ozone systems

OZONO ELETTRONICA INTERNAZIONALE

Ozono Elettronica Internazionale, for several decades successful in the field of applications of ozone, produces equipment of all sizes for all industrial purposes.
Not only does Ozono Elettronica Internazionale produce the equipment; it also offers, through a team of highly qualified experts working in collaboration with research institutes, applied engineering of ozonation systems.
These services are offered by Ozono Elettronica Internazionale in the belief that OZONE, the "ecological element" has an increasingly important rôle to play in the life of twentieth century man.

What is it?

Ozone (from Greek OGEIV = smell) is an associative form of 3 atoms of oxygen. Chemical formula = O_3.
It is a blue gas the principal characteristics of which are:

molecular mass	48 g/mole
density relative to air	1,66
specific weight at 0°C and 760 mmHg	2,143 kg/m^3
heat of formation	34,5 kcal/mole - 144,21 KJ/mole
boiling point	–112°C (dark blue liquid)
melting point	–193°C (dark red solid)

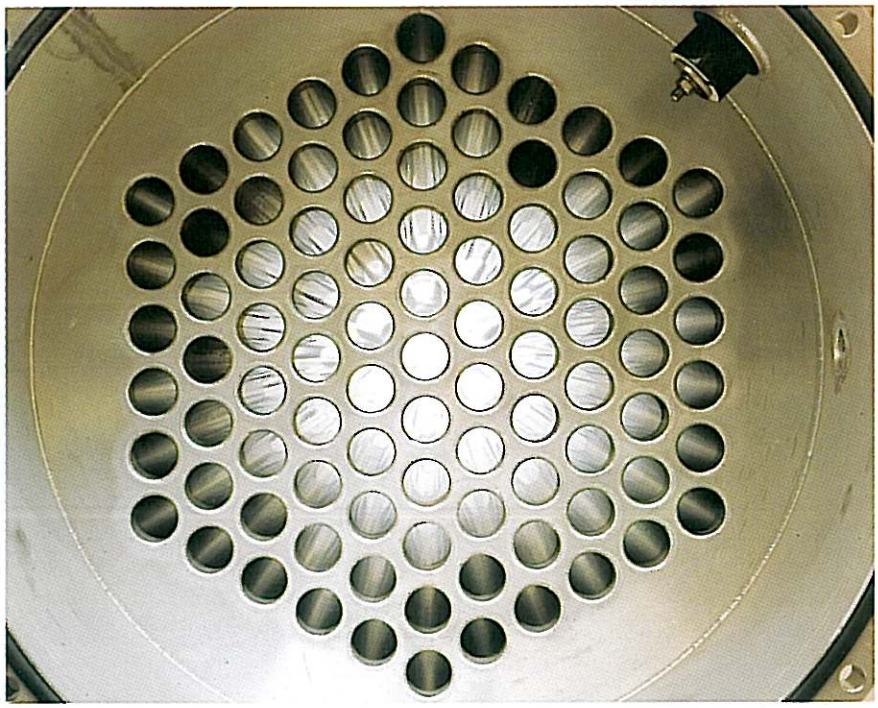
As is shown in the following table, it oxidizes easily.

REACTION	Eo
$O_3 + 2H^+ + 2e^- = O_2 + H_2O$	2,07 V.
$H_2O_2 + 2H^+ + 2e^- = 2\ H_2O$	1,77 V.
$MnO_4^- + 4H^+ + 3e^- = MnO_2 + 2H_2O$	1,69 V.
$O_2 + 4H^+ + 4e^- = 2\ H_2O$	1,23 V.
$HOCl + H^+ + e^- = ½\ Cl_2 + H_2O$	1,63 V.
$HClO_2 + 2H^+ + 2e^- = HClO + H_2O$	1,64 V.
$Cr_2O_7^= + 14\ H^+ + 6e^- = 2\ Cr^{3+} + 7\ H_2O$	1,33 V.

How it is made

Ozone is formed by subjecting a gas containing oxygen, usually air, to an electric exhalation between two electrodes charged to tensions of 3 to 9 kilovolts (as schematized in fig. n. 2).

