil emulsions)**

Hyperfloc / Mag-netic Floc Product line

Potable and Sanitary Water – Borman Solutions

Potable and sanitary water treatments:

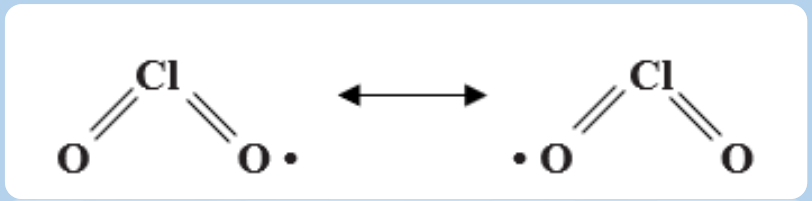
- Pre-Oxydation and Post-Disinfection (ClO_2 Technology)
- Antiscales
- Corrosion inhibitors

Potable and Sanitary Water – Borman Solutions

Waterwork Kyivvodokanal

КИЇВВОДОКАНАЛ

- **First Application in Ukraine of ClO_2 Technology (200.000 cu.m/day)**
- The application involves the on-site mixing of two products, one of which is an **activated** sodium chlorite (Biogreen "Acticlor")
- The equipment was designed by Borman in cooperation with De Nora water technologies Italy and includes chlorite control



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Potable and Sanitary Water – Borman Solutions

Waterwork Kyivvodokanal

Borman Approach

Pre-sale service:

all proposals follow an accurate study of the system, in order to verify its actual conditions and to suggest the best technical and economical solutions

Borman Approach

Qualified after-sales service:

complete assistance during treatment start-up, system water analyses, control of dosing systems correct operation, control of correct plants asset; verification of treatment objectives achievement

Borman Approach

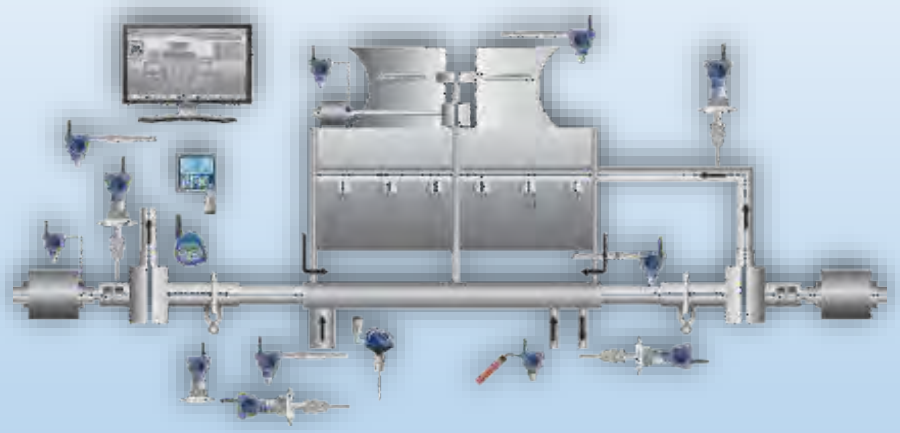
Extra assistance:

advice and assistance in modifying existing plants or in new water treatment plants design

Advanced monitoring and control systems

Borman cooperates with qualified companies in these applicatons:

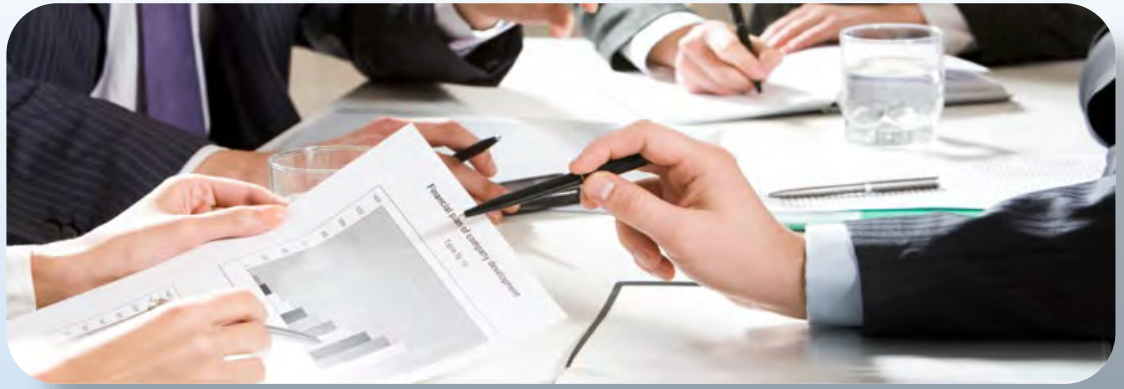
- **Tailor made design**
- **Supply of integrated control systems.**
- **Online pH, Cond, Redox, free or total Cl_2, ClO_2, turbidity, corrosion probes.**
- **Optional o-PO_4 , P_{tot} , Total Hardness online analyzers**
- **PLC for acid dosage (pH control), biocide temporization, chemicals proportional dosage (ppm vs blowdown or vs makeup) and blowdown on conductivity setpoint regulation**
- **Remote consultation / modification and alarm interface, on web server.**



Complete preassembled dosing systems

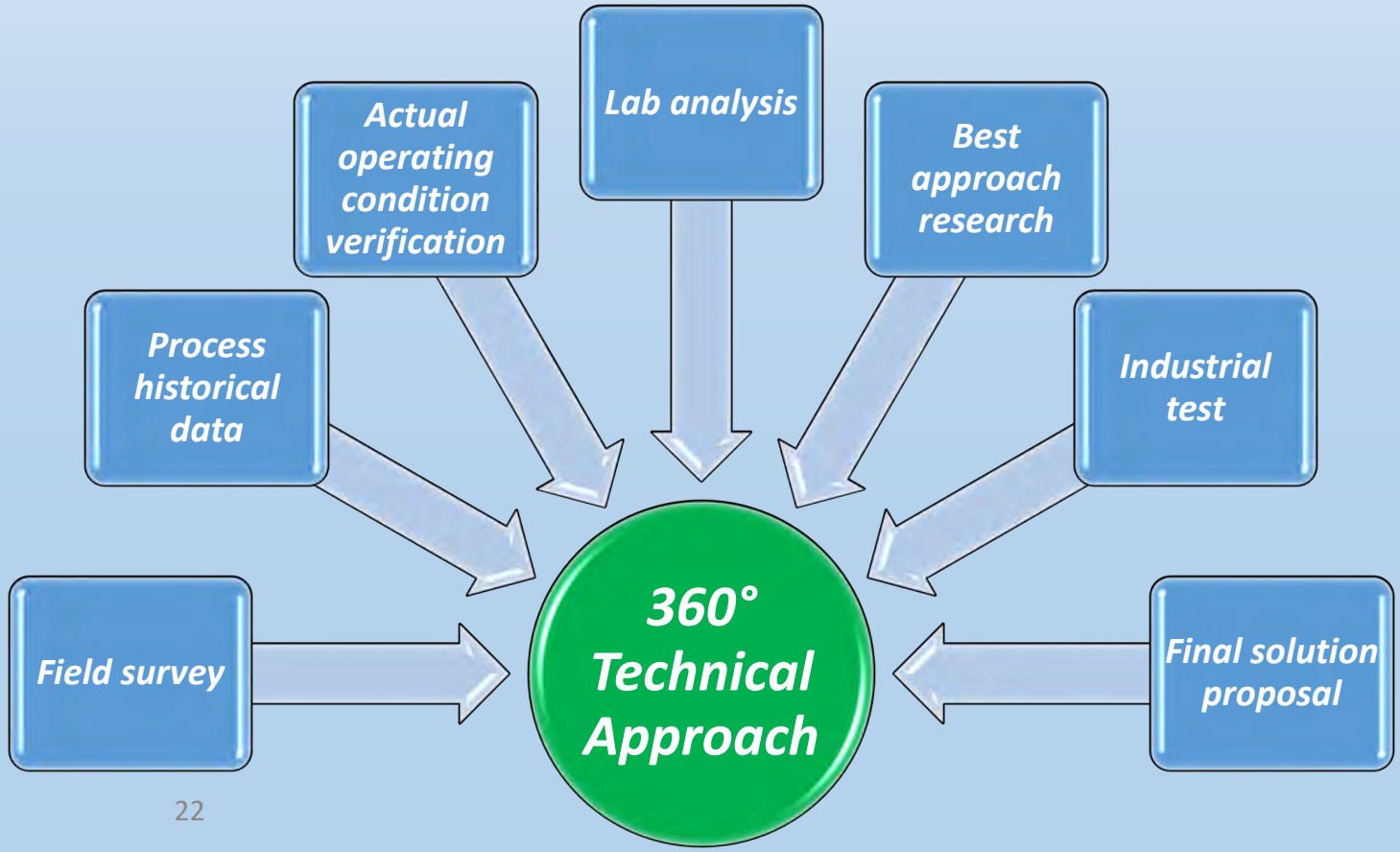
Reliable dosing systems, pre-assembled skids, electromagnetic pulse pumps, volumetric motor pumps, mixers for polymers, equipment availability for atex area installation.

