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h2o.TITANIUM

TiO2-WATER TREATMENT

TECHNICAL – ECONOMICAL TEASER

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WATER PURIFICATION: A WORLD ISSUE.

Water purification represents one of the most important issues nowadays.

Certain world regions, like Africa or India, suffer a lack of drinkable water so high that people is forced to buy bottled water to employ either in home works or simply to drink.

The World Health Organization highlights the water contamination as one of the top worldwide issues present nowadays causing an important amount of diseases and deaths in undeveloped countries.

Even though it represents a major issue, not all the countries can afford to build proper water purification systems and distribution infrastructures due to the costs associated to all the facilities and civil works previously required all along the country, like sewages, dams or depuration plants for example.

The water purification process can be developed by means of different procedures that will be now described.

Some of them offer partial solutions to the infrastructures required in common first-world purification facilities.

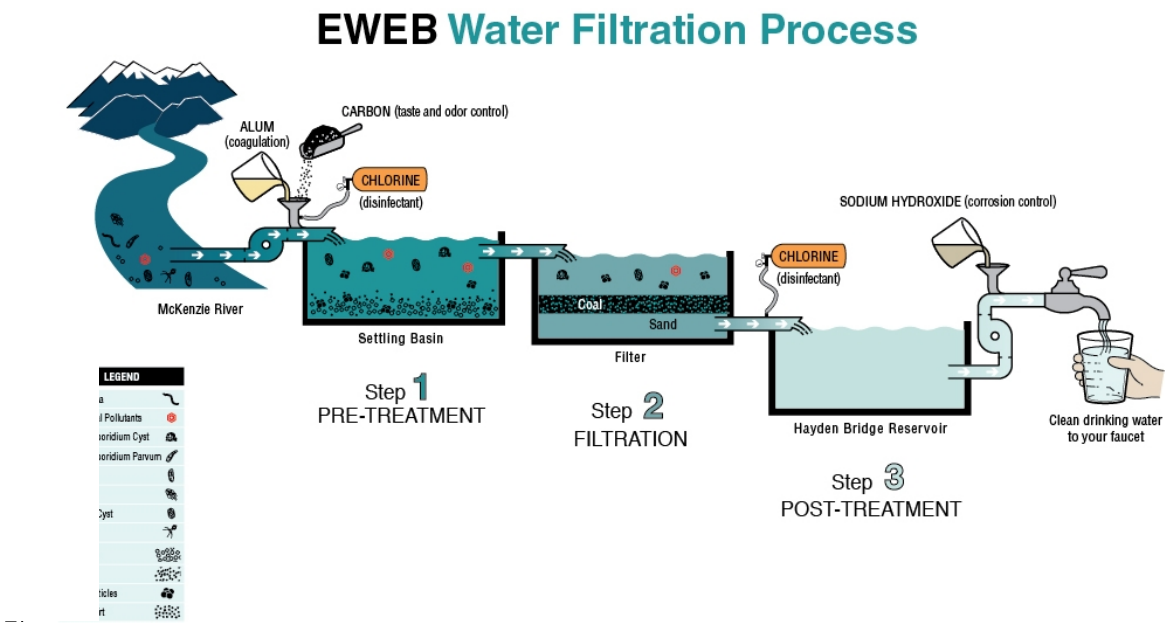
MAIN MARKET ALTERNATIVES:

Depending on the population and the use given to the resulting water (to be drunk and/or employed for home works and/or used to be reused and/or used in industrial sector, etc) there are different market options available that will be now described.

1. **Water filtration stations using chemicals:**

Although is the most common source to remove solids of water in first-world populations at low specific costs (overall cost per water treated) it presents some drawbacks for certain potential consumers.

It is based on different filtration particles to remove solids from water but not to disinfect it. To do this, it is necessary to add chemical treatments like Chlorination; the stages are commonly as follows:



3. **Figure-1: Water filtration station stages. [Source: www.eweb.org]**

Present in big towns, not for single consumers or small population sizes.

High developing and maintenance costs and difficult to build if there is not a proper sewage system. This can increase the overall project costs making it sometimes non-viable for second and third world countries, regions or populations.

4. **Figure -2: Common home filtration system.**

2. **Reverse Osmosis:**

It consists of a pressing-membrane system that allows just the pass of a H2O molecule-size stream throughout these membranes.

