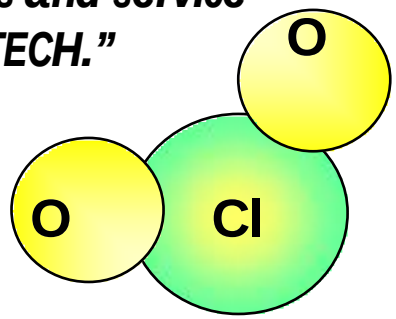
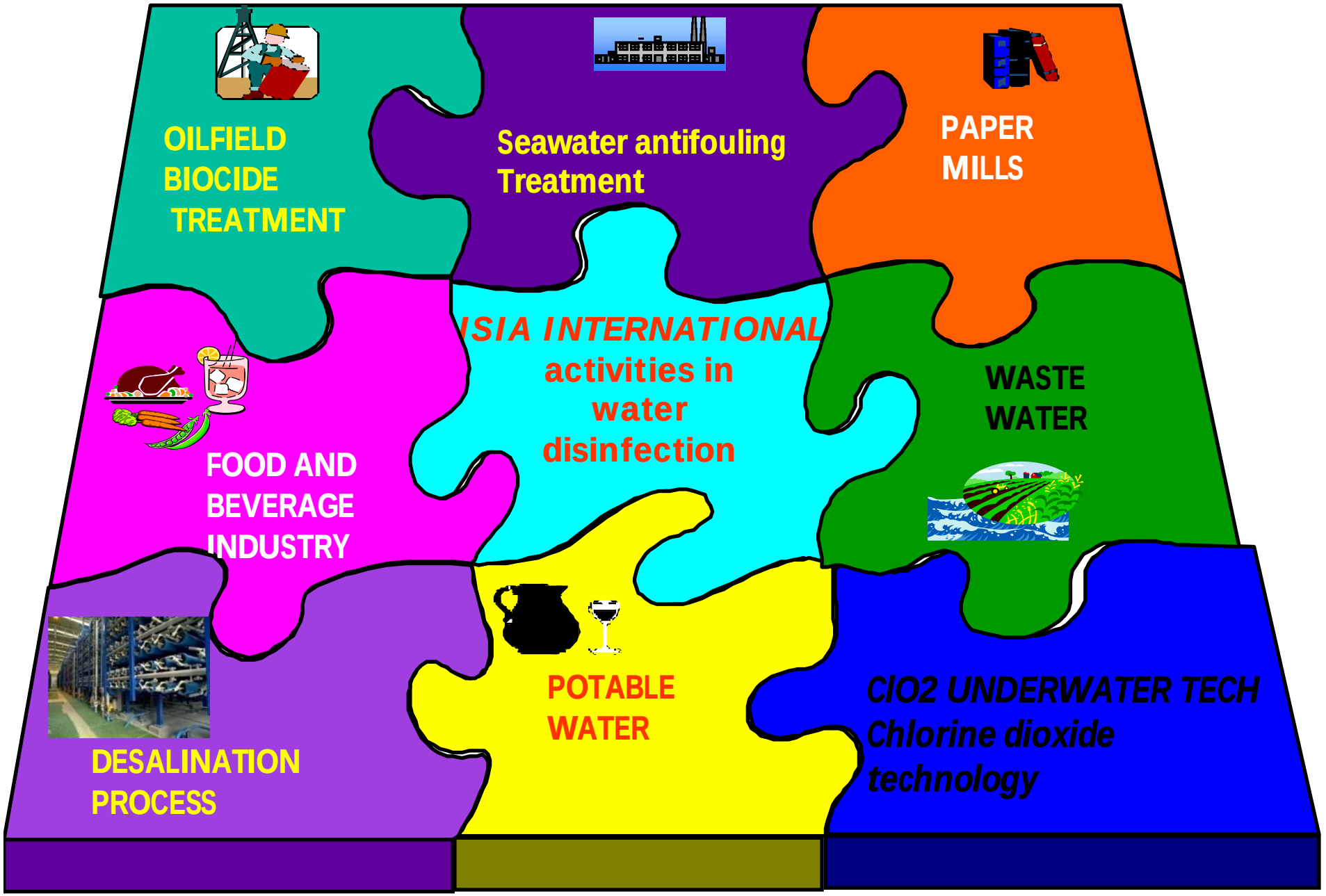
Water Arabia 2011 Conference and Exhibit.
Gulf Hotel-Manama,
Kingdom of *Bahrain*
January 31, February 1 & 2, *2011*.

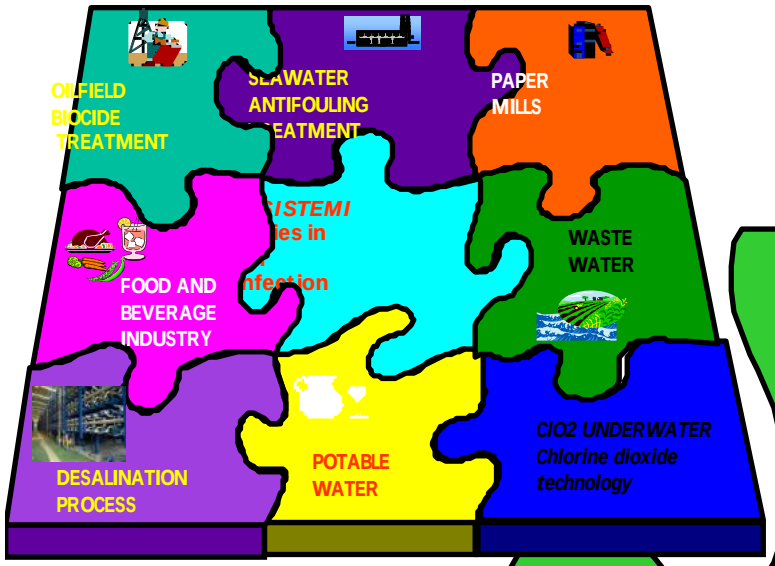
Chlorine dioxide as a successful antifoulant treatment in large cooling system-Case history

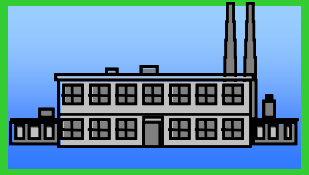
Giuseppe Petrucci

ISIA INTERNATIONAL FZCO DUBAI-UAE
ClO2 technologies and service
"UNDERWATER TECH."




OILFIELD
BIOCIDE
TREATMENT
Seawater antifouling
Treatment
PAPER
MILLS
ISIA INTERNATIONAL
activities in
water
disinfection
FOOD AND
BEVERAGE
INDUSTRY
WASTE
WATER
DESALINATION
PROCESS
POTABLE
WATER
ClO2 UNDERWATER TECH
Chlorine dioxide
technology



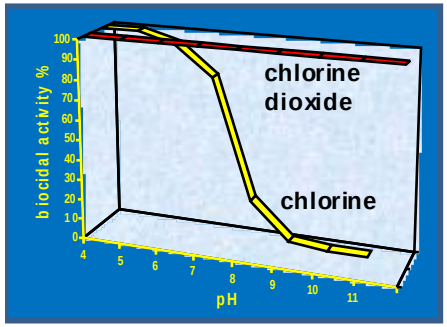


SEAWATER ANTIFOULING TREATMENT

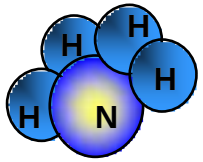
- Power plant
- Petrochemical plant
- Refinery
- Steel mills
- Fertilizer plant
- Thermal and R.O. desalination plant make up

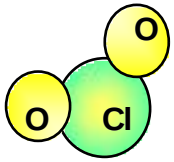
CHLORINE DIOXIDE CHARACTERISTICS

CHARACTERISTICS

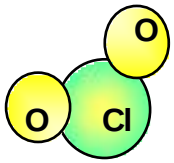


The biocidal activity is constant over the pH 6 - 9





No reaction with ammonia and urea



No reaction with organic matter and oil

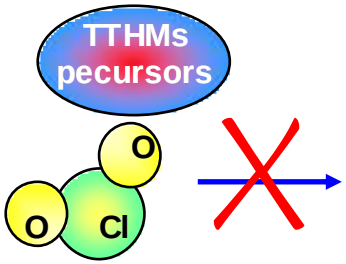
SUITABLE FOR:

- u sea water once-through cooling system (pH 8.5)
- u recirculating cooling water system (pH > 8)
- u fertiliser & ammonia plant cooling system
- u waste water
- u refinery and petrochemical cooling system
- u seawater desalination plant

CHLORINE DIOXIDE CHARACTERISTICS

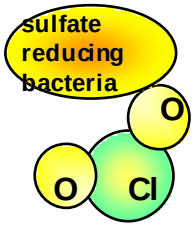
CHARACTERISTICS

SUITABLE FOR:



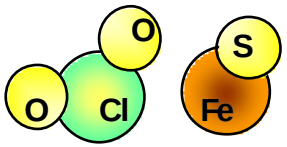
No formation of halogenated compounds (TTHMs-dangerous for human health)