Customer Care:
Borman Technical Approach



Problem preliminary study

- Accurate system study (survey)
- Current operating condition verification
- Lab analysis
- Best technical and economical solution proposal



Customer Care:
Borman Technical Approach

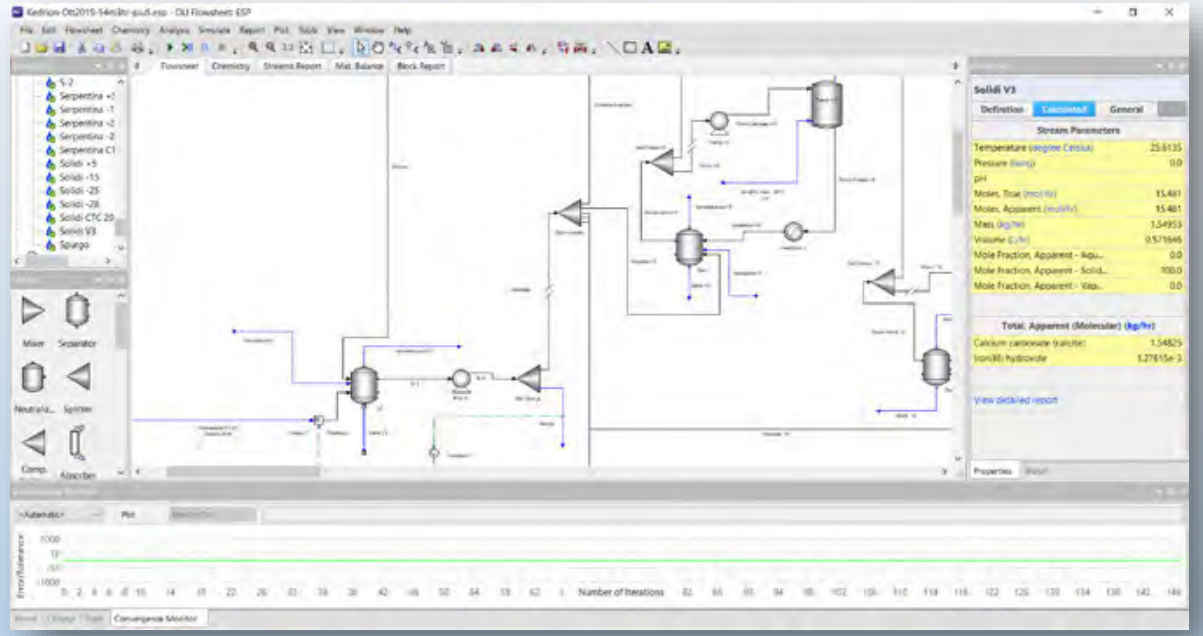
Actual operating conditions verification:

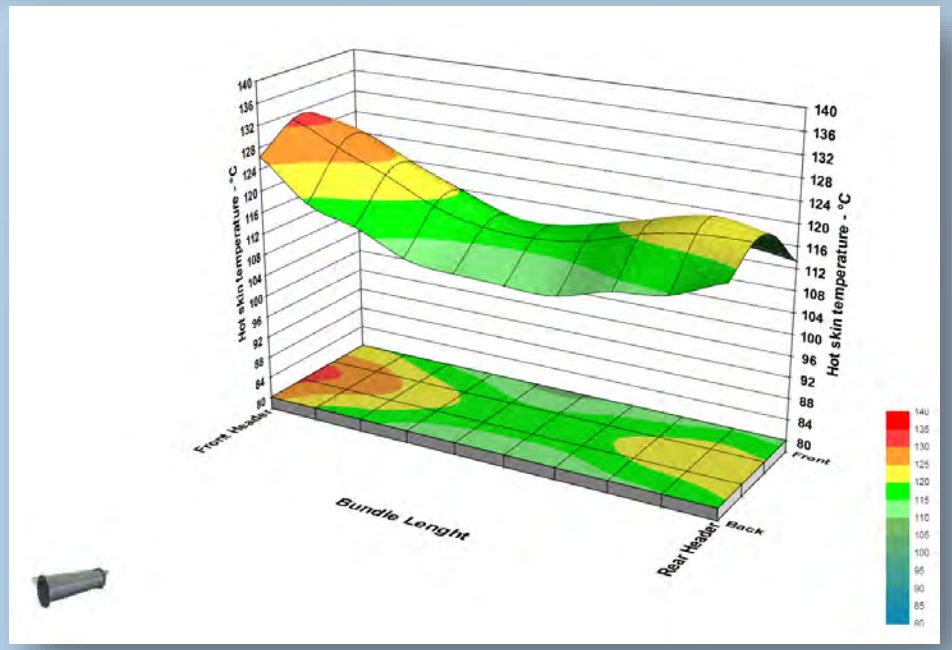
Computer simulation to enhance process research, design and operations performance with rigorous chemistry analysis

Rigorous verification of
- solubility constants of each chemical species present in the system;
- precipitation thermodynamic conditions

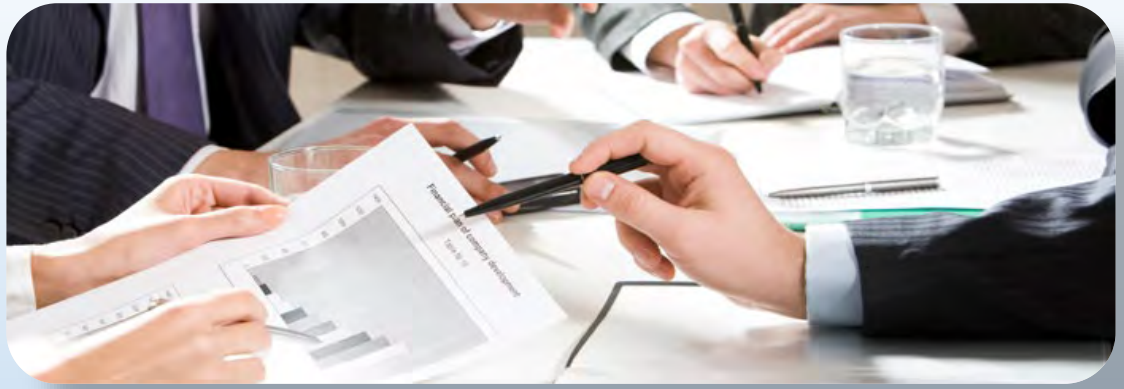
Process parameters verification, including flow rate and regime, deviation from design data, actual skin temperature of heat exchangers for scaling simulation.

Process optimization suggestions.



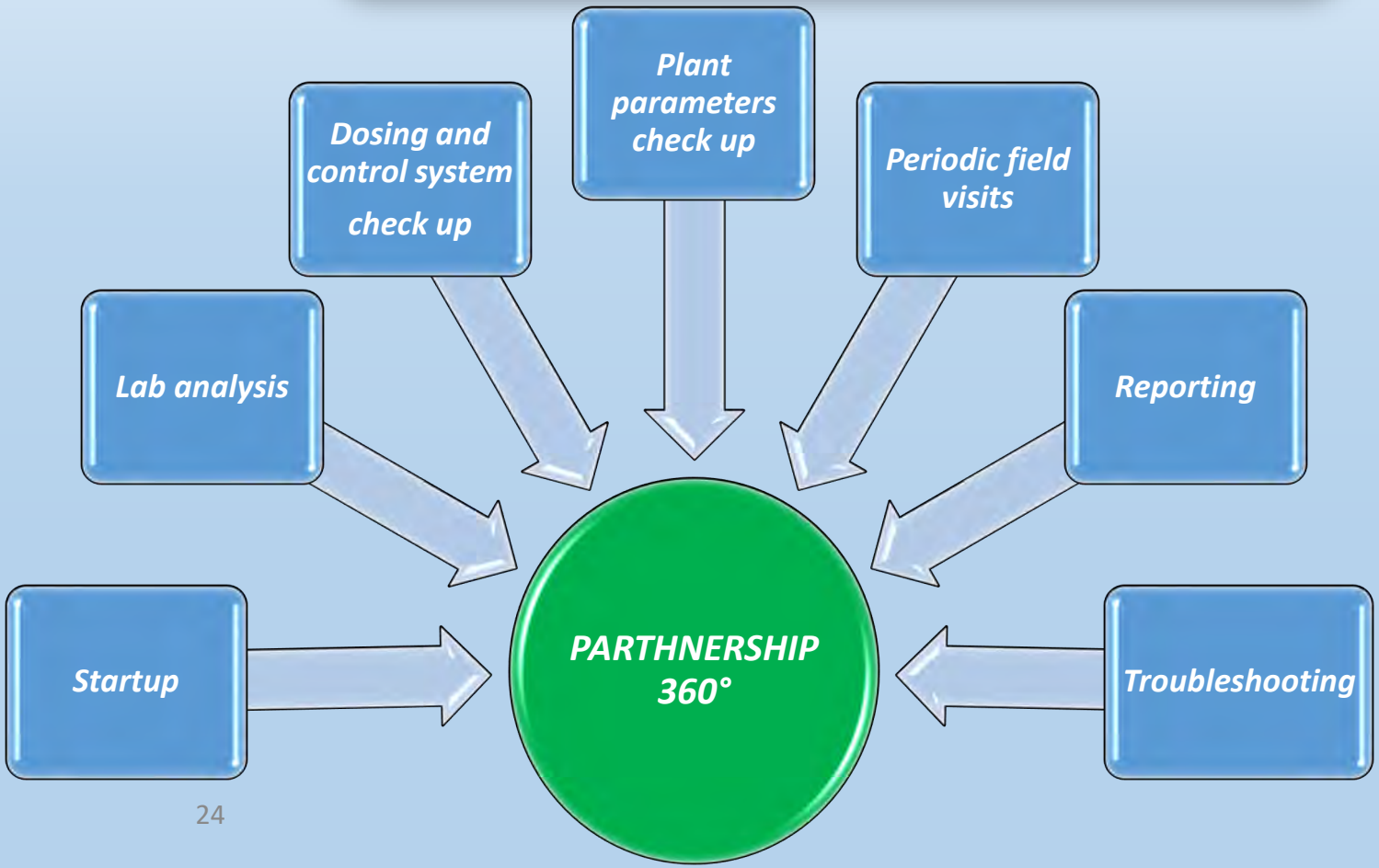


Customer Care:
Borman Technical Approach



Technical assistance and treatment management:

- **Startup: accurate assistance and frequent field presence**
- **System Water analysis**
- **Check of dosing systems**
- **Check of plant parameters**
- **Scheduled periodic visits**
- **Visit reports, monthly report, management report.**
- **Troubleshooting, continuous study of systems, improvement proposals**



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CASE HISTORIES

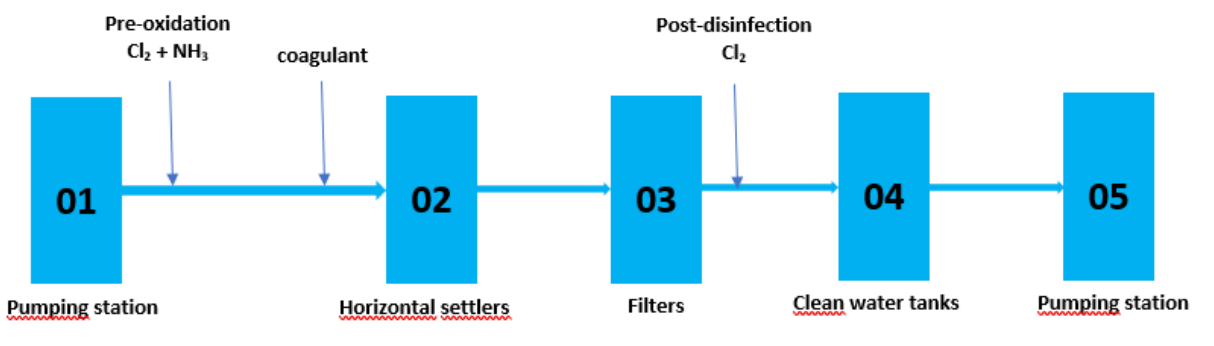
No.1: Kyivvodokanal - Waterwork

General characteristics of water potabilization system in the city of Kyiv

- Design capacity: 2.200.000 cu.m/day
- Current capacity: 670.000 cu.m/day
- Network length: 4628 Km

Technological details and scheme

Kievvodokanal has been using chlorine, in absence of free residual, for several years both in pre-oxidation and in post-disinfection, following the scheme shown below.