1 – OZONE VESSEL

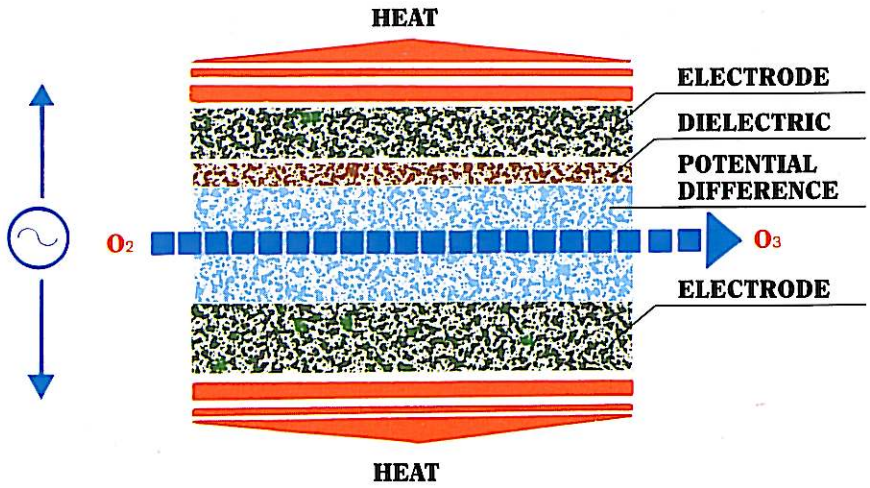


This operation is carried out in an apparatus known as an Ozonizer.
Ozone is therefore produced "In situ" and the only requirements are electric energy and cooling water (or air).
It is formed according to the reactions:

$1/2\ O_2 \rightarrow O$	$\Delta H_A = +59{,}1$ Kcal (247 KJ)
$O + O_2 \rightarrow O_3$	$\Delta H_B = -24{,}6$ Kcal (103 KJ)
$3/2\ O_2 \rightarrow O_3$	$\Delta H_{AB} = +34{,}5$ Kcal (144 KJ)

It needs energy (endothermic reaction) that is provided during the electric exhalation ("silent discharge") or crown effect.

2 – OZONE FORMATION



How it acts

Ozone is strong oxidant and principally in three different ways:

- ☐ direct oxidation on the substrate by a process of ozonolysis
- ☐ direct oxidation on substrate for the loss of an atom of oxygen
- ☐ catalytic oxidation due to the oxygen present in oxonised air

It is active against groups of molecules with such formulae as: >C=C<, -C≡C-, SH^-, S^{2-}, NH_2^-, NH^{2-}, OH^- (phenolic), CHO^-, Fe^{2+}, Mn^{2+}, Cr^{3+}, SO_3^{2-}, NO_2^-, I^- (this reaction is used in the analytical determination of ozone).

Where it is used

It's most important applications are:

- ☐ bacterial and viral disinfection of water and air
- ☐ potabilization of water through decolorization, deodorization, deferrisation, demanganization, and elimination of humus materials (aloform precursors) and organic substances generally
- ☐ treatment of waste water containing cyanides, sulphides, surfactants, etc.
- ☐ treatment of recycled waters

☐ treatment of water for the sea stock farming of mussles

☐ deodorization of industrial exhaust fumes

☐ deodorization of air surrounding biological treatment plants

☐ treatment of swimming pool waters

3 – ANALYSIS AND PILOT TEST LABORATORY

4 – PILOT PLANT

5 – STERILINE DISINFECTION STANDARD UNITS

Some of the principal reactions of ozone

$Fe^{2+} + O_3 + H_2O \longrightarrow Fe^{3+} + O_2 + 2OH^-$

$Fe^{3+} + 3H_2O \longrightarrow Fe + (OH)_3\downarrow + 3H^+$

$Mn^{2+} + O_3 + H_2O \longrightarrow Mn^{4+} + OH^- + O_2$

$Mn^{4+} + 4\ (OH)^- \longrightarrow Mn(OH)_4 \rightarrow MnO_2\downarrow + 2\ H_2O$

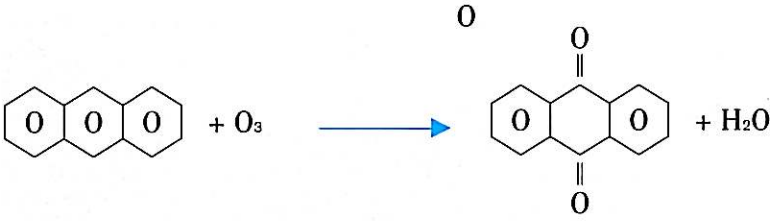
$CN^- + O_3 \longrightarrow CNO^- + O_2$

$2\ (CNO^-) + 2\ H_2O \longrightarrow 2\ CO_2 + N_2 + 4H^+$

$3\ S^{2-} + 4\ O_3 \longrightarrow 3\ SO_4^{2-}$

$NO_2^- + O_3 \longrightarrow NO_3^- + O_2$

$R\text{-}C{\equiv}C\text{-}R + O_3 \xrightarrow{H_2O} 2\ R\text{-}\underset{\underset{O}{\|}}{C}\text{-}OH$