- potable waterworks
- food and beverage industry
- waste water treat. plants



Strong biocidal activity against anaerobic bacteria

- minimize corrosion



Oxidation of sulfide to sulfate (sulfide scavenger)

- minimize corrosion
- minimize bad smell

CHLORINE DIOXIDE

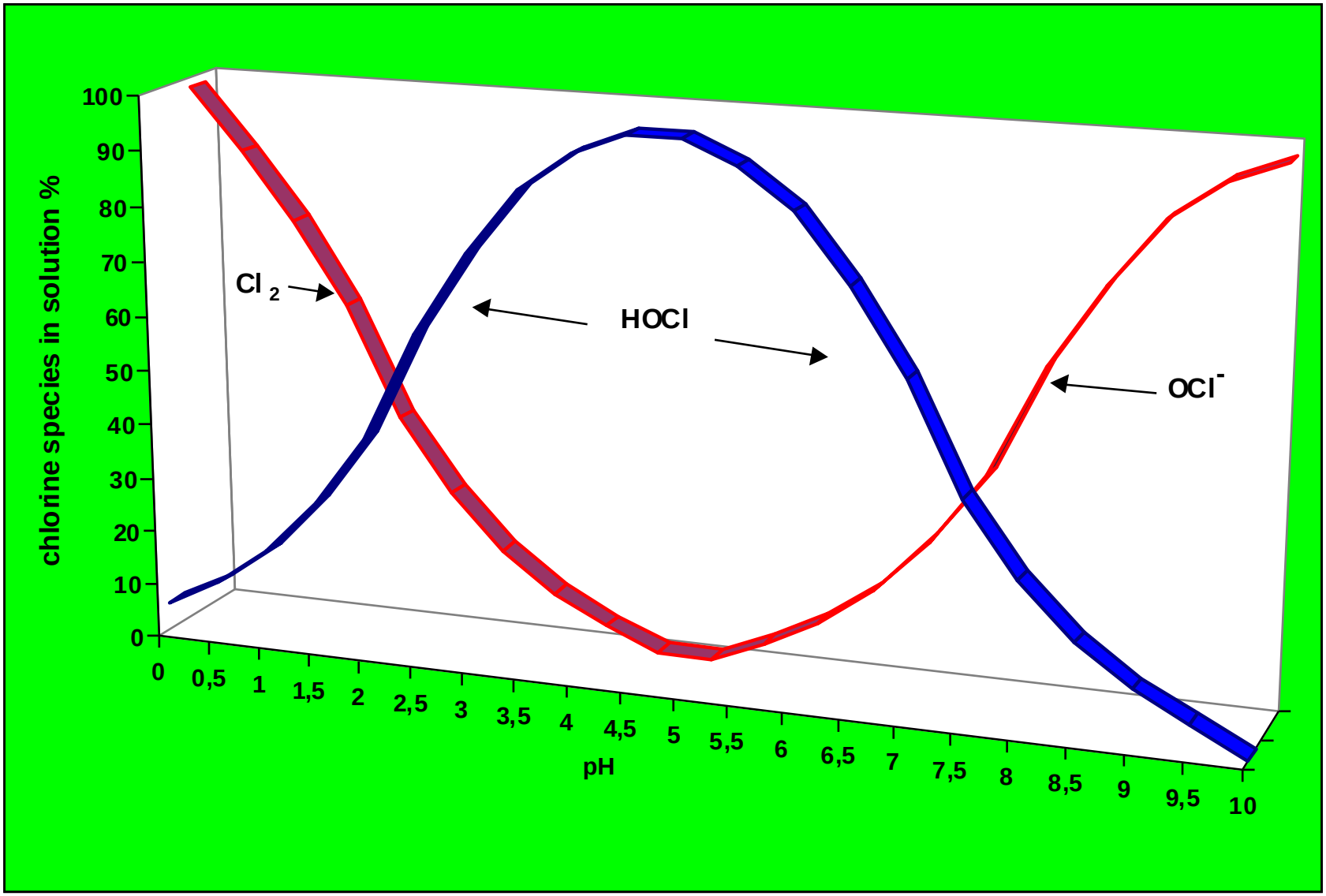
$ClO_2 + e^- \rightarrow ClO_2^-$ ($E_o = 0{,}95$ V)

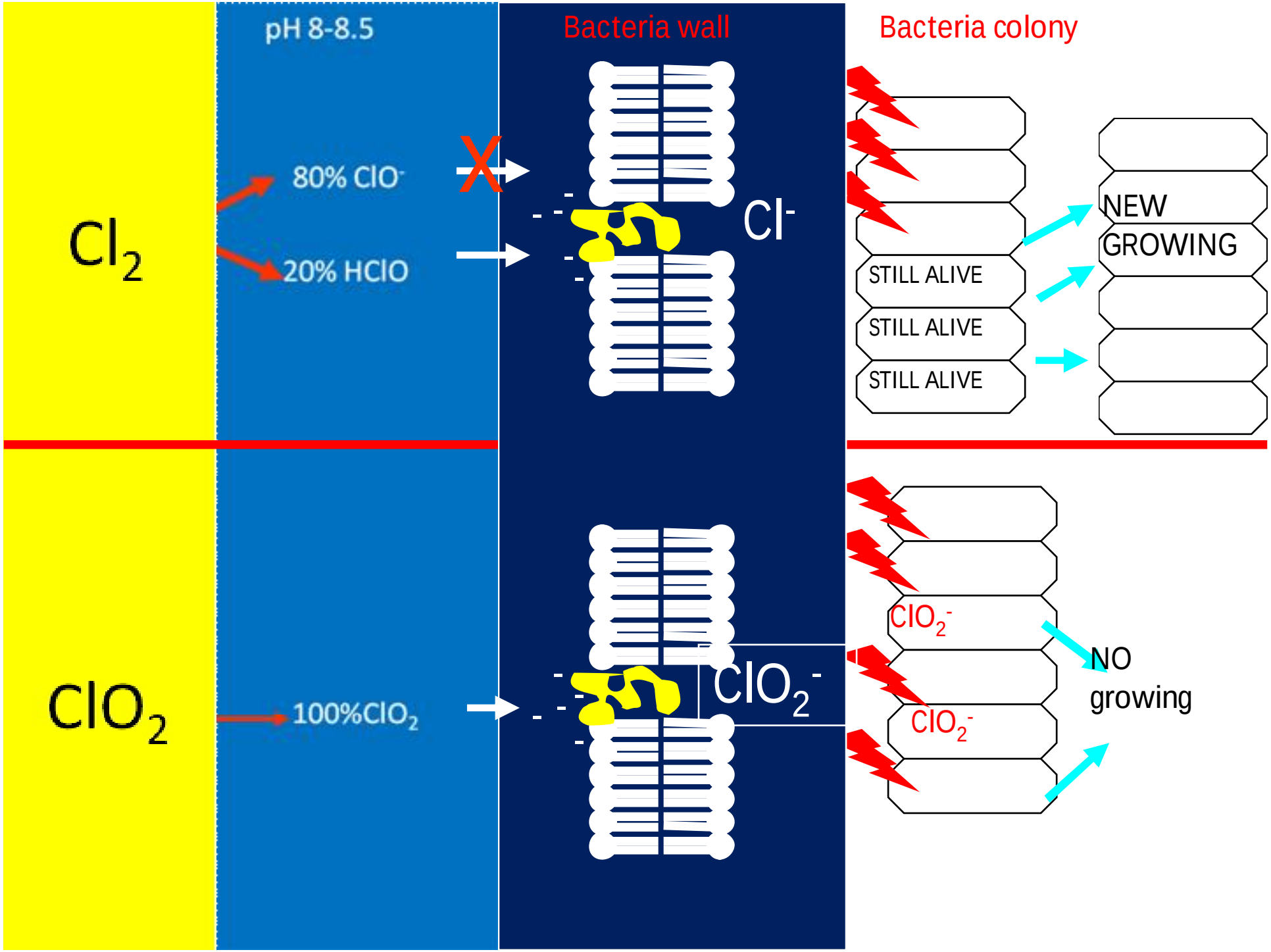
$ClO_2 + 4\,H^+ + 5\,e^- \rightarrow Cl^- + 2\,H_2O$ ($E_o = 1{,}51$ V)

Chlorine Dioxide is very active against:

- bacteria
- viruses
- algae
- fungi
- macroorganism

CHLORINE SPECIES FORMATION IN WATER ACCORDING TO pH




pH 8-8.5
Bacteria wall
Bacteria colony
Cl_2
80% ClO^-
20% HClO
Cl^-
STILL ALIVE
STILL ALIVE
STILL ALIVE
NEW
GROWING
ClO_2
100%ClO_2
ClO_2^-
ClO_2^-
ClO_2^-
NO
growing

CHEMICAL FEATURES OF CHLORINE DIOXIDE (ClO_2)

- it is a gas and must be generated on site
- it is soluble in water
- it does not undergo hydrolysis at pH of cooling water
- it is a strong oxidising agent