It gives a by-distilled water stream as result together with relatively high disposable materials, depending on the inlet water conditions.

The principle of a reverse osmotic system is shown in the following figure:

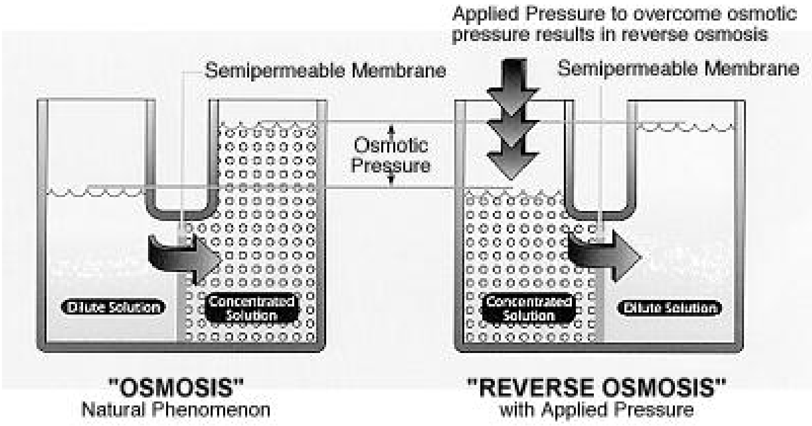


Figure -3: Reverse Osmosis principle (source: alpinewatersystems.com).

Machinery, **<u>operating and maintenance costs are remarkably high</u>**, being the most expensive purifying system available.

Standard reverse osmosis station:

Figure -4: Standard reverse osmosis station.

Moreover, the water obtained must be treated in order to making it drinkable by means of different salts addition.

3. **Ozone:**

Ozone is widely used in the deodorization of environments, this is a good technology for disinfection and reduction of organic material in the water but due to the complexity of the system and comprehensive checks to be carried out to not exceed the dose limit in water, its application is justified only in very specific cases; in others, it cannot be applied because it gives color and flavor to the products with which it is in contact, not to mention the corrosion caused in the installations. Also, you need expert care, they are very expensive installations and take up a lot of space.

Figure -5. UV traditional treatment:

With the use of traditional UV, it is possible that inactivation of microorganisms by action of UV light produces a recombinant effect lowering its effectiveness in disinfection. In addition, factors such as turbidity, TSS or organic material content, could decrease the disinfection effectiveness making that, in most of the cases, was zero. This is a good equipment for disinfection of clean and filtered water. Big installations are difficult and expensive to be maintained.

Figure -6. UV traditional treatment:

OVERVIEW: ANORA-h2o TITANIUM, THE FUTURE OF WATER TREATMENT.

TiO_2 is an abundant and available material that has been broadly studied for its numerous properties. Even though it is commonly employed as pigment in different construction and industrial components, the possibilities it can offer are much more interesting when it is combined with water and UV light.

When combined with UV light and water, TiO_2 generates highly reactive Hydroxyl Radicals. These radicals can (1) eliminate the carbon-based compounds present in the water by mineralizing them to CO_2 and H_2O and (2) remove microbiological compounds breaking its membrane and inactivating them. t

When UV light have an impact on TiO_2 surface in aqueous media, the hydroxyl radicals produced are able to break the C-C links of the organic and microbiological compounds present in water, this principle has been employed to purify water sources that contain pollutants or biological compounds that can be easily eliminated by using these oxidation properties.

Water Anora - h2o TITANIUM -based purification:

The water can be exposed to the TiO_2 in different ways but there are mainly three employed nowadays:

- Using a coating of TiO_2
- Using TiO_2 powder
- Using h2o.TITANIUM reactor

Here below are exposed the comparison between these three TiO_2-based water treatment methods:

Table 1: Water - TiO_2 exposition methods comparison

	TiO_2 Coating	**TiO_2 Powder**	**h2o.TITANIUM**
Particle shedding	Possible	Sure	No
TiO_2 periodically exam required	Yes	Yes	No
Useful life	Limited	Limited	>25 years
UV Light	Yes	Yes	Yes

Hence, the optimal water-TiO_2 exposure would be by means of a solid surface made up totally by TiO_2: h2o.TITANIUM reactor.

This h2o.TITANIUM reactor would not shed particles in the water stream and neither would require a periodically TiO_2 exam since the entire duct would be 100% TiO_2-based. In addition, h2o.TITANIUM reactor has a useful life for more than 25 years.