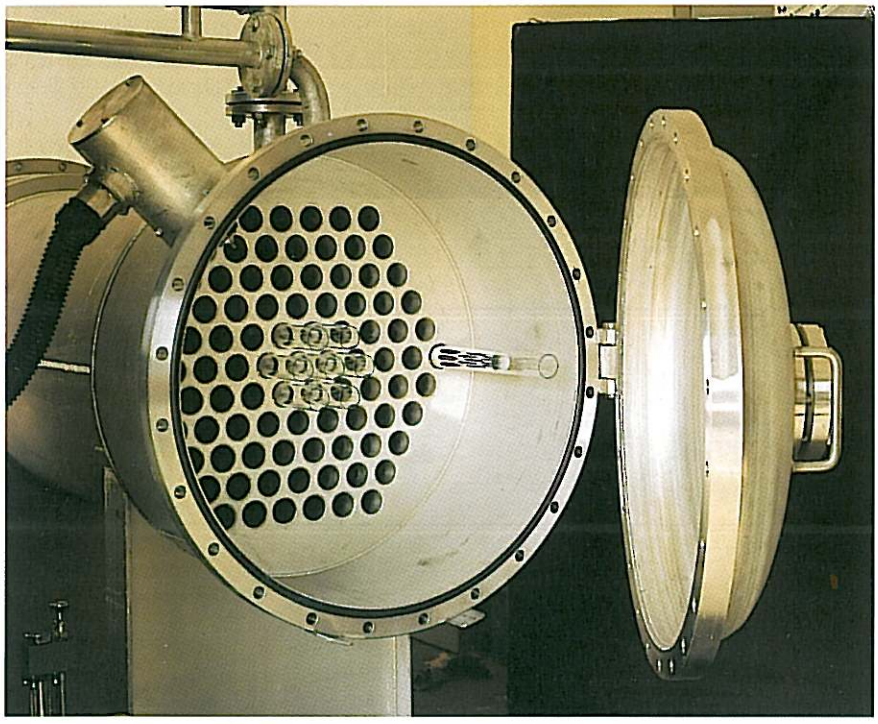
Advantages derived by its use

- ☐ Disinfection from bacteria and viruses with improvement of the qualities of the effluent
- ☐ elimination of particularly resistant substances
- ☐ absence of undesirable secondary effects
- ☐ enrichment of oxygen

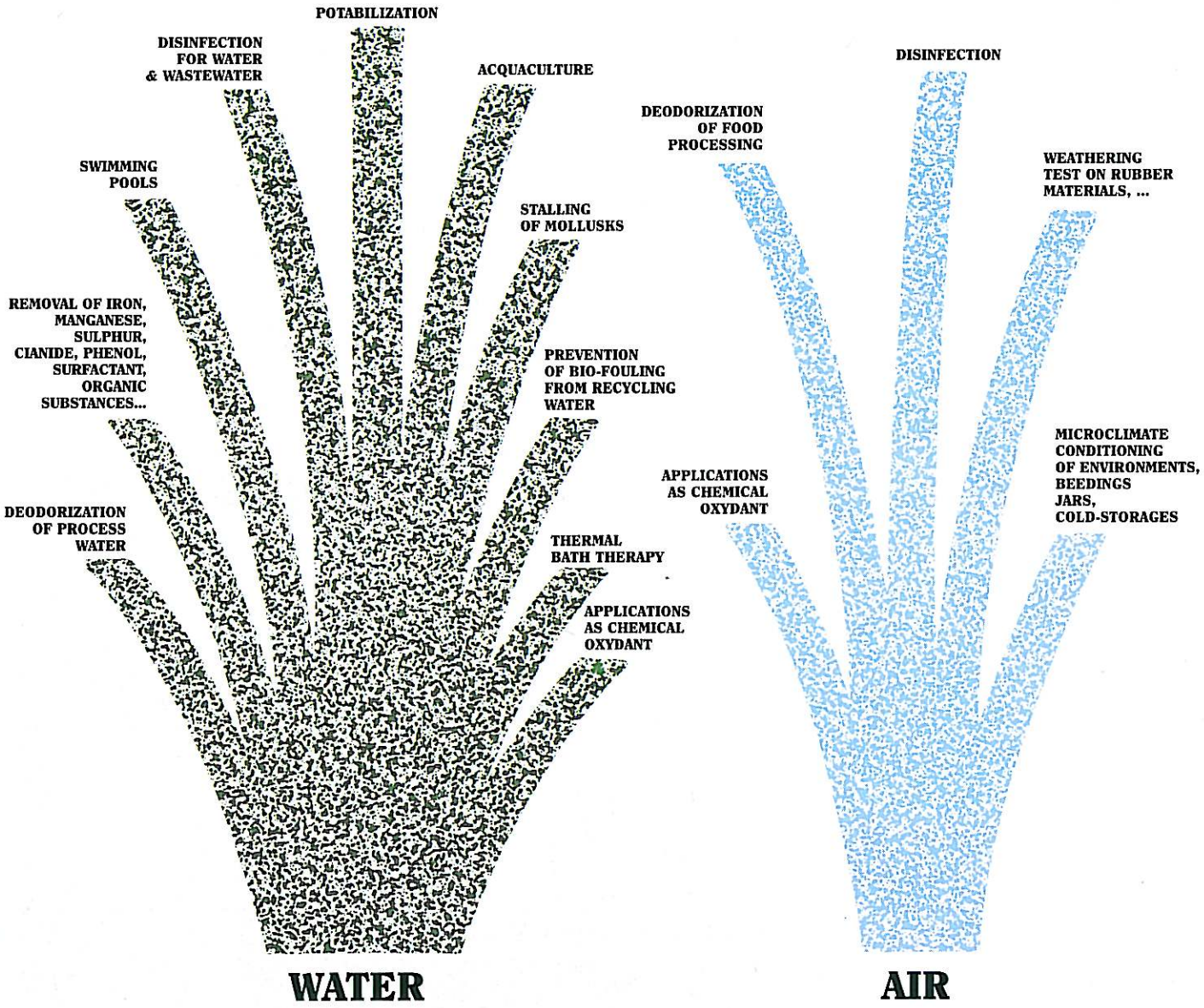
How ozone is produced inside our generators