The Biofouling problem

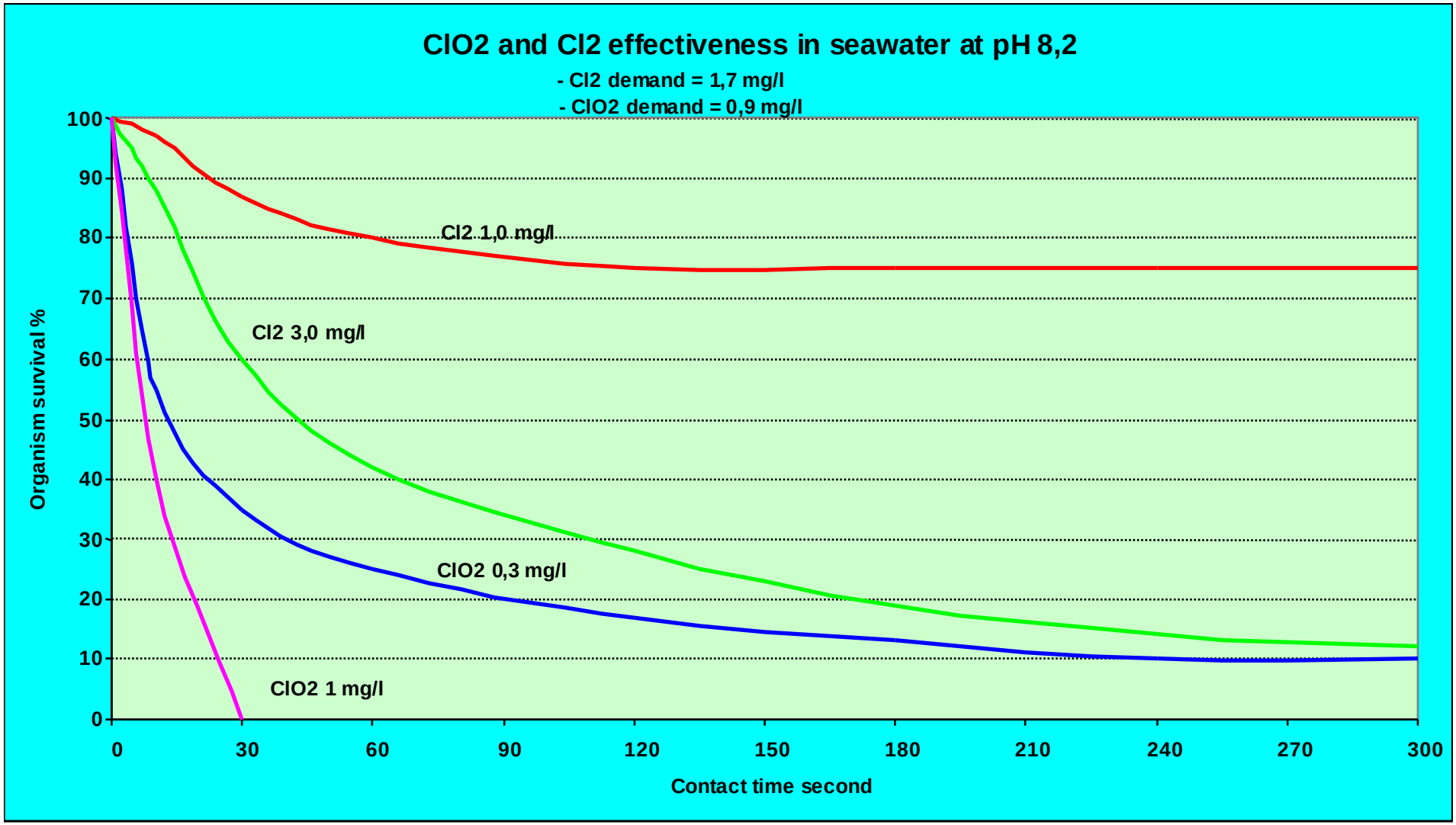
MICROFOULING

- Bacteria, Algae, Fungi,
- Microbial corrosion
- Loss of the heat exchange (loss in the efficiency of the thermal cycle)

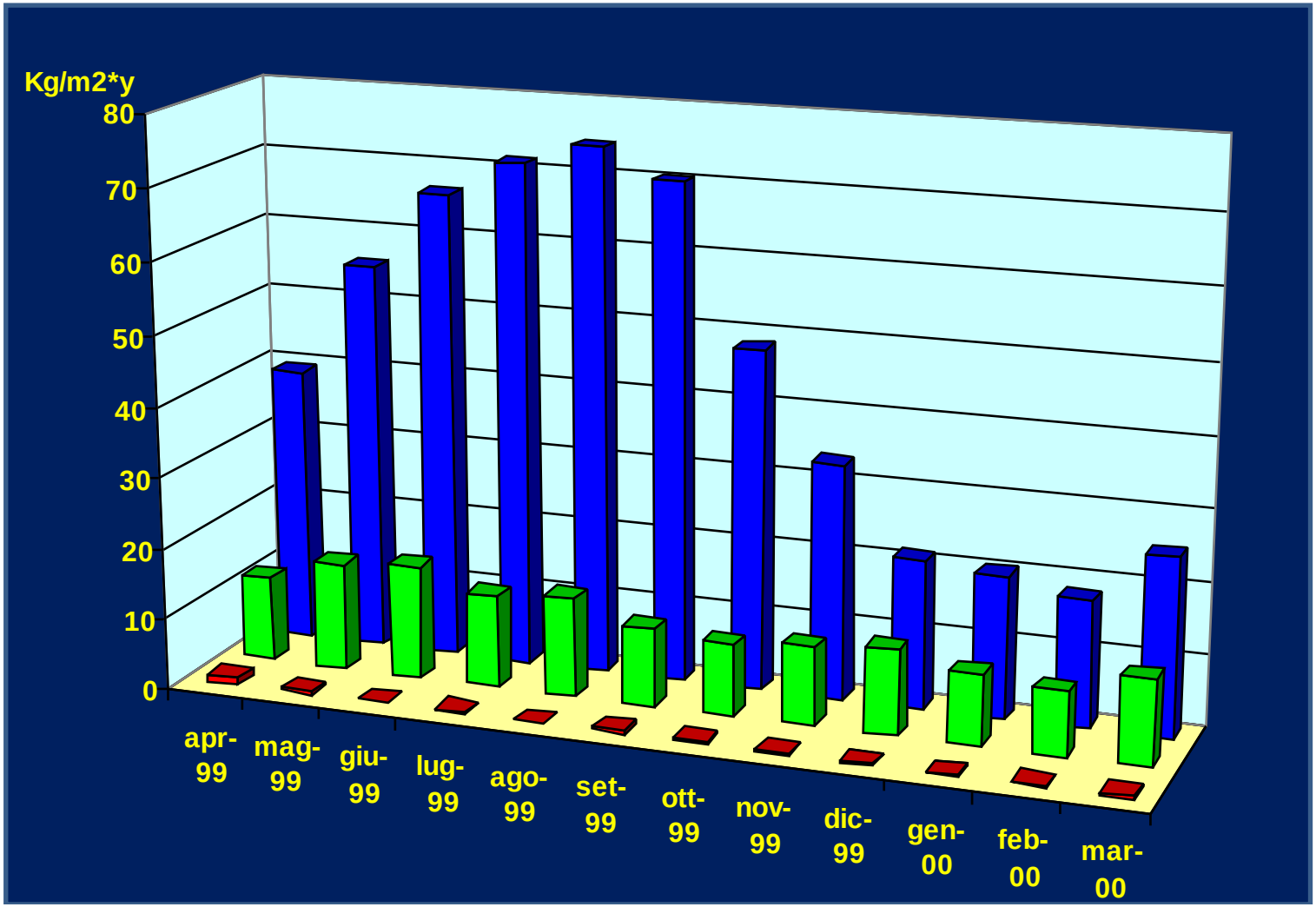
MACROFOULING

- Mussels, Barnacles, Serpulid worms, Hidroys
- Encrusting, loss of water flow, tubes plugging corrosion under deposit.