As mentioned in Table 1, this would result in a water-reactor with a very high useful life with no maintenance required (apart of that required for changing the UV lamps) and optimal performances.

h2o.TITANIUM

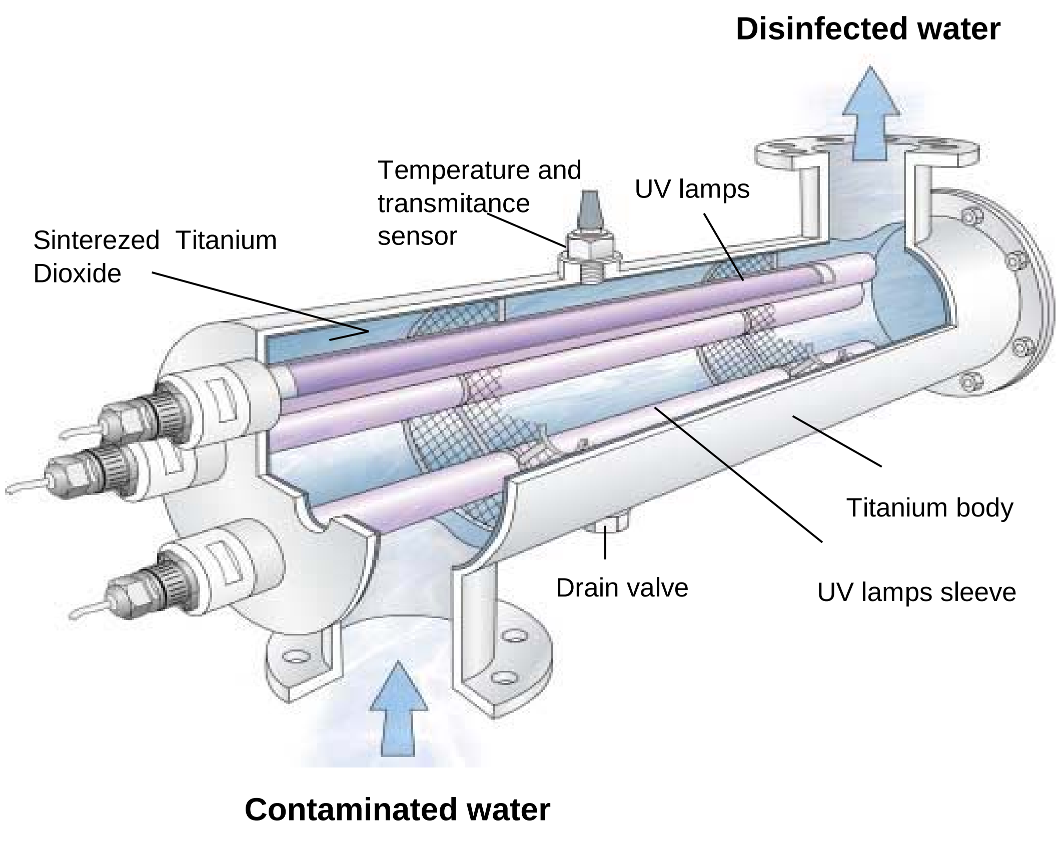
The current project presents h2o.TITANIUM, a unique reactor made up exclusively by one-piece block TiO_2.

ANORA AmbientCare develops h2o.TITANIUM, an entire-TiO_2 reactor with UV lamps inside, that generates hydroxyl radicals making **the most efficient and safe photocatalytic reaction in the market nowadays**.

<u>ANORA Ambientcare is the only world company able to produce this h2o.TITANIUM reactor</u>.

As mentioned before, the system works generating large amounts of hydroxyl radicals (•OH): when ultraviolet light hits a titanium dioxide (TiO2) surface it causes the excitement of an electron (e-) in the molecule's valence shell, which at the end of a series of chemical reactions eventually leads to the rupturing of a huge quantity of water molecules causing the formation, in large concentrations, of the hydroxyl radicals (•OH).

The photocatalytic effect occurs only inside the h2o.TITANIUM equipment's, since the life of the hydroxyl radicals (•OH) lasts nanoseconds, but, as we say later, they react many times faster than, for example, the ozone (O3). In fact, from 106 to 109 times!



Why is it so effective?