The air is compressed to the required system pressure and cooled down in the aftercoller, water vapour will be condensed and removed from the air by a water separator.
Dust, water droplets and oil vapours are separated and removed in the filters. The dryer will reduce the water vapour content of the air down to the required value. The dryer consists of two columns filled with dessiccant.
While one is drying the gas, the other will be being regenerated.

6 – INTERIOR OF AN OZONE GENERATOR



The dried air is pushed through the electric exhalation which exists between the stainless steel tubes and dielectrics.
During this passage is produced ozone.
The ozonator works automatically checked by PLC and is operated through a touch screen. The power supply unit is made up of interchangeable rack modules following the last technology IGBT.



7 – COLOR AND SURFACTANT REMOVAL AT ALTOURA; 80 KgO_3/h AND 1.000 m^3/h CAPACITY

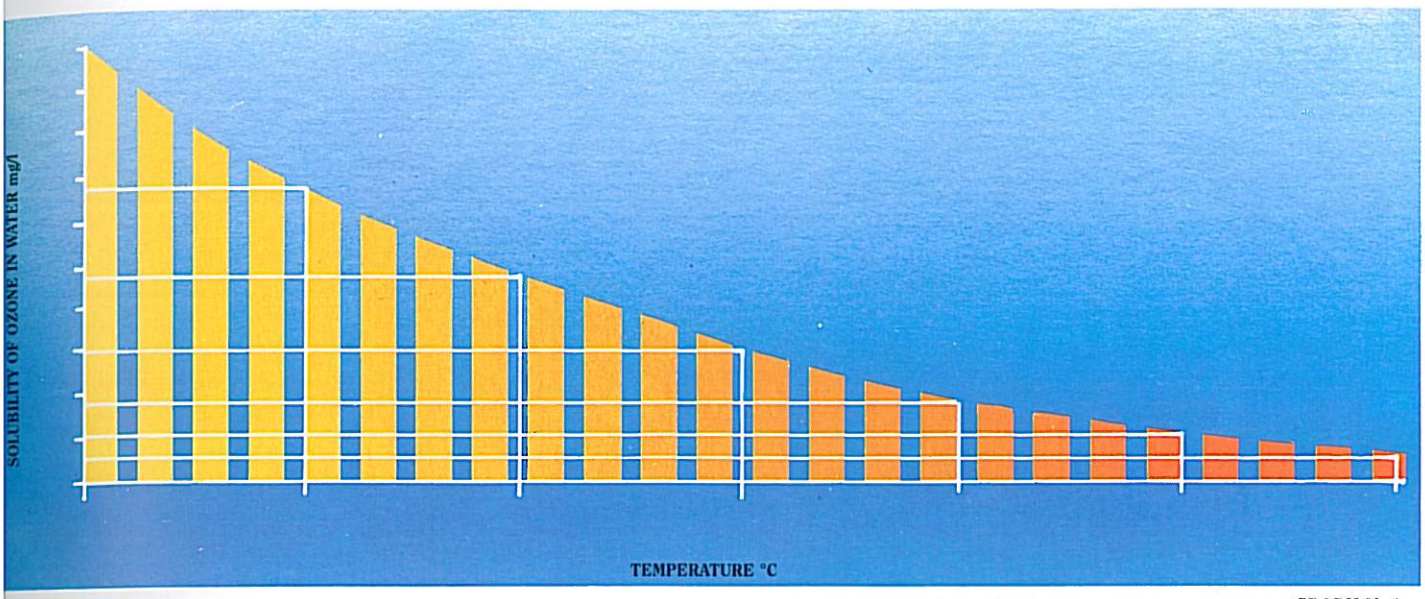
8 – COLOR AND SURFACTANT REMOVAL FROM THE TEXTILE INDUSTRY WATERS

9 – IRON AND MANGANESE REMOVAL PLANT

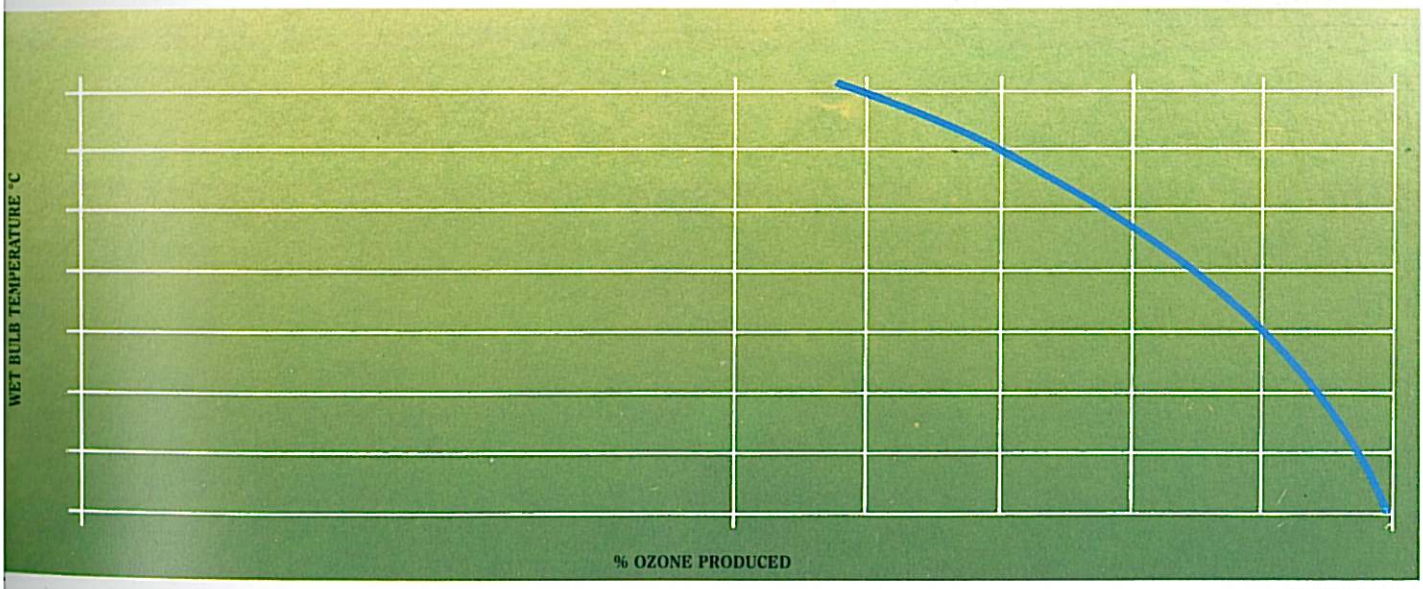
Characteristics of ozone generators

Generators work with medium frequency technology, both with air and with oxygen at the required concentrations.
They are ready for immediate use, all that is necessary is electric power from the mains and cooling water.

10-11 – TPF TYPE OZONE GENERATORS



GRAPH N. 1 –

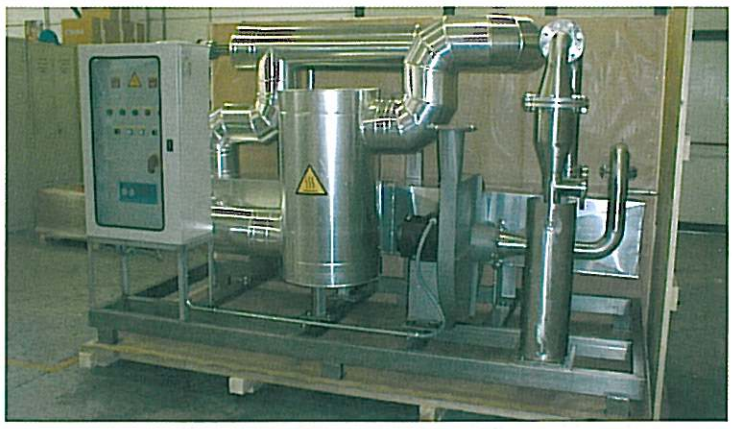


GRAPH N. 2 –

GRAPH N. 1 – SOLUBILITY OF OZONE IN WATER AS FUNCTION OF THE TEMPERATURE

GRAPH N. 2 – INFLUENCE OF THE WET BULB TEMPERATURE ON THE PRODUCTION OF OZONE

12 – OZONE DESTROYER MOD. DTR



Principal applications of ozone

13 - PSU - POWER SUPPLY UNIT

14 - N. 2 X 40 KgO_3/h OZONE GENERATORS

15 - PUMPING STATION

Potabilization

The advantage offered by ozonization are:

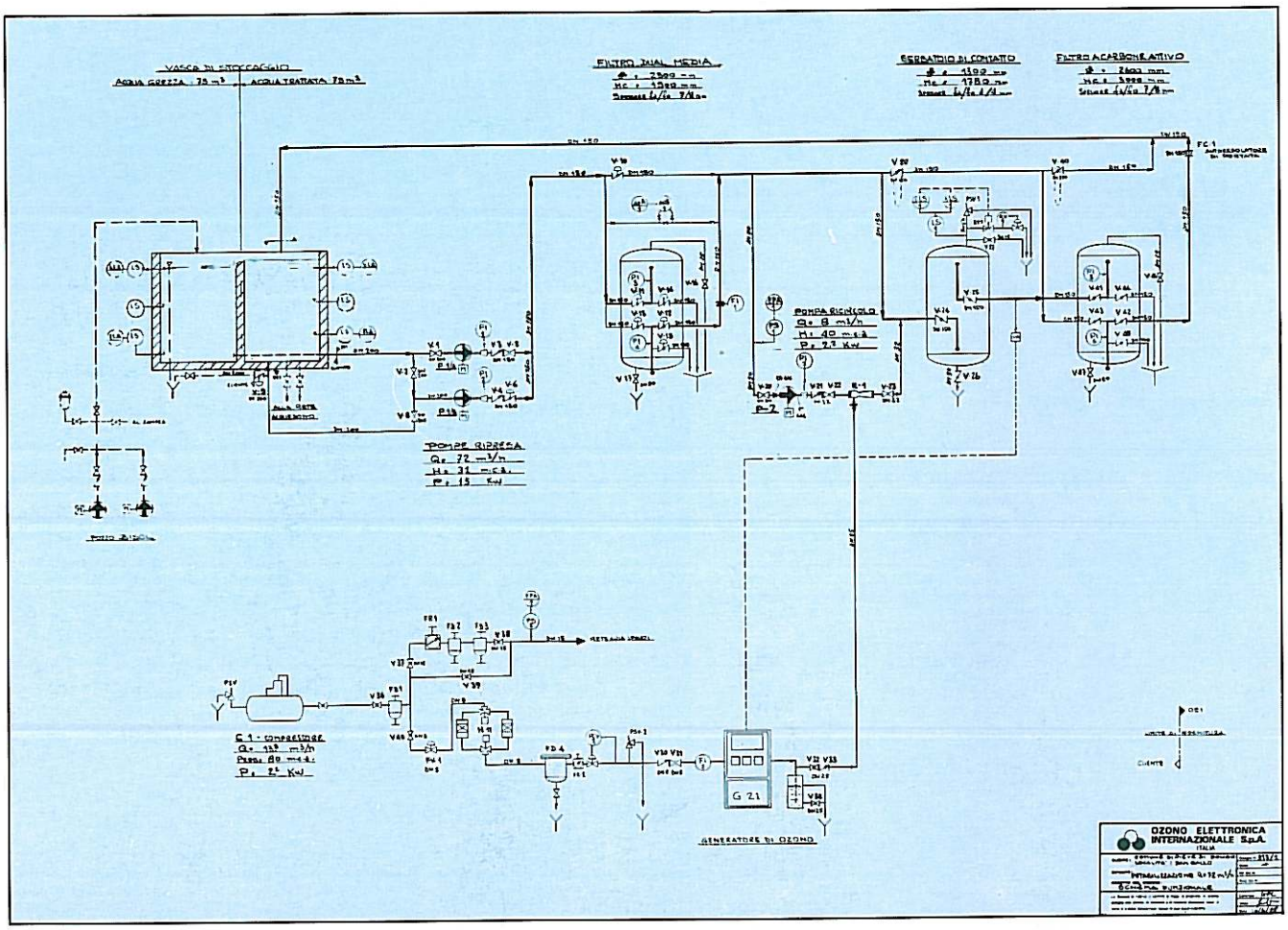
- ☐ colour, odour and taste are reduced or eliminated
- ☐ efficient disinfective action over a wider range of temperature and ph
- ☐ bactericidal action and rapid destruction of spores (in some cases up to 3000 times faster than chlorine) and with brief periods of contact
- ☐ non creation of aloform
- ☐ odour is neither created nor increased by the treatment
- ☐ does'nt require use of chemical products such as hypochlorite (unstable) or chlorine dioxide chloride (toxic) or chlorine gas (toxic and to be used only by licensed personnel)
- ☐ immediate oxidant action against organic impurities and reduction of BOD and COD

Table comparing the results of potabilization using ozone and chlorine

	CHLORINE	OZONE
Odour	unpleasant in water	none
Taste	unpleasant in water	none
Colour	tending to yellow	colourless
Oxidating power	good	inferior only to fluorine
Anti-viral activity	practically none	elevated
Anti-bacterial activity	very variable from species to species	very wide bacterial activity
Destructive activity on parasites	slight	elevated
Destructive activity on algae and protozoa	slight	elevated
Activity on fungus	slight	elevated
Activity on cysts and spores	slight	elevated
Structural activity on microcontaminants (hydrocarbons, detergents, phenols, colouring substances, pesticides)	none to slight	elevated
Activity on unpleasant organic molecules (odour and taste)	none	high
Meccanism of reaction and intermediate production	indirect oxidation with production of chloramines, chlorophenols, etc.	direct oxidation with oxygenation of water

16 – DRINKING WATER PLANT

POTABILIZATION SYSTEM



Treatment of the air

The efficiency of ozone is realized by:

- ☐ anti-microbiological action by oxidation to achieve the breaking of proteinaceous structures, either bacterial or virus, with guarantee of bacteriostatic action at certain levels of concentration left in the air;
- ☐ complete deodorizing action, on the groups that cause odour, (a) by oxidation or (b) by the formation of some unstable compound (oxonides) with the odorous decomposing substance.
  e.g. (a) oxidation of urea
  (b) formation of an unstable oxonid with phenols.