Problems related to chlorine technology

Continuous chlorination – combined residual – has several drawbacks:

- It is dangerous for transportation, storage and use:
  - Absence of a reliable chlorine neutralization system in case of an emergency;
  - Possible very serious environmental and social consequences in the event of a large-scale accident (radius of possible impact greater than 30 km)
- It does not grant a really effective water disinfection:
  - Poor microbicidal activity
  - Poor effectiveness in preventing biofouling formation in distribution network
  - Formation of toxic and carcinogenic disinfection by-products which cannot be controlled except by introducing very costly changes to the treatment chain.
- Only one manufacturer: no competition

No.1 : Kyivvodokanal - Waterwork

Search for alternative technologies

In 2017 Borman submitted to Kyivvodokanal management the technology based on chlorine dioxide.

In the case of Kyivvodokanal, the technology based on chlorine dioxide has no alternatives, since, compared to chlorine - or hypochlorites which are chemically equivalent - it has the following advantages:

- It has a greater oxidizing power;
- unlike chlorine or hypochlorites, it acts EXCLUSIVELY as an oxidizing agent, for this reason it has the advantage of not forming trihalomethanes and haloacetic acids;
- the disinfection by-products formed do not require particular technologies for their control;
- it acts effectively against bacteria, viruses and spores that chlorine or hypochlorites cannot eliminate;
- as a bactericidal agent it can be active in water for at least 48 hours and its effectiveness is granted for longer periods than chlorine or hypochlorites. Therefore, the use of chlorine dioxide can grant the inhibition of "bacterial regrowth" (regrowth) in the distribution network, thus allowing it to be kept cleaner;
- it allows not only the inhibition of biofilm growth but also its gradual removal from heavily contaminated distribution networks.
- it does not have the typical smell of chlorine;
- its reactivity does not depend on the pH of the water.
- it allows to obtain drinking water without any modification of the current treatment chain, there is NO need to add an activated carbon filtration system, inevitable in the case of chlorine-based treatment – in any form, chlorine gas or hypochlorite, regardless of how it is generated –

No.1 : Kyivvodokanal - Waterwork

Chlorine dioxide technology implementation – steps –

Unlike sodium hypochlorite, chlorine dioxide cannot be applied as a ready-to-use product.
Due to its volatility as a gas, chlorine dioxide must be produced in situ and applied immediately using a generator.
Two separate chemical reagents are placed in a reaction chamber, where chlorine dioxide is generated and diluted, ready to go to the process:

- Biogreen «Acticlor» - Borman formulation based on sodium chlorite 24 ÷ 25%, which fully meets the chemical-physical characteristics required by the European standard UNI EN 938: 2016 – chemical products used for the treatment of water intended for human consumption -.
- HCl 32–35%, hydrochloric acid suitably purified in order to meet the chemical-physical characteristics required by the European standard UNI EN 939: 2009 – chemicals used for the treatment of water intended for human consumption -.

Over the past 50 years, several methods and generators have been developed.
The chemical yield determines the purity of the chlorine dioxide.
Different chemicals, different raw materials and different production methods have different yields.
Not all generated chlorine dioxide are equal, for this reason Borman developed Biogreen «Acticlor», sodium chlorite formulated with a specific activator able to improve chlorine dioxide generation yield and identified in DE NORA WATER TECHNOLOGIES ITALY the most reliable partner for the supply of chlorine dioxide generation devices.
To have the effectiveness of chlorine dioxide verified directly by the management of Kyivvodokanal, Borman and De Nora invited them to visit some plants that had been using this technology for years.
These plants were located not only in Italy (Palermo, Rimini, Ravenna – the most modern and automated in Europe –) but Abroad too (Vienna – Austria –, Dusseldorf – Germany –, Barcelona – Spain –)

No.1 : Kyivvodokanal - Waterwork

Step 1: Laboratory tests

Laboratory tests on chlorine dioxide effectiveness were carried out on both Kyiv stations: Dnipro and Desna.
Dnipro Station: from 5/4/2017 to 14/7/2017
Desna Station: from 27/2/2018 to 26/7/2018

Conclusions

- Chlorine dioxide doses were two times less than those of liquid chlorine in existing technological regimes
- During the laboratory tests, the residual concentrations of chlorine dioxide and chlorites did not exceed the regulatory values for drinking water (and precisely: chlorine dioxide ≤ 0.1 mg/L, chlorites ≤ 0.2 mg/L);
- The effectiveness of drinking water disinfection has been confirmed, the quality of drinking water has met the requirements of DSanPiN 2.2.7-171-10 "Hygienic requirements of drinking water intended for human consumption".

Step 2: Industrial Test – Dnipro Potabilisation Station: from 20/10/2017 till 4/11/2017

No.1 : Kyivvodokanal - Waterwork

КИЇВВОДОКАНАЛ

Permissive Documents

1. Conclusion of the state sanitary-epidemiological expert opinion № 602-123-20-2/32798 dated 19.10.2017 on drinking water treatment technology at the plants of the potabilisation station Dnipro in Kyiv with chlorine dioxide produced by De Nora T70G4000 generators with the use of hydrochloric acid and sodium chlorite Biogreen “Acticlor” produced by Borman Italiana.
2. Conclusion of the state sanitary-epidemiological expert opinion № 602-123-20-3/30654 dated 09.29.2017 on chlorine dioxide generator T70G4000.
3. Conclusion of the state sanitary-epidemiological expert opinion № 602-123-20-3/30652 del 29.09.2017 on the reagent Biogreen “ Acticlor ”.

Conclusions

1. The operation of the T70G4000 chlorine dioxide generators during the test period complied with the characteristics indicated in the technical documentation (Instructions).
2. The pre-oxidation treatment dose of 1.2-1.5 mg/L granted the absence of deviations in the microbiological parameters and the correct hygienic-sanitary state of the plant. The post disinfection treatment dose was 0.3-0.45 mg/L and ensured an increase in the residual concentrations of chlorine dioxide in accordance with the standards.
3. The drinking water quality of Dnipro station in the test period met the requirements of SanPiN 2.2.4-171-10 for physicochemical and microbiological parameters, including the concentration of chlorine dioxide of 0.10 – 0.17 mg/L and the concentration of chlorites less than 0.2 mg/L.
4. The use of chlorine dioxide ensured reliable disinfection of drinking water at all stages of treatment, during transportation and directly in the city water distribution network.

Показники контролю	20.10	21.10	22.10	23.10	24.10	25.10	26.10	27.10	28.10	29.10	30.10	31.10	01.11	02.11	03.11	04.11
Температура, °С	12	12	12	11	11	11	11	11	11	11	10	10	10	8	8	8
Забарвленість, градус	11	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10
Каламутність, мг/дм³	0,3	0,35	0,35	0,35	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Лужність, ммоль/дм³	2,0	1,95	1,85	1,8	1,8	1,8	1,8	1,85	1,9	1,85	1,95	1,85	1,95	1,90	1,95	1,90
Окислюваність, мгО/дм³	4,6	4,6	4,8	4,8	4,8	4,7	4,9	4,8	4,7	4,7	4,8	4,7	4,7	4,7	4,7	4,7
pH, одиниці	7,0	7,0	7,0	7,0	7,05	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Загальне залізо, мг/дм³	0,12	0,12	0,13	0,10	0,11	0,12	0,12	0,12	0,11	0,10	0,12	0,12	0,12	0,12	0,12	0,12
Марганець, мг/дм³	–		–	0,10	–	–	–	–	–	–	0,06	–	–	0,05	–	–
Загальні коліформи, КУО/100см³	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.	Відс.
Мікробне число, КУО/см³	1 2	2 3	1 2	1 2	1	1 3	1 2	2 4	2 4	1 4	0	1	1	1 5	1	1 2
Фітопланктон, кл/см³	14	–	–	21 28	14 21	14 21	14 21	14	–	–	14 21	14	14	7 14	7	–
Діоксид хлору, мг/дм³	–	0,055 0,050	0,05 0,06 0,06 0,07	0,05 0,05 0,14 0,15 0,17	0,10 0,09 0,08 0,07	0,10 0,09 0,12 0,15 0,16	0,15 0,16 0,14 0,16 0,17	0,12 0,14 0,15 0,13 0,10	0,15 0,16 0,14 0,16 0,15	0,12 0,13 0,14 0,16 0,15 0,17	0,14 0,16 0,17 0,15 0,15	0,14 0,15 0,16 0,17 0,17	0,13 0,15 0,14 0,10 0,08	0,13 0,15 0,14 0,17 0,18 0,19	0,12 0,14 0,15 0,14	0,15 0,16 0,18 0,12 0,14 0,16
Хлорити, мг/дм³	–	–	0,17 0,19 0,19 0,19	0,16 0,18 0,16 0,18	0,18 0,19 0,16 0,17	0,14 0,16 0,17 0,18	0,19 0,18 0,17 0,18	0,18 0,19 0,19 0,17	0,16 0,14 0,18 0,20 0,17	0,15 0,14 0,13 0,16 0,18 0,17	0,17 0,19 0,17 0,18 0,19	0,18 0,16 0,17 0,19 0,18	0,19 0,18 0,17 0,18 0,19	0,17 0,18 0,19 0,18 0,17	0,17 0,16 0,18 0,17 0,16	0,15 0,18 0,19 0,16 0,14 0,15