Chlorine dioxide and chlorine comparison against bacteria



CHLORINE DIOXIDE AND CHLORINE COMPARISON ON MACROFOULING GROWTH



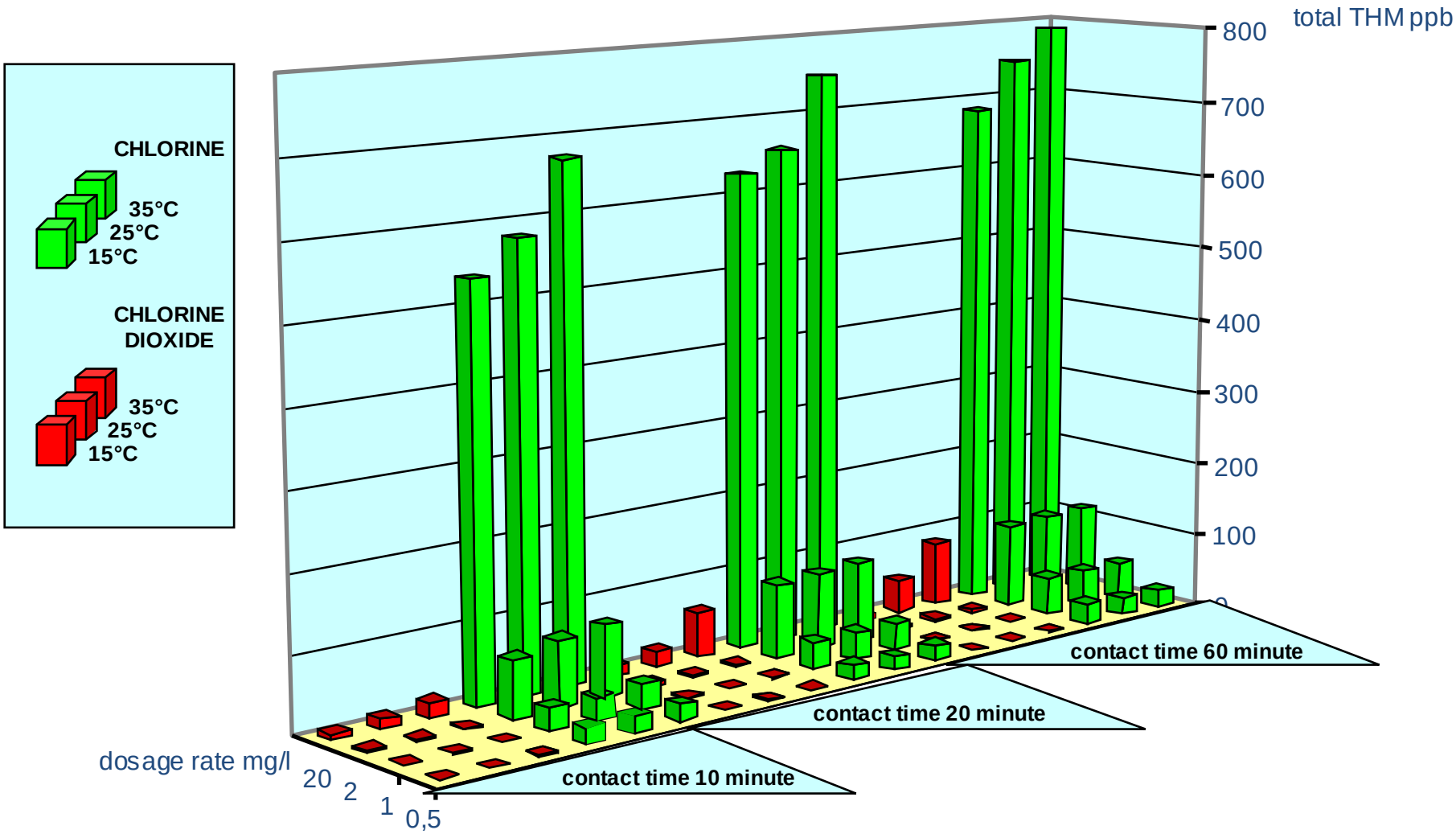
ClO2
Cl2
blank

Dosage mg/l

Summer
- Cl2 2.0
- ClO2 0.4

Winter
- Cl2 1.3
- ClO2 0.2

CHLORINE DIOXIDE AND CHLORINE COMPARISON ON THM FORMATION IN SEAWATER HAVING A TOC OF 5 MG/L



From " environmental impact of biocidal antifouling alternative treatments of seawater once through cooling systems"
R. Ambrogi ENEL

CHLORINE DIOXIDE ADVANTAGES

- very performant in short time contact system
- reduced corrosion (compared with chlorine)
- very performant at high pH (sea water, all organic and Zn/phosphonate treat.)
- very performant in ammonia contaminated system (fertilizer and ammonia plant)
- It can be applied by a simply chlorine plant modification or possibility no chlorine treatment
- environment friendly disinfection treatment

CHLORINE DIOXIDE GENERATION

ClO_2 can be generated on site by using water solutions of:

Sodium Chlorite,Hypochlorite and acid
according to the following reaction:

2NaClO2 + NaClO + 2HCl → 2ClO2 + 3NaCl + H2O

Or by using

Sodium Chlorite and Chlorine

according to the following reaction:

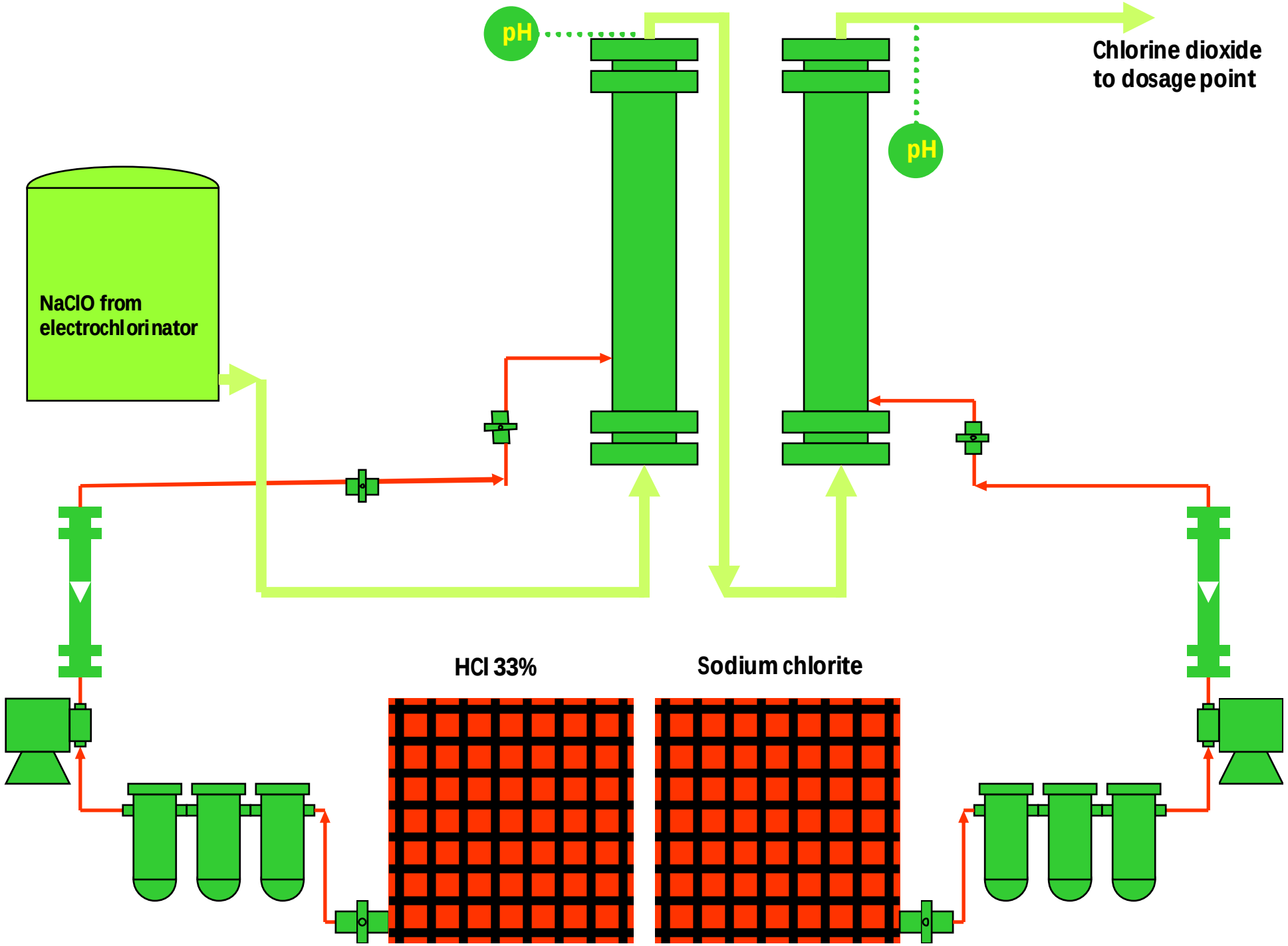
$2\ NaClO_2 + Cl_2 \dashrightarrow 2\ ClO_2 + 2\ NaCl$