Advantages offered by ozonation:

- ☐ bactericidal efficiency apart from smell destruction
- ☐ large variety of organic reactivity
- ☐ does not create odour causing by-products (chloro derivatives)
- ☐ absence of stock of chemical products and their handling
- ☐ low running costs
- ☐ brief period of contact

17 – DOUBLE STAGE DEODORIZING PLANT

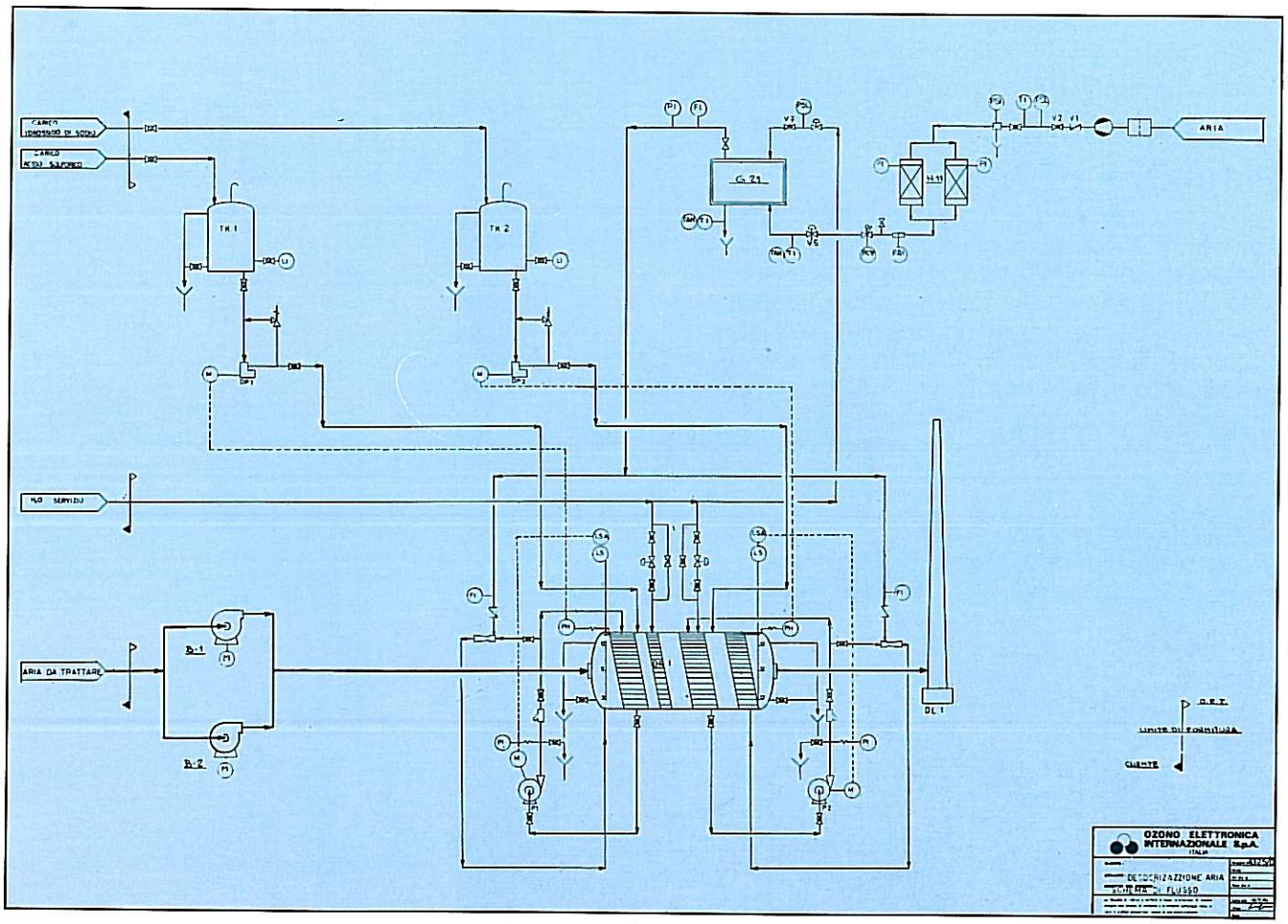
18 – DEODORIZING PLANT OF 30.000 Nm^3/h

19 – IBIZA - DEODORIZATION PLANT - DABO TYPE

Therefore it is particularly useful for:

- ☐ treatment of air expelled from factories using animal matter, such as bones, feathers, fats, skins, etc.
- ☐ treatment of air surrounding biological sewage treatment plants
- ☐ air conditioning equipment, as it eliminates smells, adds oxygen, oxidises carbon oxides and other by-products of tobacco
- ☐ installation of microclimate conditioning on stock-farms (chickens, pigs, etc.) because it disinfects air, destroys smells, increasing the ratio of conversion of food to animal weight
- ☐ air conditioning of refrigerator and food stores because of bacteriostatic action on food surfaces prevents decomposition
- ☐ treatment of air used in the production of rubber, fish, food-stuffs, phenols, etc.
- ☐ stock-farms which breed animals, for example, the flesh fly, which cause unpleasant odours