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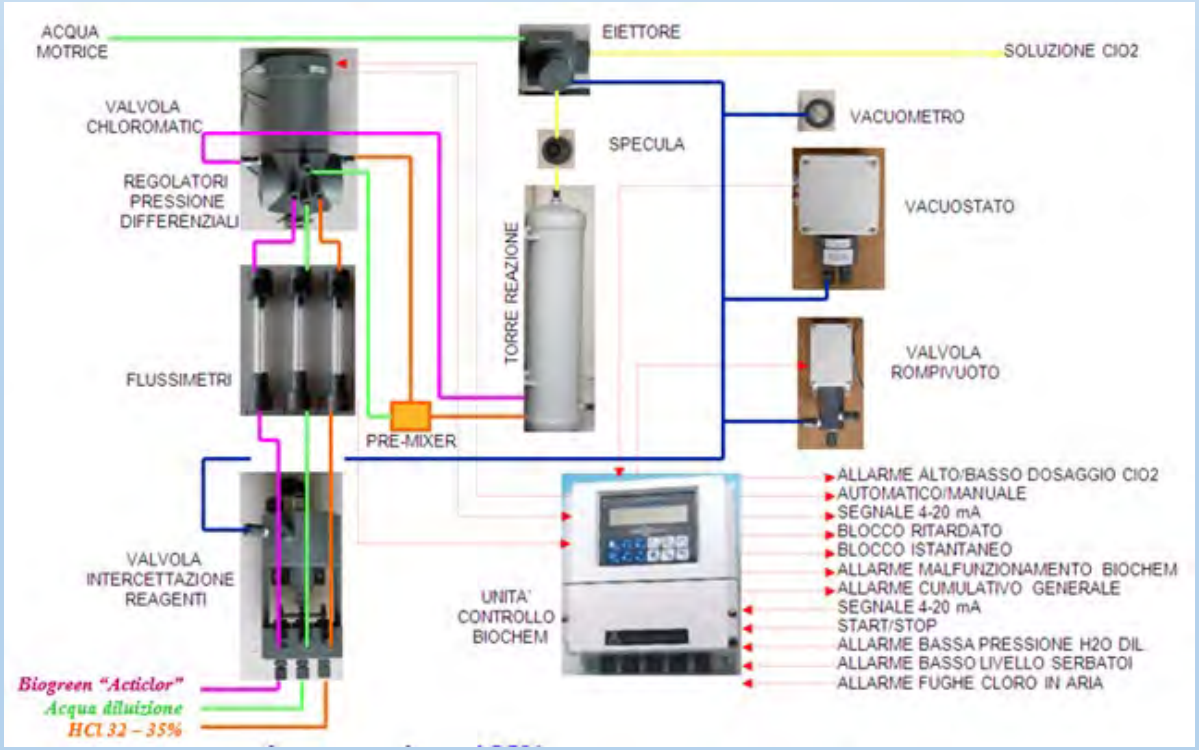
No.1 : Kyivvodokanal - Waterwork

Step 3: Chlorine dioxide technology implementation roadmap - Dnipro Potabilisation Station

1. Following the fully satisfactory results both of laboratory and industrial tests, Borman in co-operation with De Nora Water Technologies Italy submitted to Kyivvodokanal management the project for the realization of the whole plant.
2. Project expertise – 2018 –
3. Construction of the chlorine dioxide plant, including the chlorite abatement automatic system, for the definitive elimination of chlorine-based technology – 2019-2020 –
4. Plant commissioning – July 2020 –

- ***Generation yield: > 95%***
- ***Specific Consumptions:***

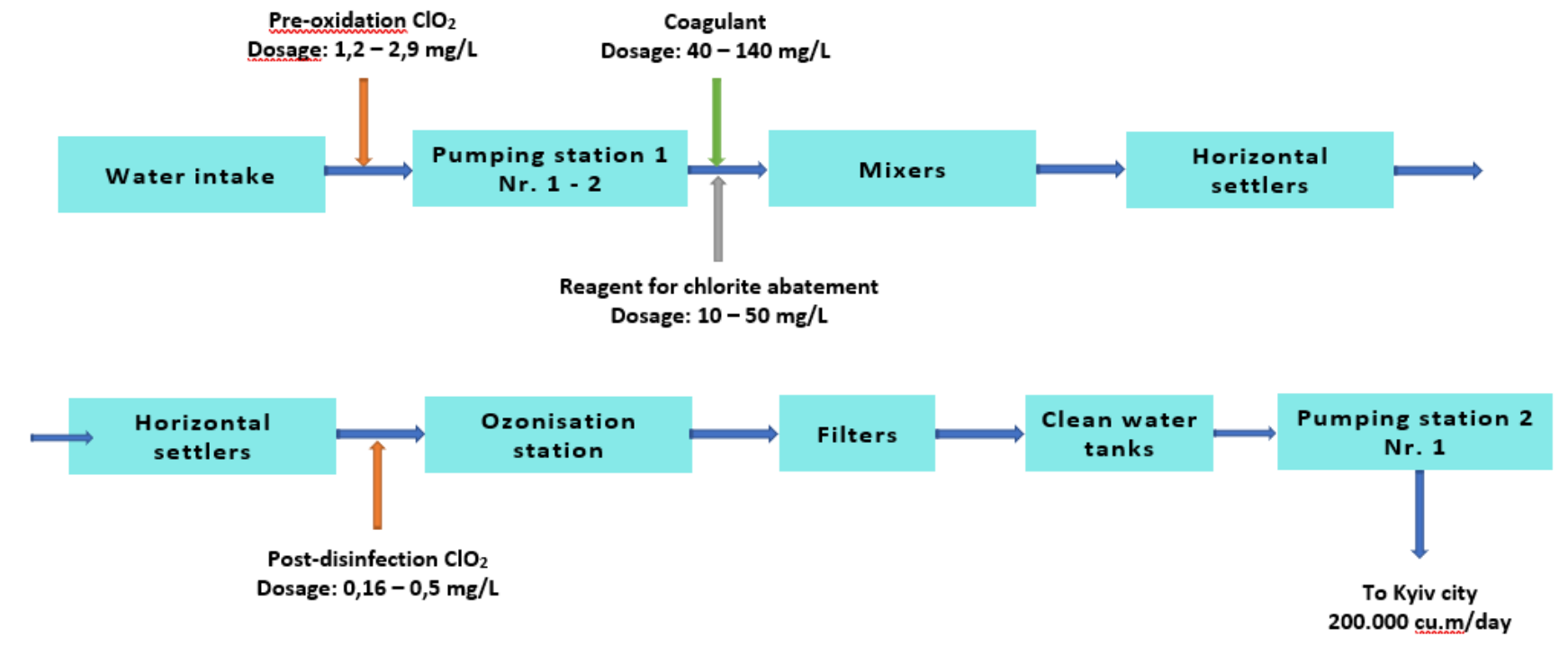
✓ ***Biogreen "Acticlor" = 6.0 L/kg ClO_2 ≡ 7.35 Kg/Kg ClO_2***
✓ ***HCl 32 ÷ 35% = 4.3 L/ Kg ClO_2 ≡ 5.0 Kg/Kg ClO_2***
✓ ***Dilution water = 18.3 L/kg ClO_2***



De Nora Generator – operating scheme

No.1 : Kyivvodokanal - Waterwork

Dnipro Station – Technological scheme

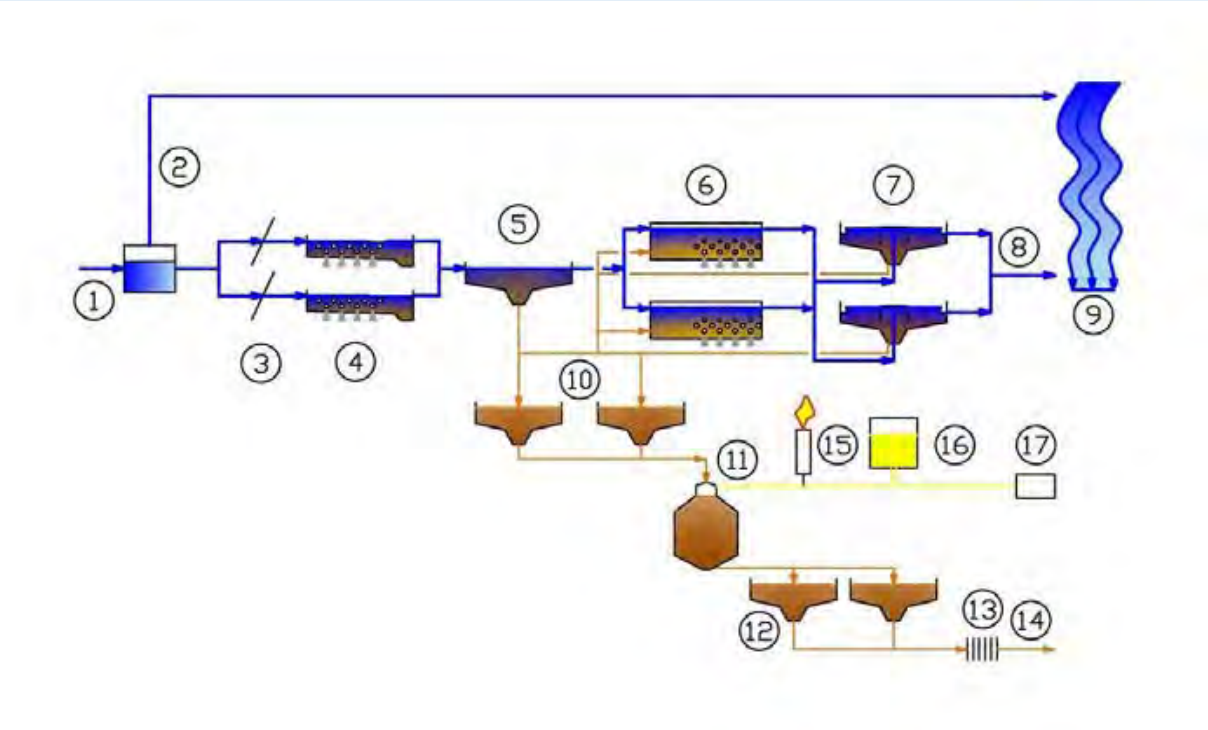


Borman continuous technological assistance allowed to manage the network clean-up phase with no phenomena of massive detachments of biofilm broken up and removed from the surface.

The drinking water quality of Dnipro station as well as that in the entire city network always met the requirements of SanPiN 2.2.4-171-10 for physicochemical and microbiological parameters.

No.2 : CAP HOLDING – Waste Water Treatment

The plant has two lines – capacity 500 cu.m/h each – and the influent consists of 80% civil and 20% industrial wastewater.
The plant scheme is classic and it is shown in the figure.



1) Inlet wastewater
2) Emergency overflow
3) Mechanical screening
4) Desander
5) Primary settling
6) Activated sludge tank (biological reactor)
7) Secondary settling
8) Discharge
9) River or reused for irrigation
10) Sludge thickening
11) Anaerobic digestion
12) Post-thickening
13) Sludge dewatering
14) Sludge disposal
15) Biogas torch
16) Gas holder
17) Cogeneration

Main problems:

- Poor floc formation in the activated sludge tank (high Sludge Volume Index – SV –)
- Poor settling in secondary clarifiers and presence of flocs in water effluent – impossibility of reusing water for irrigation –
- Presence of biological foams in the activated sludge tank mainly due to the sludge poor quality.

No.2 : CAP HOLDING – Waste Water Treatment

in January 2020 CAP HOLDING, our customer for sludge dewatering, asked Borman to study an alternative to the unsatisfactory treatment used. It involved the dosage of an inorganic coagulant downstream of the biological reactor and upstream of the secondary clarifier.