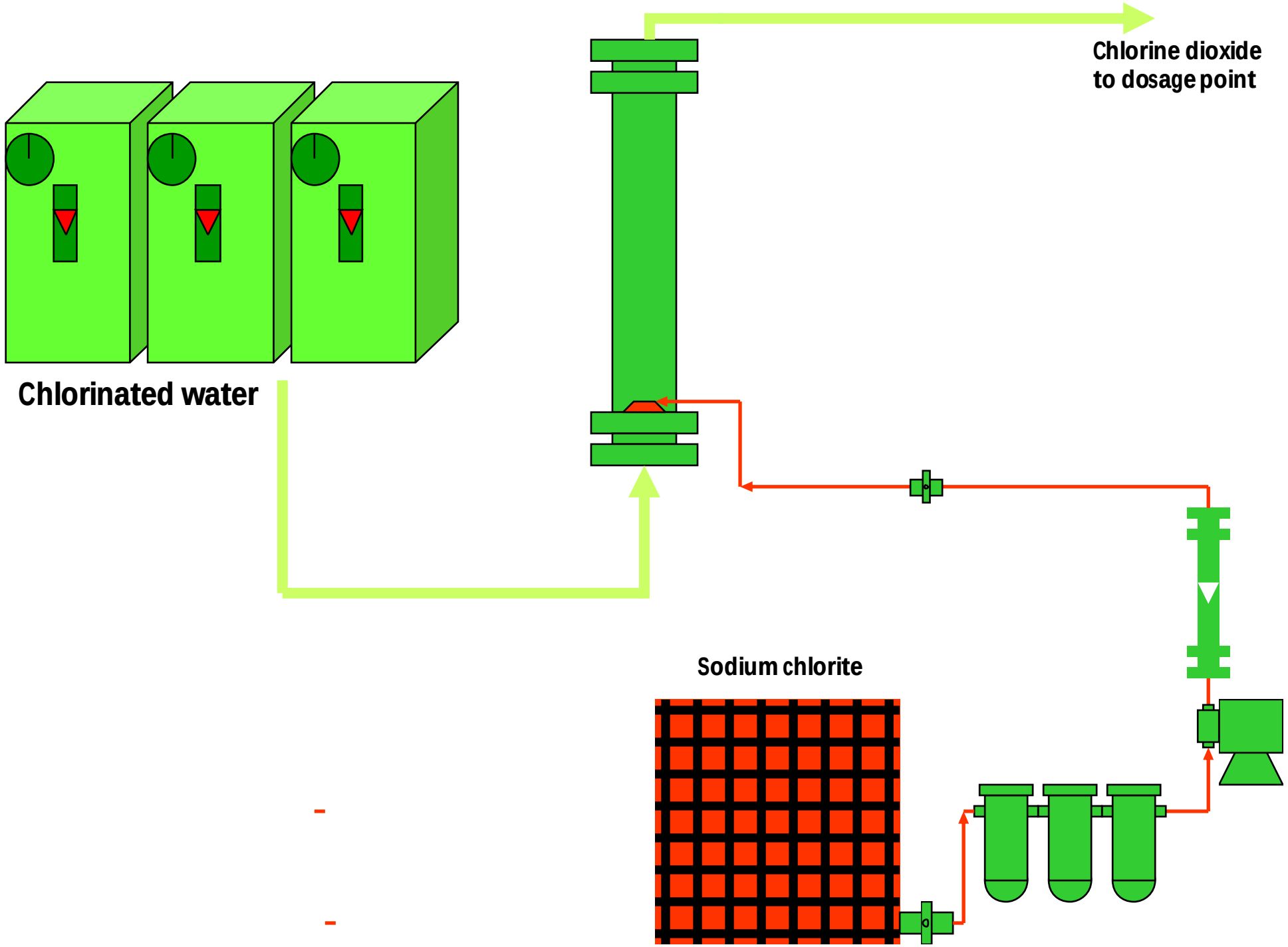
Or by using

Sodium Chlorite and Hydrochloric Acid

according to the following reaction:

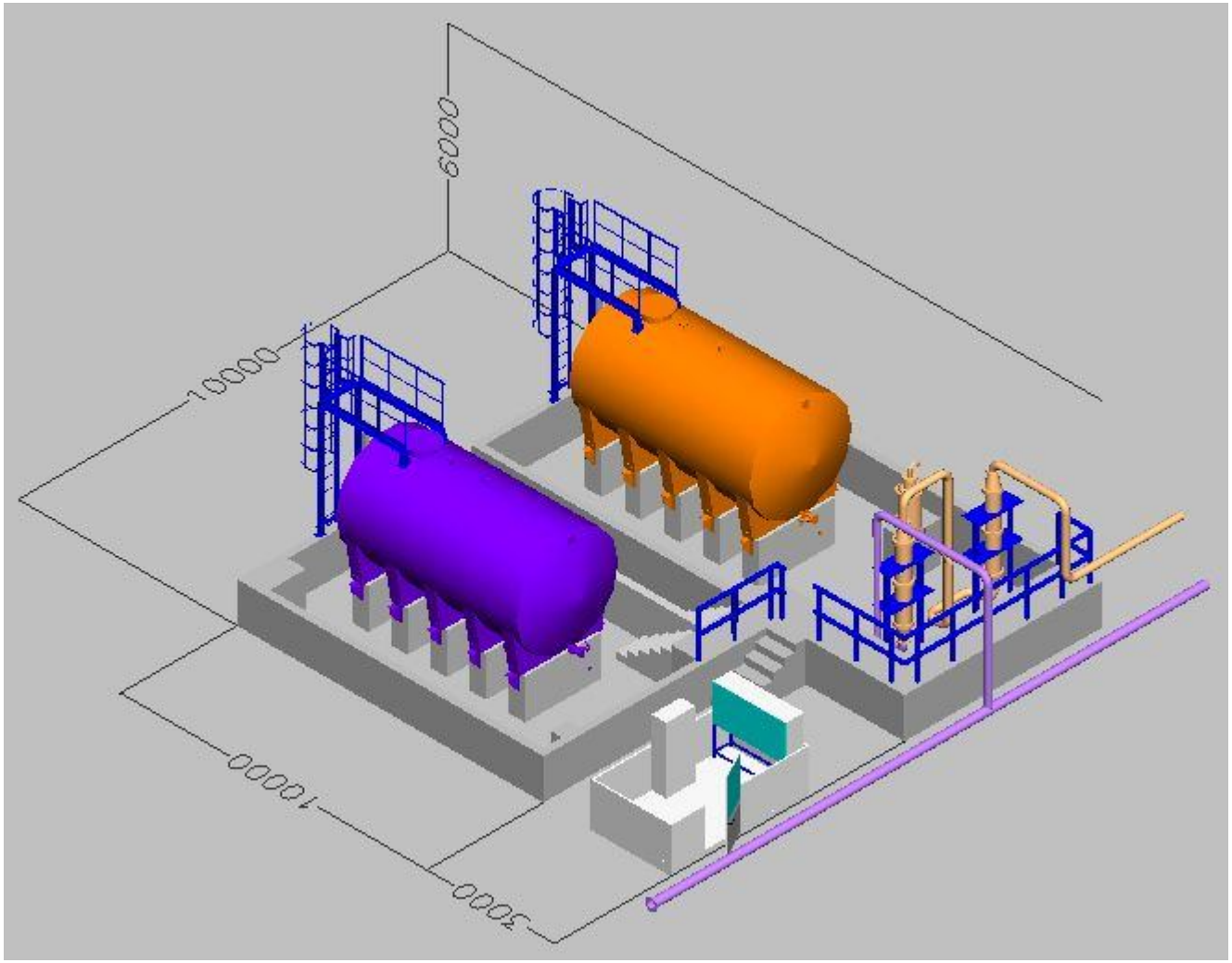
$5\ NaClO_2 + 4\ HCl \dashrightarrow 4\ ClO_2 + 5\ NaCl + 2\ H_2O$


pH
pH
Chlorine dioxide
to dosage point
NaClO from
electrochlorinator
HCl 33%
Sodium chlorite