AIR DESODORIZATION SYSTEM



Some other uses of ozone

Swimming pools

The waters of swimming pools are susceptible to pollution by metazoa, (elminti) miceti, bacteria and virus, which are, in their turn, responsible for many infections.
O_3 guarantees the elimination of all pathogenic organisms, including protozoi, spores, microbacteria etc. and offers the following advantages:

- ☐ the characteristics of water are left unaltered
- ☐ action on macromolecules in solution, thus giving the water pleasant organolectic characteristics
- ☐ has no influence on pH or cloudiness, does not cause by-products or unpleasant additions to the water content
- ☐ enriches oxygen content and lends a slight blue tint to the water.

Water to be recycled

O_3 possesses certain characteristics which readily lend themeselves to the treatment of these waters:

- ☐ it disinfects, preventing the formation of algae and bacteria
- ☐ it eliminates a part of the COD residue
- ☐ it enriches the oxygen content
- ☐ it has a redox potential high enough to eliminate unpleasant smells and odours
- ☐ it is produced "on the spot", and thus does not need to be stored. There is no necessity to take on qualified personnel
- ☐ it is efficient through a wide spectrum of pH.

Pounding of molluscs

It is necessary to "pound" mussels, so that when they are in pure sea water, they will rid themeselves of germs. Thus a plant destined for this purpose must have both a filler system and apparatus for disinfection.
Here also O_3 acts on the bacteria which infect mussels, by oxidizing the proteinaceous part, thus altering the molecular structure and combating the macromolecular substances extant in the sea, (hydrocarburates, detergents, phenols, etc.) O_3 improves the organolectic characteristics of the water and thus renders it suitable for "pounding" purposes.
It is also possible to use O_3 for washing and disinfecting fish and other sea creatures.

Waste waters

O_3 both disinfects and reduces the organic load.
The first action is general for all waters, the second is linked to the water type. The disinfectant action is especially effective with waters which have been biologically processed, and contain such large quantities of microorganisms that other disinfectants (e. chlorine) would have to be used in quantities that would negatively affect the characteristics of the water.

Storehouses and cold storage

O_3 eliminates odours and bacteria caused by metabolic materials of animal and vegetable products. It is useful for storing meat, fruit, eggs, vegetables, sausage, cheeses... as it prevents the discoloration of food, the formation of mould, while allowing a high rate of humidity and prolonging possible storage periods.

Air conditioning and microclimatic conditioning

O_3 is particularly useful where air must be recycled and deorized, eliminating bacteria odours, anhydrous sulphur, ammina, urea, carbon oxide, and other common polluting materials. O_3 also enriches the air by raising its oxygen content.

Livestock, raising

Exhalations of toxic gas, high microbe load and lack of oxygen are relevant factors in the high mortality rates.
The action of ozone destroys mould, bacteria and virus, and oxidizes the products of fermentation. Ozone also revitalizes the air.

Ozono Elettronica Internazionale "Packages": the swift, sure method

Ozono Elettronica Internazionale offers a gamma of highly-tested, ready - to use plants for:

Processing drinking water

These plants are avaible with a production capacity varying from 90 to 20000 l/h. They are suitable for a multitude of uses: domestic, small communities, society, precarious installations, emergencies, calamities...
They guarantee a high level of efficiency and disinfection.

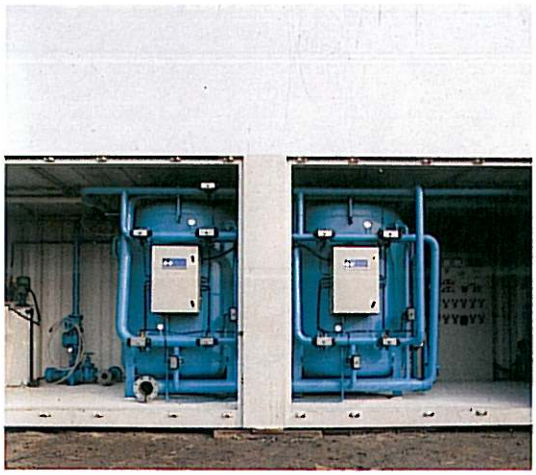
Swimming pools

Available for swimming pools with capacities ranging from 10 to 400 m^3 and offer recycling from 2 to 40 m^3/h. These plants come complete with mixer system. They require only filters.

Air fresheners

Can deodorize from 50 to 10.000 m^3 of air according to the size of the plant. Dosages are in accordance with MAC.

20 – MOBILE DRINKING WATER UNIT FOR ETHIOPIA Q = 18 m^3/h



21 – DEODORIZING STANDARD PLANT

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