Approach for problem solving

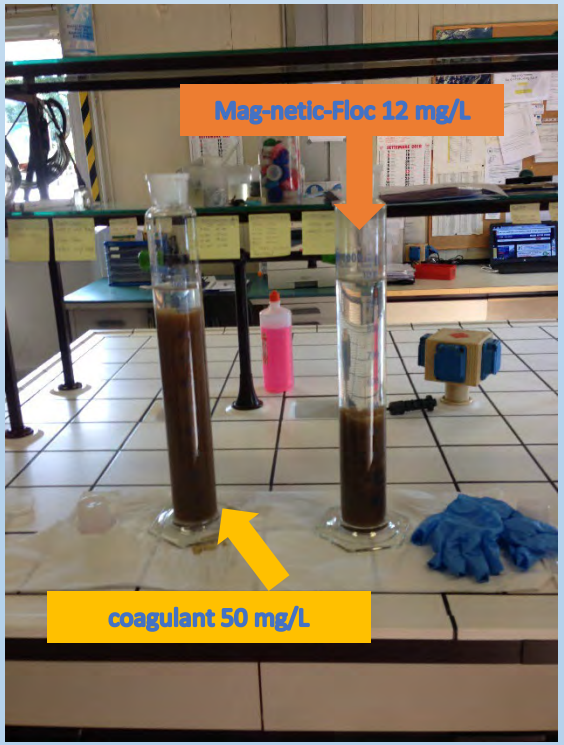
The proposed approach consisted of an online comparison between two products:

- Line A: dosage of Mag-netic Floc (Borman mixed-organic coagulant)
- Line B: dosage of the inorganic coagulant at present used.

Dosages identification

Based on laboratory tests, the starting dosage for both products was identified.
The tests were conducted in cooperation with the customer by comparing two samples of one liter each of biological sludge and conditioning both with the products under test.
The starting dose of Mag-netic Floc was 12 mg/L against 50 mg/L of the inorganic coagulant.

Laboratory comparison Mag-netic Floc and coagulant

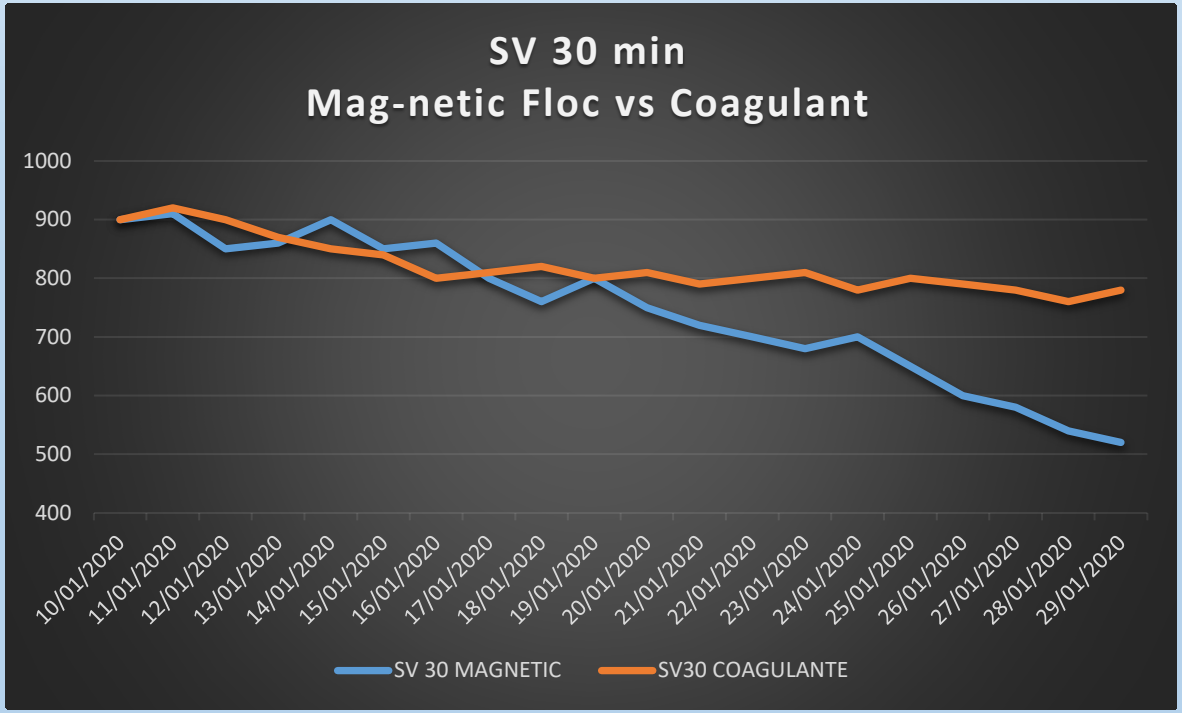


No.2 : CAP HOLDING – Waste Water Treatment

Industrial Test

These dosages were maintained for one week; during this period the Sludge Volume Index at 30 min (SV 30) was monitored daily, as well as the qualities of the sludge in the biological reactor.
Later, the dosages of the two products were gradually reduced on both lines, bringing the Mag-netic Floc to 5 mg/L and the coagulant to 30 mg/L.

After about 3 weeks of treatment, the time necessary for the conditioning of the entire oxidation reactor, SV30 values showed a clear difference between the two lines. It was demonstrated a reduction of about 45%, compared to the initial phase, on line A - treated with Mag-netic Floc - and a 15% reduction on line B - treated with the inorganic coagulant -



No.2 : CAP HOLDING – Waste Water Treatment

Conclusions

In conclusion, the use of Mag-netic Floc has shown significantly greater improvements compared to the inorganic coagulant, both in terms of sludge settleability and surnatant clarity.
Moreover, the dosages of Mag-netic Floc have proved to be much lower than those of the inorganic coagulant

After the definitive acquisition of this treatment, it was also possible to reuse the water for irrigation.

No.3 : Ferriere Nord – Steel Mill

Borman's Customer since 2008

Open Recirculating Cooling Systems

- Critical Circuits: primary continuous casting and primary electric arc furnace (EAF)
- Non-critical circuits: secondary continuous casting, secondary EAF, EAF fumes cooling

In 2010 Ferriere Nord asked Borman to find a solution for the following problems:

- Research of technological and plant engineering solutions allowing the elimination of softened water, used in the most critical circuits;
- Substantial reduction in the water drawn from the wells and used as make-up of the various circuits:
- Reset the water discharges, recovering the blow-downs of each circuit (water re-use)
- Remodulate the water treatment programmes to adapt them to the new plant assets

Approach for problem solving

- **Identification of a system as effective alternative to softened water (accessory system)**
- **Rigorous and extensive characterization of well water ionic species**
- **Computer simulation of make-up and recirculating water for each circuit**
- **Heat balance of each circuit and determination of the relative make-up and blow-down flow rates**
- **Sizing of the accessory system and rearrangement of the various circuits to obtain "zero discharge".**
- **IDENTIFICATION OF A SUITABLE WATER TREATMENT PROGRAMME.**

No.3 : Ferriere Nord – Steel Mill

Circuits have been divided into two categories:

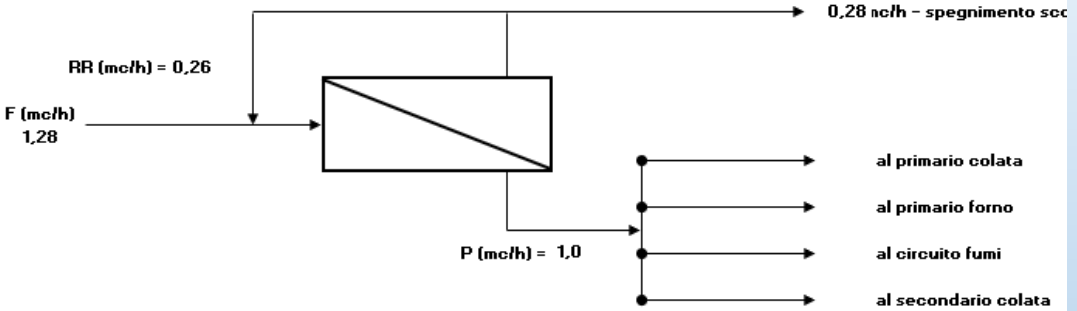
a) critical circuits for which it is absolutely necessary to limit the hardness concentration as much as possible: ingot mold (primary casting) and primary furnace;

b) non-critical circuits for which the hardness concentration is not a fundamental parameter: EAF fumes circuit, EAF secondary and continuous casting secondary.

c) The installation of a reverse osmosis plant allows both the reduction of the quantity of water withdrawn from the wells - through a drastic closure of the cycles (increase of the concentration factor of the circuits) - and the complete recovery of the blowdowns.

The rigorous and extensive well water characterization through accurate laboratory analyses allowed us:

- To simulate the performances of the reverse osmosis plant specifying the chemical characteristics of both permeate and concentrate (reject) streams;
- To determine for the make-up water of each circuit the correct well water / permeate ratios and the recovered blow-down flow rate to ensure a safe asset of each circuit;
- To define the most suitable concentration factor of each circuit in order to minimize the water consumption while ensuring the absence of fouling phenomena and an effective control of corrosion;
- To perform the heat balance of each circuit and to determine the relative make-up and blow-down flow rates.



	u/m	F	C	RR/(RR + F)	Alimento	R.F.	R	C.R.	permeato	concentrato
pH		7,8	9,1	0,167	8,0				6,2	9,10
cloruri	ppm Cl	3,0	13,4	0,167	4,7	0,980	0,65	2,80	0,1	13,2
TH	ppm $CaCO_3$	272,0	1211,6	0,167	428,9	0,980	0,65	2,80	13,20	1201,0
CaH	ppm $CaCO_3$	185,0	824,1	0,167	291,7	0,980	0,65	2,80	8,98	816,8
MgH	ppm $CaCO_3$	87,0	387,5	0,167	137,2	0,980	0,65	2,80	4,22	384,1
M-Alk	ppm $CaCO_3$	149,0	663,7	0,167	235,0	0,980	0,65	2,80	7,23	657,9
solfati	ppm $CaCO_3$	131,0	583,5	0,167	206,6	0,980	0,65	2,80	6,4	578,4
Silice	ppm SiO_2	3,4	15,1	0,167	5,4	0,980	0,65	2,80	0,2	15,0
cond.	µS/cm	516,0	2298,5	0,167	813,7	0,980	0,65	2,80	25,0	2278,3
Revos AF 1201	ppm	7,5	33,4	0,167	11,8	0,980	0,65	2,80	0,4	33,1
BA/BNPA	ppm	5,0	22,3	0,167	7,9	0,980	0,65	2,80	0,2	22,1
pH sat										6,32
L.I. - 15 °C -										2,78

F	RR	RR/(RR + F)	Alimento	R.F.	R	C.R.	permeato	concentrato
mc/h			mc/h				mc/h	mc/h
1,28	0,26	0,167	1,54	0,98	0,65	2,80	1,0	0,28
				R (su F - % -):	78,0			

No.3 : Ferriere Nord – Steel Mill

Following the results obtained, it has been possible the design of the reverse osmosis plant and the definition of the system new arrangement.