Chlorine dioxide
to dosage point
Chlorinated water
Sodium chlorite

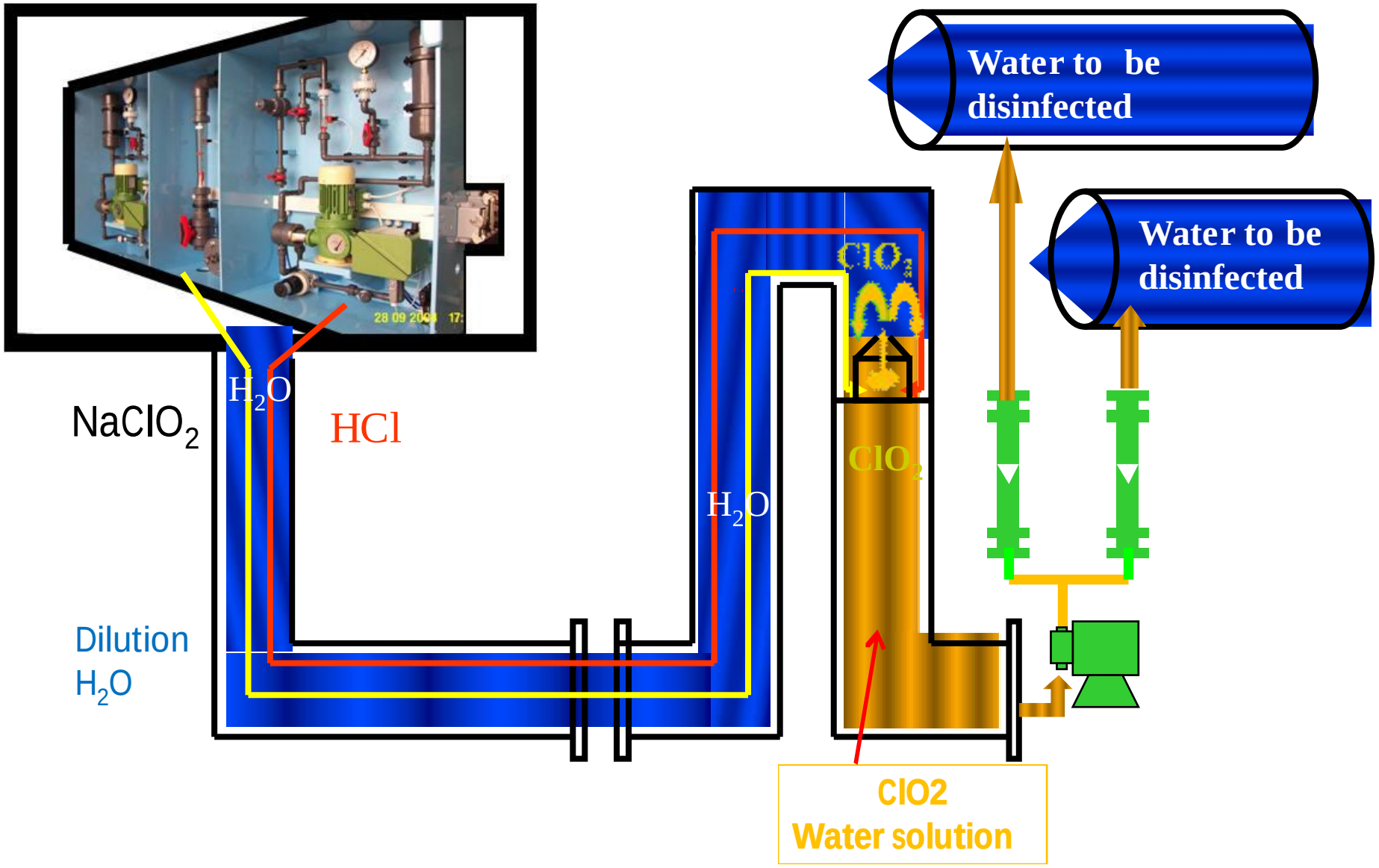
ClO2 “hypochlorite” generating system

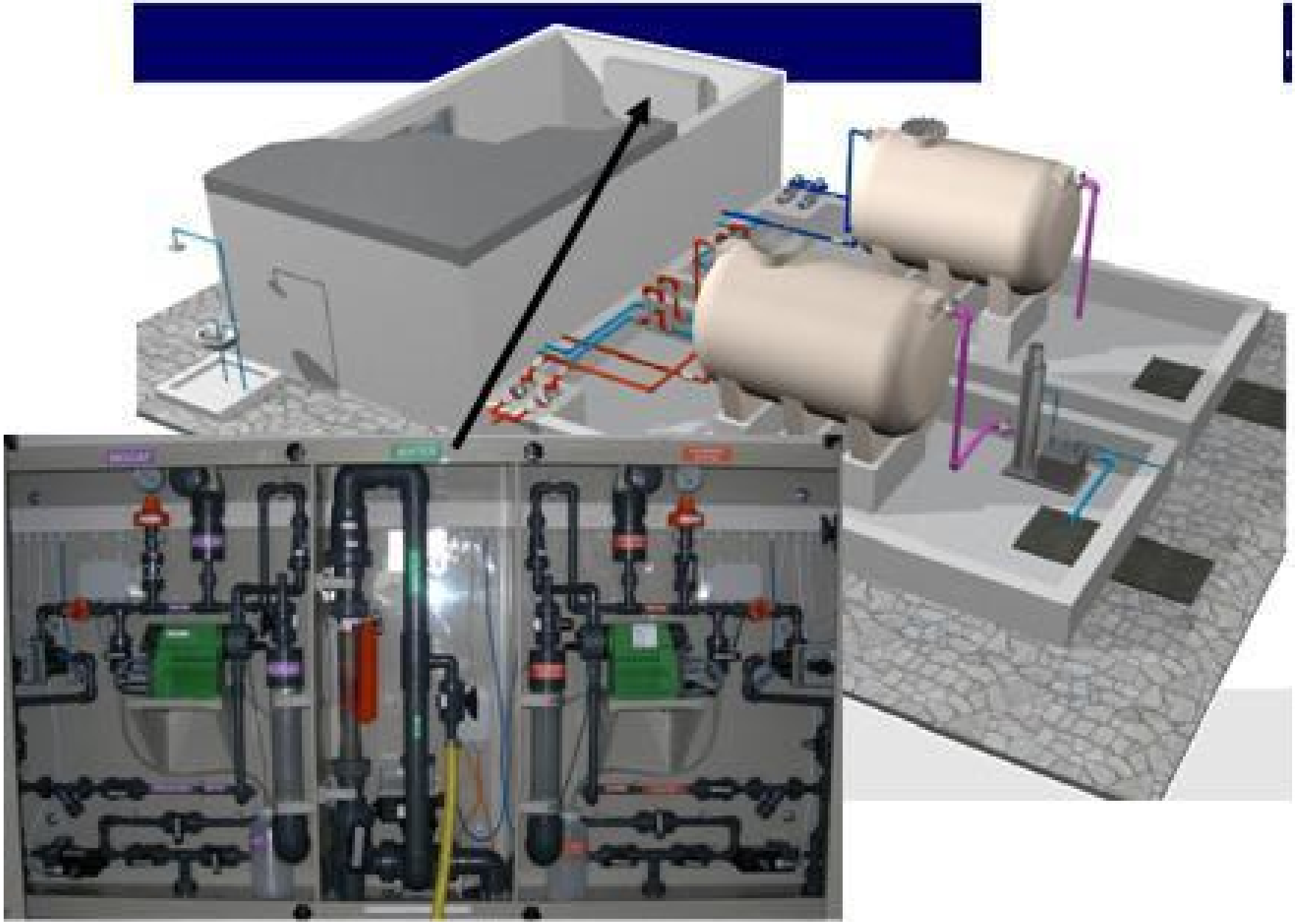
Conversion of hypochlorite from electrochlorinator into Chlorine Dioxide