Problem solved: 40 % reduction of water drawn from the wells, achieved «zero discharged», no problems with fouling and corrosion.

RO Flow Table (Stage Level) - Pass 1

Stage	Elements	#PV	#Els per PV	Feed				Concentrate			Permeate			
				Feed Flow (m³/h)	Recirc Flow (m³/h)	Feed Press (bar)	Boost Press (bar)	Conc Flow (m³/h)	Conc Press (bar)	Press Drop (bar)	Perm Flow (m³/h)	Avg Flux (LMH)	Perm Press (bar)	Perm TDS (mg/L)
1	BW30HRLE-440i	5	6	68.0	0.00	7.0	0.0	31.4	5.2	1.9	36.6	29.9	0.0	7.55
2	BW30HRLE-440i	3	6	31.4	0.0	5.0	0.0	17.0	3.6	1.4	14.4	19.5	0.0	16.62

RO Solute Concentrations - Pass 1

Concentrations (mg/L as ion)						
		Concentrate		Permeate		
	Feed	Stage1	Stage2	Stage1	Stage2	Total
NH	0.00	0.00	0.00	0.00	0.00	0.00
K	0.80	1.71	3.10	0.02	0.05	0.03
Na	27.49	58.64	106.7	0.79	1.75	1.06
Mg	20.91	45.03	82.63	0.24	0.52	0.32
Ca	74.55	160.6	294.7	0.83	1.82	1.11
Sr	0.98	2.11	3.87	0.01	0.02	0.01
Ba	0.02	0.04	0.08	0.00	0.00	0.00
CO_3	2.19	7.32	17.48	0.00	0.00	0.00
HCO_3	225.1	477.1	863.6	4.59	10.09	6.14
NO_3	4.00	8.39	15.03	0.24	0.53	0.32
Cl	4.20	9.05	16.60	0.05	0.10	0.06
F	0.10	0.21	0.39	0.00	0.01	0.00
SO_4	131.0	283.0	520.6	0.76	1.66	1.01
SiO_2	3.40	7.34	13.48	0.02	0.07	0.03
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO_2	2.74	4.18	6.52	3.11	4.82	3.59
TDS*	494.8	1,061	1,938	7.55	16.62	10.10
pH	8.0	8.1	8.2	6.4	6.5	6.4

Footnotes:

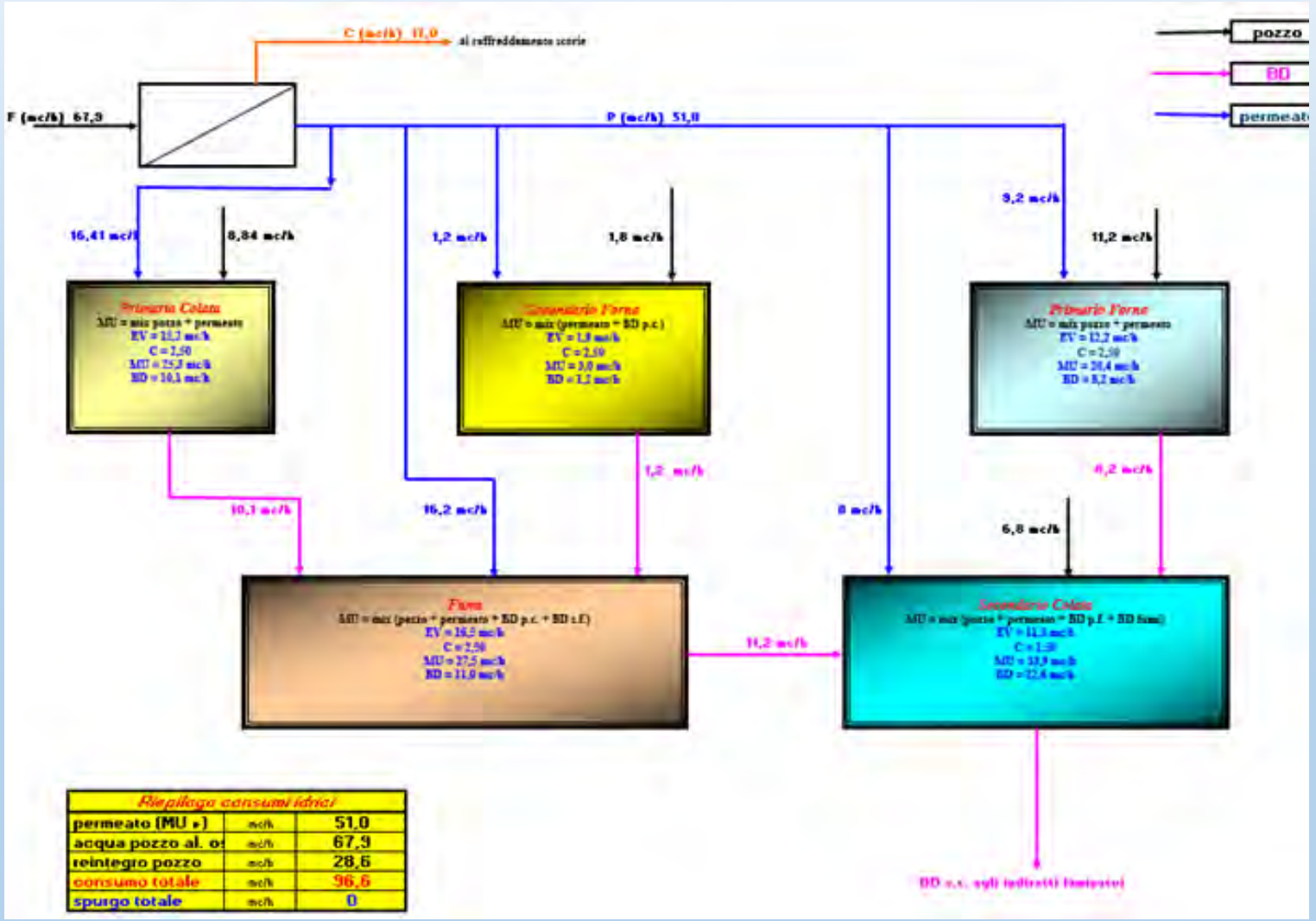
* Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$ - it does not include NH_3 and CO_2

RO Design Warnings

None

RO Solubility Warnings

Warning	Pass No
Langelier Saturation Index: 1,92	1
$BaSO_4$ (% saturation) > 100	1
Anti-scalant may be required. Consult your anti-scalant manufacturer for dosing and maximum allowable system recovery.	1



No.4 : SALOV - Edible Oil Refinery

Borman's Customer since 2011

- **Cooling System Treatment**
  - Evaporative cooling tower - Refinery
  - Evaporative cooling tower primary waste water plant outlet
- **Steam Generators treatment**
  - 4 boilers Babcock Wanson, instant steam generators, Tot 15 Ton/hr @ 12 Bar.
  - NO PROBLEMS AT ALL till Feb 2019
  - In Feb 2019 SALOV carried out a revamping: installation of valves for modulating the flow of fuel gas to the burners and inverters both on the combustion air blower and on the volumetric diaphragm pumps, to feed the individual coils of the boilers. The modulation keeps pressure set point of the HP steam network constant by regulating its production to the actual withdrawal. Due to customer revamping, some problems arised and in May 2019, 1 boiler coil holed by under deposit corrosion due to water solids precipitation.
  - SALOV asked Borman to help them for problem solving.

Approach for problem solving

- **fluid dynamics study of the system**
- **Linear velocity of both steam and liquid phases verification through a process simulation**
- **% vaporization at different coil lenght**
- **Historical trend of process waters concentration factors.**
- **Identification of the source of pollutants in the system and proposal of plant asset and chemical modifications.**
- **PROBLEM SOLVED.**

No.4 : SALOV - Edible Oil Refinery

Surely the optimization brings considerable advantages in terms of production stability and system flexibility. **On the other hand, the modulation of the feed flow on the single boiler modifies its fluid dynamic characteristics in the vaporization phase.**

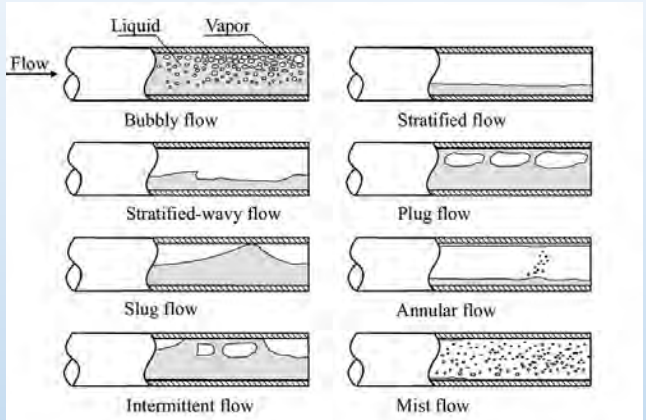
Single pass flash steam boilers are designed for a > 95% vaporization at the outlet, to work in a two-phase "annular/mist" flow regime so granting a high velocity of the steam at the outlet, the distribution of the nebulized liquid phase in the stream of vapor and the minimization of the liquid film on the metal wall of the coil.

If the flow rate fed, or the vaporized fraction, changes, the different relative velocities of the two phases will give rise to a greater layer of liquid film on the piping, concentrating the ionic species present on the liquid film in contact with the metallurgy and favouring their deposition.

The fluid dynamics analysis was implemented as follows:

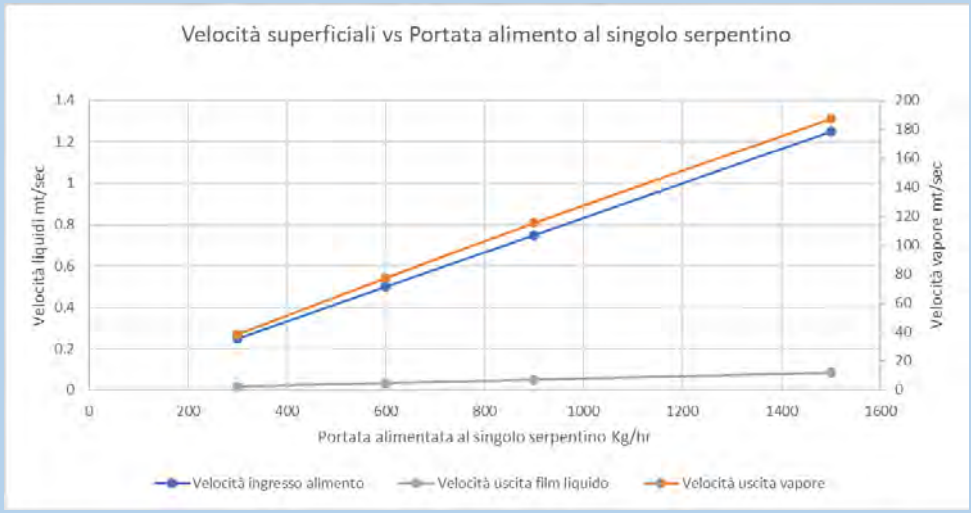
- Computer simulation of a single coil as a ¾" horizontal pipe, schedule 40, 30 meters long
- Product steam pressure setpoint 11.5 bar
- Pure water as feed, 4 cases with flow rate 300, 600, 900, 1500 Kg/hr on single coil
- Heat duty supplied to the coil, calculated to have 95% vaporization at the outlet.

Following the fluid dynamics analysis with simulation of the boundary conditions, it was evident how the flow rate modulation particularly affects the velocity factor and therefore the tendency for the dissolved solids to deposit in the liquid film in contact with the pipe.



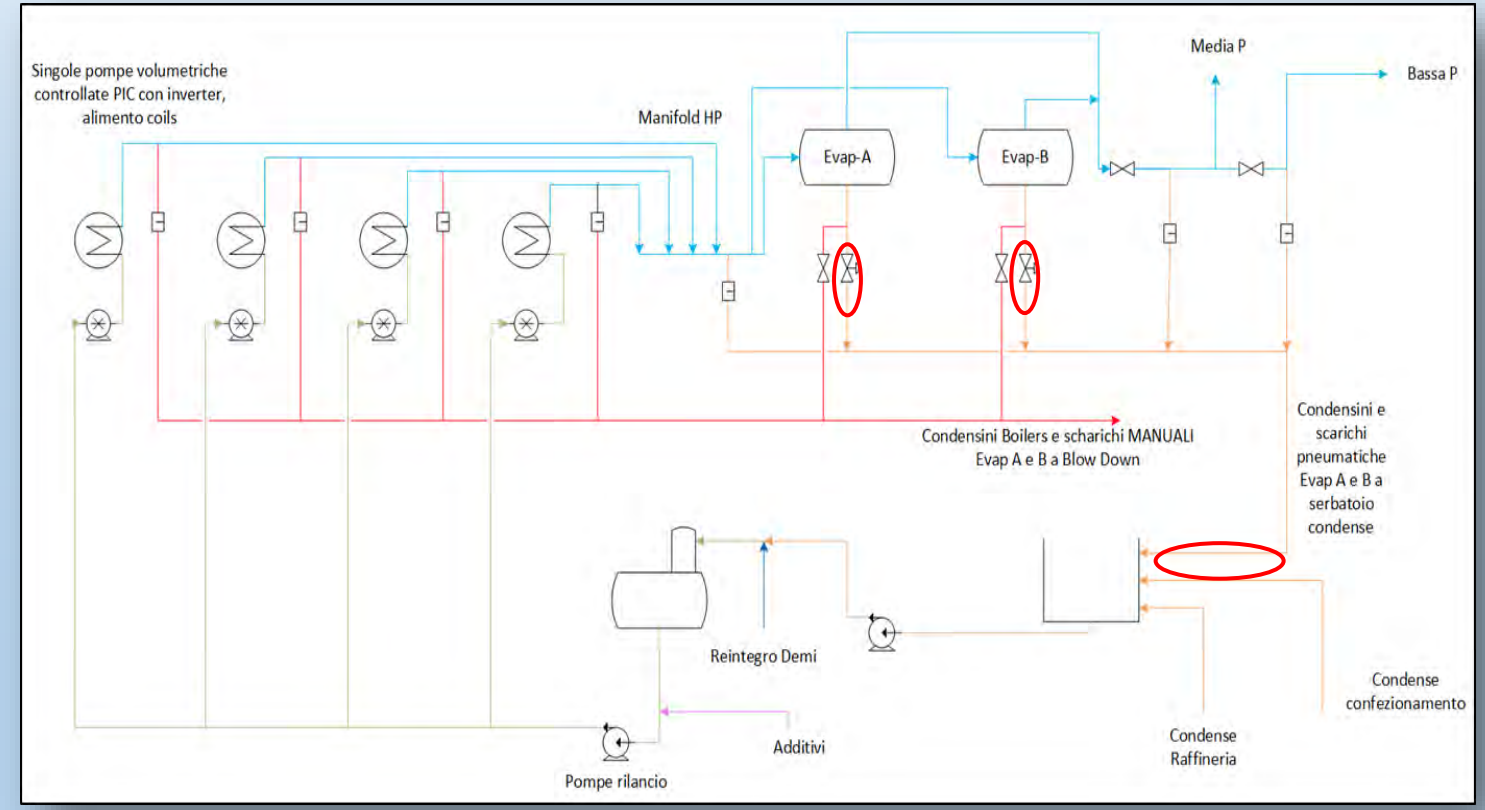
Flow regimen of a two-phase fluid in a horizontal pipe

Feed rate	Kg/h	300	600	900	1500
Average inlet velocity	m/sec	0.25	0.5	0.75	1.25
Average outlet velocity	m/sec	38.7	77.4	115.5	187.4
Liquid film outlet velocity	m/sec	0.017	0.033	0.05	0.084
Slip Liquid outlet Holdup fraction	% vol	0.0022	0.00047	0.00017	0.000047
Flow regimen		annular	annular	annular	annular/mist
Actual density	Kg/m³	5.9	5.9	5.85	5.85



No.4 : SALOV - Edible oil Refinery

In addition to the considerations made on the fluid dynamics of the system, we have examined the aspects related to the condensate return network from evaporators and the chemistry of the feed water. Finally, we examined the blowdown system of the entire system (boilers, evaporators, condensate network of the high-pressure steam header) to verify their disposal or recovery mode.



Conclusions

Coil failure was due to:

- Low velocity of liquid film and steam at moderate production instead of at full load; this increases the tendency to deposition of all TDS present in the feed water.
- Condensate recirculation from evaporators, highly concentrated in pollutants, to feed boilers via condensate tank. Only manual purges are blown down.

Solution

- Suggestions on how to manage the plant running by minimizing as much as possible the transients at low load.
- Modification of the current system blowdowns asset to eliminate the most polluting flows.
- Installation of a panel providing the continuous control of boiler feedwater pH, conductivity, and hardness with an automatic discontinuous titrator. **The panel permits remote consultation / modification and alarm interface, on web server.**

No.5 : KEDRION BIOPHARMA
Medicinal Products derived from human blood plasma

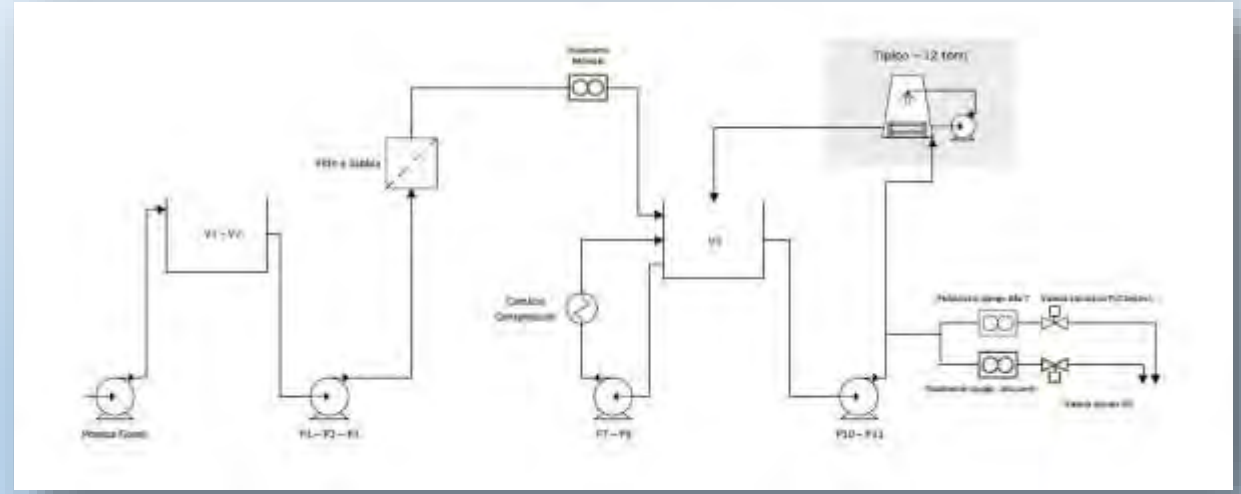
Treatments managed by a different supplier for over 15 years, unsatisfied customer for continuous fouling of the cooling system

- **Cooling Systems Problems**
  - 15 cooling towers on a complex circuit, for cooling of refrigeration cycles compressors from +5°C to -30°C Continuous fouling by calcium carbonate
  - 1 closed cooling system (low pH, corrosion, iron fouling)
- **Steam Generators Problems**

  3 Mingazzini boilers , instant steam generators, Tot 9 Ton/hr @ 12 Bar.

  Inadequate treatment

Borman Customer since July 2020



BORMAN APPROACH

- Process asset detailed study
- Deposits analysis and their characterization
- **Action Strategy Definition**

No.5 : KEDRION BIOPHARMA
Medicinal Products derived from human blood plasma

KEDRION BIOPHARMA Keep Life Flowing

BORMAN ACTIONS

- **Cooling Systems Treatment**
  - Automed concentration factor and dosages with remote control.
  - Suggested and implemented circuit layout modifications

No further fouling problem;
Reduction of purged disposal costs: 80,000 €/year

- **Closed Cooling System Treatment**

No further fouling and corrosion problems;

- **Steam Generators Treatment**
  - Chemicals FDA approved.
  - No problems at all

Customer absolutely satisfied

borman

ISO 14001 BUREAU VERITAS Certification — ISO 9001 BUREAU VERITAS Certification

No.5 : KEDRION BIOPHARMA
Medicinal Products derived from human blood plasma

Closed cooling system rearrangement

Application of a Borman formulation based on dispersants and corrosion inhibitors with side-stream application of a specific filter for the removal of accumulated iron.