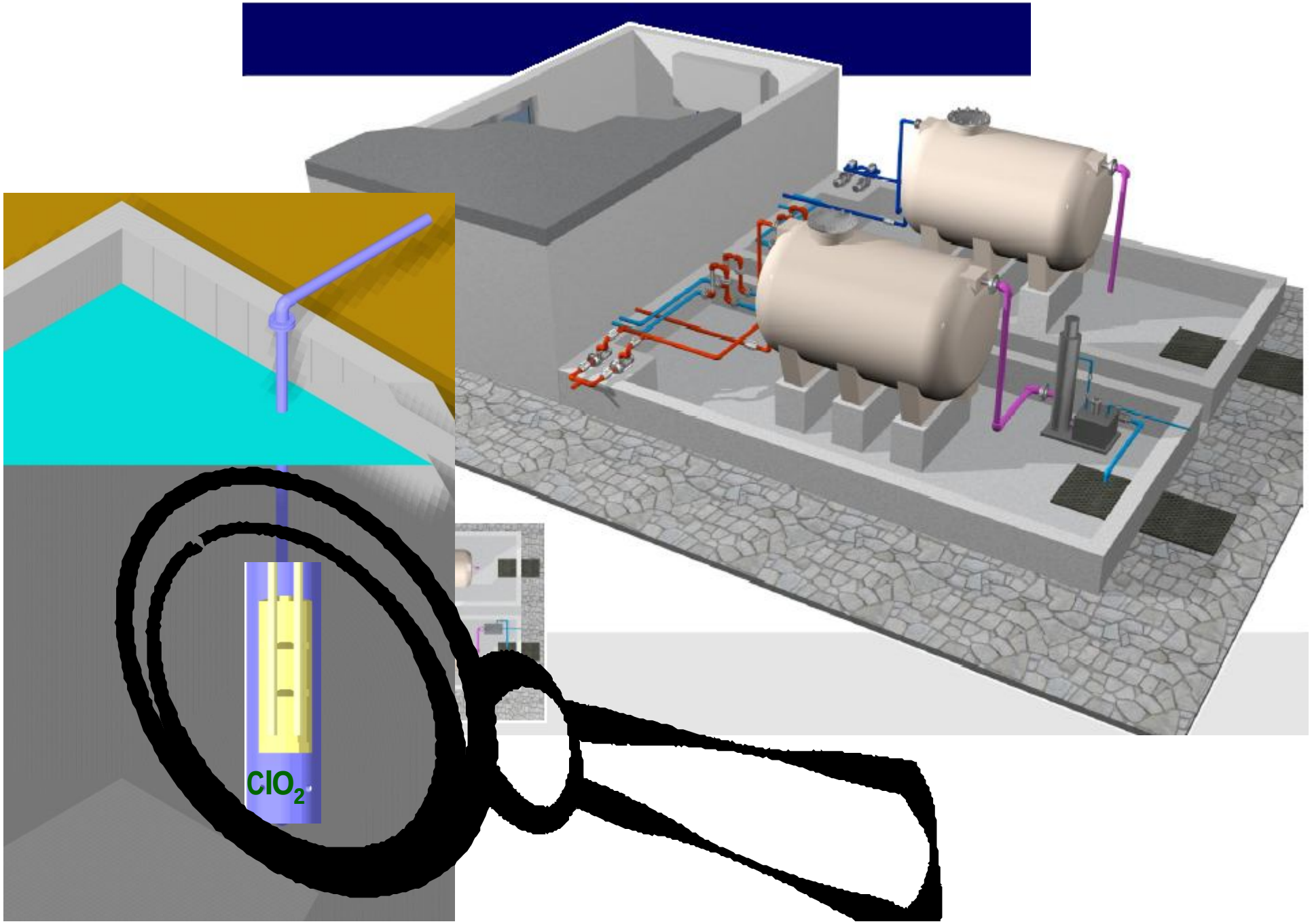


ClO2 “under water” generating system

Reaction chamber located into the dilution water line





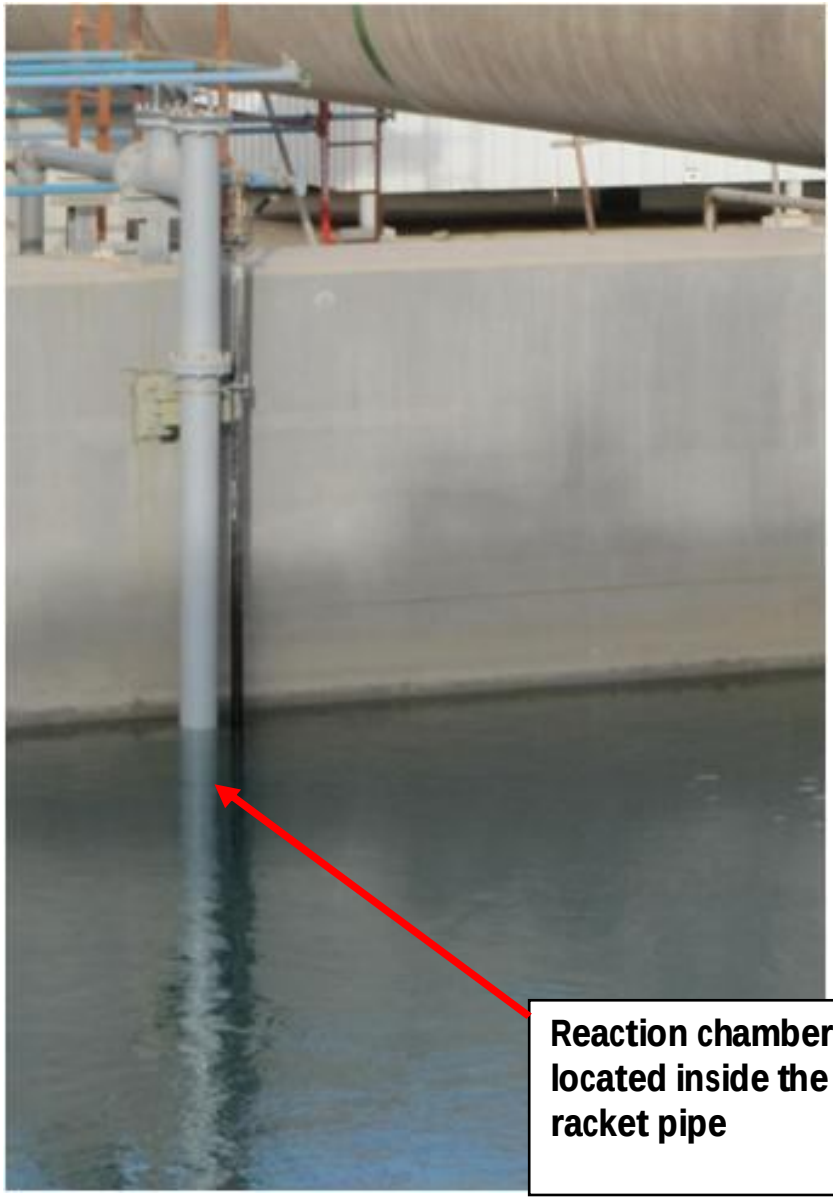

ClO_2

Chlorine dioxide reagents storage tanks

Chlorine dioxide reagents pumping station and control monitoring system

Chlorine dioxide “underwater reaction chambers”

water basin after 18 month operation.



Description of the Facility and Cooling Water (PLANT 1)

PLANT: LARGE PETROCHEMICAL

FEEDING: SEAWATER FROM THE INTAKE

SYSTEM: BASIN, SCREEN FILTERS, PUMPING STATION BASINS, COOLING TOWERS BASIN, HEAT EXCHANGERS, RETURN TO THE TOWERS, BLOW DOWN TO THE SEA.

FLOWRATE: RR. 175,000 m3/h (full capacity)

CHLORINE DIOXIDE DOSAGE:

from March to October 2 shot/day at 0.5 ppm as long as 1.5 hour each shot (TOTAL 3 H/DAY).
Winter 2 shot/day at 0.5 ppm as long as 1 hour each shot (TOTAL 2 H/DAY).

DOSAGE START UP: February 2009.

Description of the Facility and Cooling Water (PLANT 2)

PLANT: LARGE PETROCHEMICAL

FEEDING: SEAWATER FROM THE INTAKE

SYSTEM: SCREEN FILTERS, PUMPING STATION, PUMPING STATION, HEAT EXCHANGERS, RETURN TO THE TO THE SEA.

FLOWRATE: 32,000 m3/h (full capacity)

CHLORINE DIOXIDE DOSAGE:
2 shot/day at 0.3 ppm as long as 1 hour each shot (TOTAL 2 H/DAY).

DOSAGE START UP: February 2009.

Why chlorine dioxide?

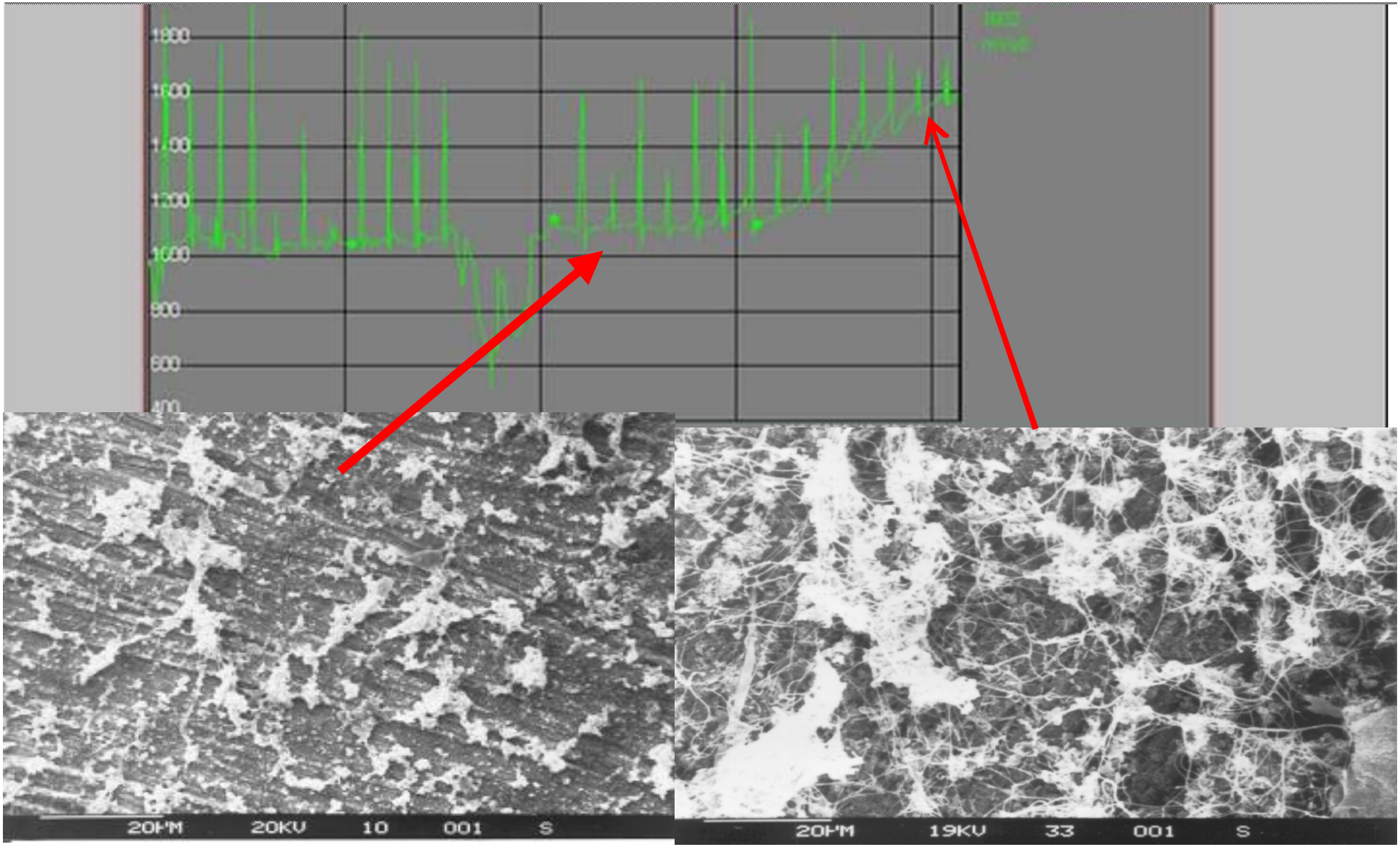
Chlorine dioxide was selected, to treat the 2 plants instead of chlorination for safety, environmental and performance reasons.