Customer Request:

Proposal of a solution for the rearrangement of a closed circuit operating at 80°C with almost no blowdown and used for the numerous air treatment units in the plant.

Problem

The circuit showed severe corrosive phenomena at the very low operating pH with very high soluble iron concentration

Consequences

Frequent plant shutdowns and continuous need for maintenance activity.

No.5 : KEDRION BIOPHARMA
Medicinal Products derived from human blood plasma

Closed cooling system rearrangement – Borman actions

First step

A sample of water from the circuit was analyzed in our laboratory: it showed a brown color due to a very high iron concentration (> 500 mg/L) and severe acidic conditions (pH 4.6).

Second Step

Obviously, the rearrangement of a system affected by corrosion phenomena for years involves calculated «risks» that must be run for the final resolution of the critical issues. It was of particular concern any instantaneous precipitation in the circuit of iron large amounts because of the necessary increase in the water pH, resulting in increased under deposit corrosion phenomena and obstruction of low diameter lines. To better understand the phenomenon, laboratory tests have been carried out at various pH

Solution

- Installation of an adequate side stream filter medium. Dosage of Hyperline T 208/DS multifunctional Borman formulation based on corrosion inhibitors, dispersing and alkalizing agents
- Dosage of a buffer solution to regulate water pH in the range 8.5 – 9.5

Conclusions

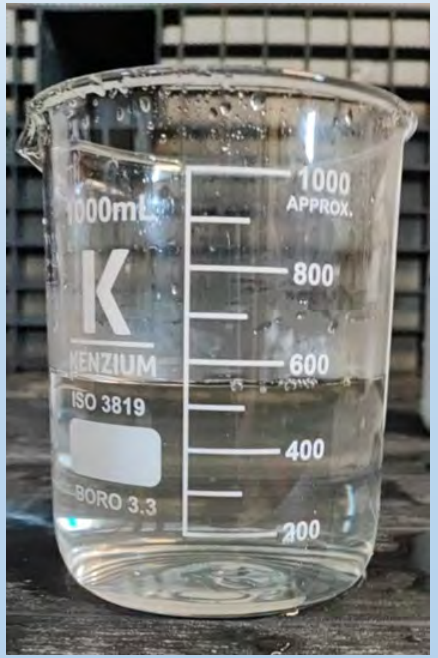
The adoption of the proposed technology has led to a clear improvement of water quality both in visual terms and in analytical results (soluble iron <1 mg/L, pH 8.8)

No.5 : KEDRION BIOPHARMA
Medicinal Products derived from human blood plasma

Closed cooling system rearrangement

January 2022

Borman Approach

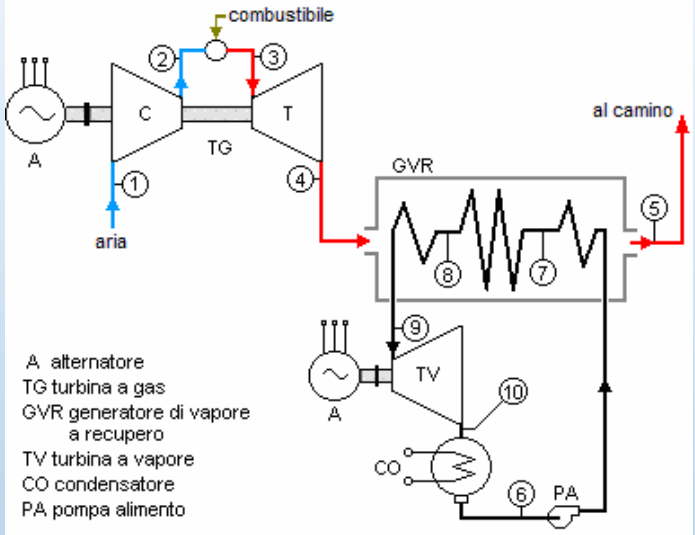


October 2022

99.99%
Removed iron

80%
Shut downs reduction

No.6 : EDISON – Power Generation



The plant is located in central Italy and is a combined cycle plant.

In a combined cycle plant, electricity is produced by alternators driven by gas turbines and steam turbines, which are "combined".

It means that the gas turbine exhaust gases, by means of a heat recovery steam generator (GVR), generates the steam needed to power the steam turbine.

This type of plant has recently found great development due to its high yields.

THERMAL CYCLE

GVR is formed by two drums: low and high pressure.

- Low pressure drum: it produces 11.0 t/h overheated steam at a pressure of 10.0 bar and a temperature of 310 °C, it is fed by the water falling from the overlying deaerator;
- High pressure drum: it produces 86 t/h of superheated steam at a pressure of 80 bar and a temperature of 500 °C, this steam is sent to a steam turbine. Attemperation is carried out between the first and second superheating banks with the same feed water.

Boiler feed water: demineralised water plus condensate return.

The gas turbine plus the steam turbine, produce about 50 MW at full load. The steam leaving the turbine is condensed by the shell and tube condenser, cooled with water from the cooling tower circuit.

No.6 : EDISON – Power Generation

COOLING SYSTEMS

- **Cooling tower**

Type: forced draft
Delivery temperature (cold): 30 °C
Return temperature (hot): 41 °C
Maximum temperature: 65 °C – oil refrigerants –
Make-up water: river water
Utilities: condensers (primary and auxiliary) – refrigerants of oil, steam and gas turbines – air of alternators – HP, LP, GVR pumps seals – sampling coils.

- **Once-through**

In addition to the Evaporative Towers circuit, there is also a cooling circuit for an Off-Gas compressor.
This circuit is of once-trough type, with river water without passing through sand filters, its temperature average inlet temperature is 15-18 °C and it leaves the most critical utilities (gas refrigerants) at temperatures close to 40-45 °C.
The type of treatment required is intended to prevent or limit scaling and fouling of the exchange surfaces. Until recently, no additives were introduced into this circuit, but a very high sludge deposition was found, considerably limiting the water flow rate and therefore the yield of the exchangers.

No.6 : EDISON – Power Generation

TREATMENT

- **Thermal Cycle**

A major goal of any feed-water conditioning programme is to protect the boiler and accessory equipment against corrosion during operation and when the system is out of service.
The most common causes of corrosion in boiler systems are dissolved corrosive gases – oxygen and carbon dioxide – and low pH.
Deposition is a further very serious problem in the operation of steam generating equipment.
Deposition is the accumulation of material on boiler surfaces that can cause overheating as well as circulation restrictions. Both conditions frequently result in unscheduled outages.

Treatment programme

- **Bormavis 1016: Oxygen scavenger/alkaliser of the steam-condensate network. Suitable for boiler systems operating at pressures up to 170 bar and for systems containing copper-bearing alloys. Based on DEHA (Edison specification) / low volatility reducing agents and volatile neutralising amines. The chemical must be dosed in order to maintain an unreacted DEHA residual concentration of 50 – 150 μg/L (ppb) in low pressure steam drum.**
- **Bormine HP: Alkaliser of the steam-condensate network in high pressure boiler systems (up to 170 bar). Based on a blend of suitable neutralising amines . The chemical must be dosed in order to maintain in the steam-condensate network a pH value in the range 8.9 – 9.2.**
- **Bormaclean HP: Deposit Control Agent/Alkaliser for boilers operating at pressures up to 95 bar. Phosphate/Dispersant treatment – polyphosphate / phosphino-groups copolymer – based. The chemical must be dosed in order to maintain in high pressure steam drum a pH in the range 9.0 – 9.6 and a PO_4 concentration in the range 3 – 5 mg/L**

- **Cooling systems**

Cooling tower

A correct treatment programme must:

a. avoid corrosive phenomena;
b. prevent suspended solids deposition and scale formation;
c. control bacterial and algal growth in order to prevent bio-fouling.

Treatment programme

- **Regulation recirculating water pH in the range 8.0 – 8.3 (Edison specification)**
- **Microbiological control: dosage of sodium hypochlorite granting free residual chlorine**
- **Hyperline AOP/E 300-LDS: Corrosion Inhibitor / Scale Preventer with excellent dispersing activity. Recommended for systems whose metallurgy is steel + copper and/or its alloys**

Once-through

- **Hyperline PI/D 320: Scale Preventer with excellent dispersing activity.**

No.6 : EDISON – Power Generation

RESULTS – Plants Inspection by Edison

Low Pressure Steam Drum

The tank is completely passivated and the red-brown color indicates this state. The walls are clean and smooth with no scales and/or corrosion.

Degasifier

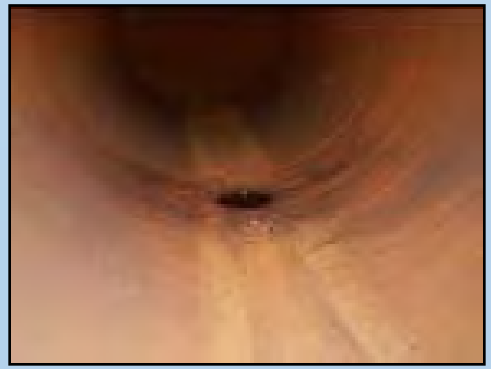
The equipment is in very good conditions and the red-brown color indicates complete passivation. The walls are clean and smooth, free from any type of scaling and/or corrosion.

High Pressure Steam Drum

The tank is completely passivated and the brown color indicates this state.
The walls are clean and smooth with no scales and/or corrosion.

Condensate Storage Tank

The tank appears to be in good conditions. The walls are clean and smooth, with complete absence of scaling and/or corrosive phenomena.



No.6 : EDISON – Power Generation

RESULTS – Plants Inspection by Edison

Heat Exchangers Off-Gas Circuit

The heat exchangers are clean, on the contrary than in the past

Condenser

The condenser appears to be in good condition, the tubes are completely clean. The walls are clean and smooth, with no scales and/or corrosion. The condition of the condenser is better than in the past

Turbogas water/oil exchangers

The exchangers turn out to be in perfect conditions

No.6 : EDISON – Power Generation

RESULTS – Plants Inspection by Edison

Cooling Tower Basin

The basin presents a sandy precipitate on the bottom.
A sample was taken for chemical analysis; it has been demonstrated that the origin is material coming from the external environment sucked in by the fans.
Basin does not have any type of incrustation on the walls.
Furthermore, no biological slime was noted.
The droplet separators are clean and free from scale and/or deposits.






Borman is your trusted partner!

Borman Italiana s.r.l.
Via Gramsci 76, 20019 Settimo Milanese (Milano) ITALIA
Tel: (+39) 02 33501283 - Fax: (+39) 02 33500096
Email: acque@borman.it