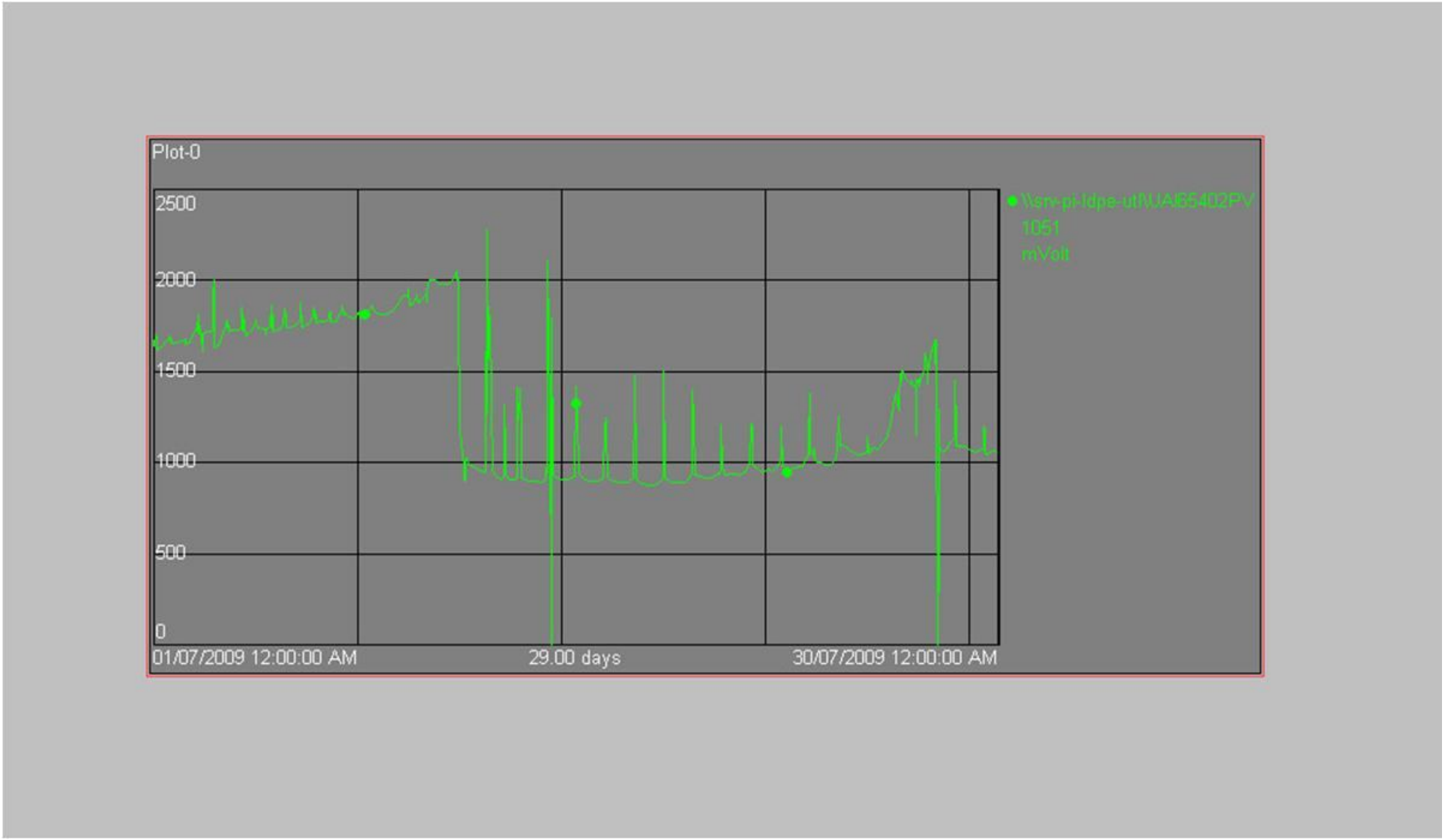
In fact, chlorine and sodium hypochlorite are responsible of bromate and bromoform formation in seawater which are considered very toxic for aquatic life of the Arabian Gulf.

Chlorine dioxide demonstrated to be very efficient at very low dosage rate, minimizing its residual and the formation of brominated compounds at the discharge point.

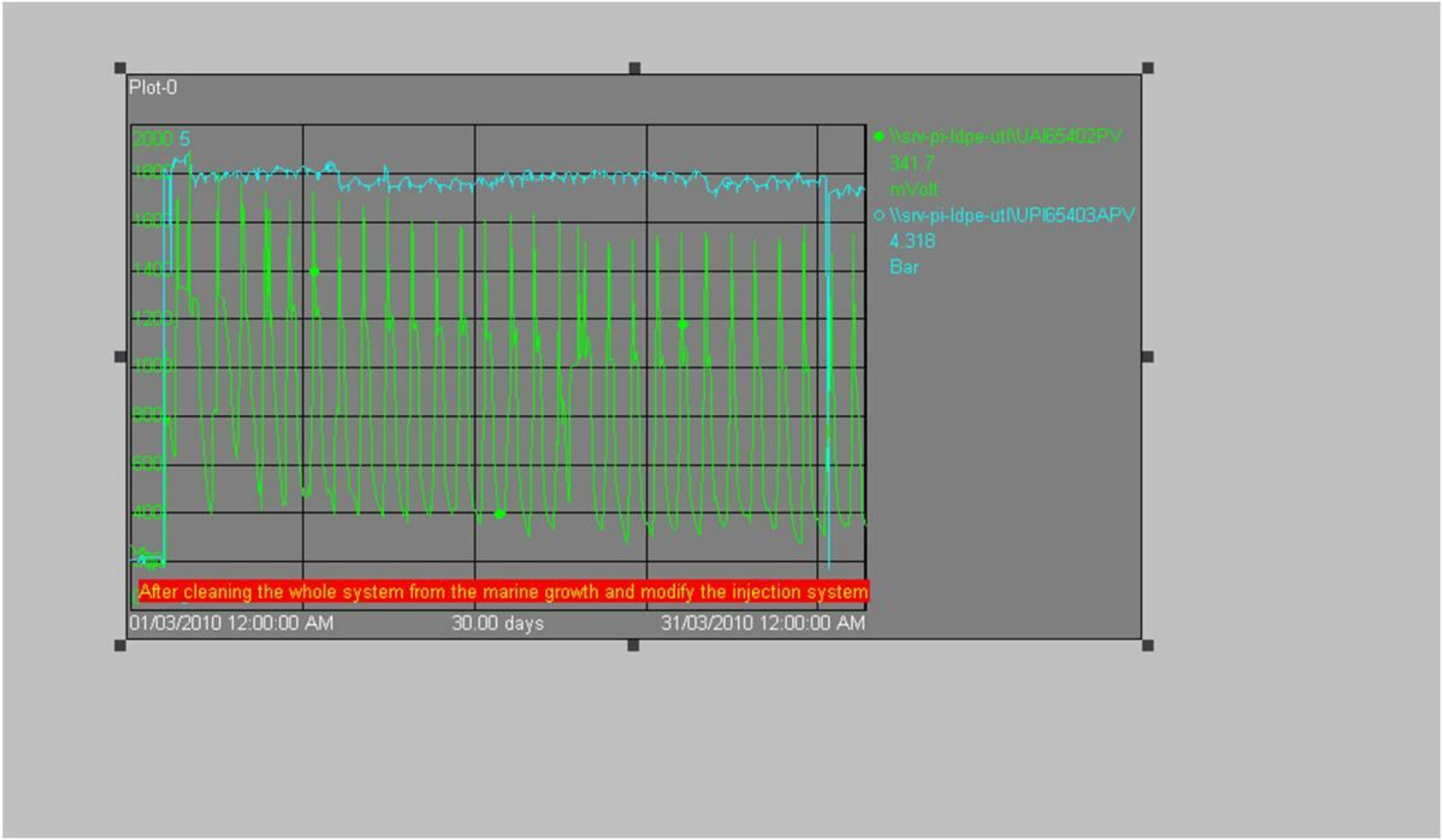
EasyaReadox SYSTEM

electrochemical biofilm sensor.





As chlorine dioxide shots increase, the baseline come back to its original value showing no biofilm activity



Constant baseline value indicates that no biofilm activity takes place and the whole system is clean.

Conclusions

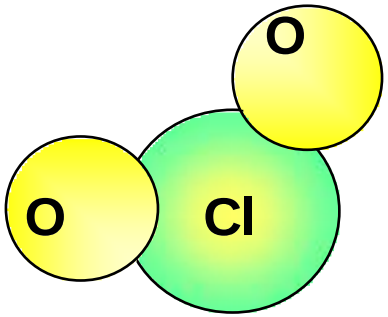
We underline the following advantages:

•Chlorine dioxide has allowed to minimize the growing of both micro and macro-fouling inside cooling systems of petrochemical plants at very low dosage rate,

•Monitoring system has demonstrated to be the “Brain” of the treatment programme. It has permitted to inject chlorine dioxide in a proper quantity and in the right moment, saving material and protecting the environment.

أشكركم على حسن ضيافتكم واهتمامكم

Thank you very much for your hospitality and your kind attention



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