Hydroxyl radicals are the second most oxidizing molecule found in nature, second only to fluorine (F) with a redox potential of more than two hundred per cent (200%) that of chlorine (Cl). Therefore, an extremely intense oxidation process occurs inside the reactor. Viruses, bacteria, and other pathogens found in the water are rendered inactive faster and more effectively than with any other system existing today.

Oxidizing Molecule	**eV**
F_2	2,87
•OH	2,80
O ($_1$D)	2,42
O_3	2,07
H_2O_2	1,78
MnO_4^-	1,67
HOCl	1,48
NH_2Cl	1,40
CL_2	1,36
HOBr	1,33
O_2	1,23
Br_2	1,07
ClO_2^-	0,95

The life of the hydroxyl radicals (•OH) lasts nanoseconds, but they react many times faster than, for example, the ozone (O3). In fact, from 10^6 to 10^9 times!

	•OH	**O_3**
Alquenos Clorados	10^9 - 10^{11}	10^{-1} – 10^3
Fenoles	10^9 - 10^{10}	10^3
Aromáticos	10^8 - 10^{10}	10^0 – 10^2
Cetonas	10^9 - 10^{10}	10^0
Alcohol	10^8 – 10^9	10^{-2} – 10^0
Alcanos	10^6 – 10^9	10^{-2}

What is its disinfecting capacity?

The level of water disinfection obtained is 99.99% for all pathogens, depending only on the incoming water quality. And not only are pathogens destroyed, but also the undesired organic molecules.

Which are our competitors nowadays?

There are three (3) technologies available on the market that do not use chemicals to disinfect water. We don't consider in this comparative:

(1) Reverse osmosis because the investment and the operating and maintenance costs in the industrial sector are the most expensive in the market, but, by the other hand, these type of equipment remove, not only microorganisms in water, but also all pollutants contained on it.

(2) Chemicals, like chlorine, because they are the cheapest solution (being an expense, not an investment), but the less sustainable and the most dangerous solution for people, animals and plants.

- **h2o.TITANIUM:** It is based in the production of highly oxidizing hydroxyl radicals by incidence of ultraviolet radiation at 254 nm on the inner reactor surface made entirely of sintered titanium dioxide.
- **Traditional UV:** It is based on the germicidal effect of UV radiation at 254 nm, that only acting directly on microorganisms, is able to inactivate these.
- **Ozone:** It is based on the generation of O3, compound with high oxidizing power, either from the air itself (lower generation) or from the forced injection of O2 (higher generation).

SPECIAL CONSIDERATIONS AND FACTORS	h2o.TITANIUM	UV TRADITIONAL	OZONE
PH changes	Does not affect	Does not affect	Low effect
High turbidity or TSS	Does not affect	Makes it ineffective	More demand of O3
Temperature decrease	Does not affect	Does not affect	Reduces efficency
Ammonia and organic products	Does not affect	Makes it ineffective	More demand of O3
Health Effects	None	None	None < limit
Effects on taste and smell	Improvement	None	Improvement
Undesirable byproducts	None	None	Bromates and aldehydes
pH requirements	4.5<pH<10.5	None	6<pH<9.5
Turbidity requirements	None	< 1 UTN	< 1 UTN
Temperature requirements	0 ºC – 60 ºC	0 ºC – 60 ºC	Better high temperature
Introduced substances	None	None	O3, oxigen or air
Effect on microorganisms	Death	Can be reactivated	Regrowth possibility
Installation and maintenance	Easy	Moderate	Complicate

Civil work	No	High flows	Ocassionally
Space requirements	Small	Medium	Big

One of the main attractive features of this technology, a part of the quality obtained, is the low operating costs required even in big water flow treatments.

1. **<u>When we have to treat high flows of water (50 m3/h or more)</u>** the h2o.TITANIUM technology is the most competitive of the market. It is an 86% and 55% cheaper than traditional ozone and UV, respectively.

2. **<u>When we have to treat small flows of water (up to 20 m3/h)</u>** traditional UV technology is the most competitive of the market. It is 25% cheaper than h2o.TITANIUM, but it is only effective for disinfect, and only for disinfect, water of quality (clean, transparent, low in TSS, etc.) and does not eliminate odors, no color, no pollution, no organic matter, etc. as ozone and h2o.TITANIUM can make.

The different h2o.TITANIUM reactors on the market are listed below together with their corresponding energy consumption:

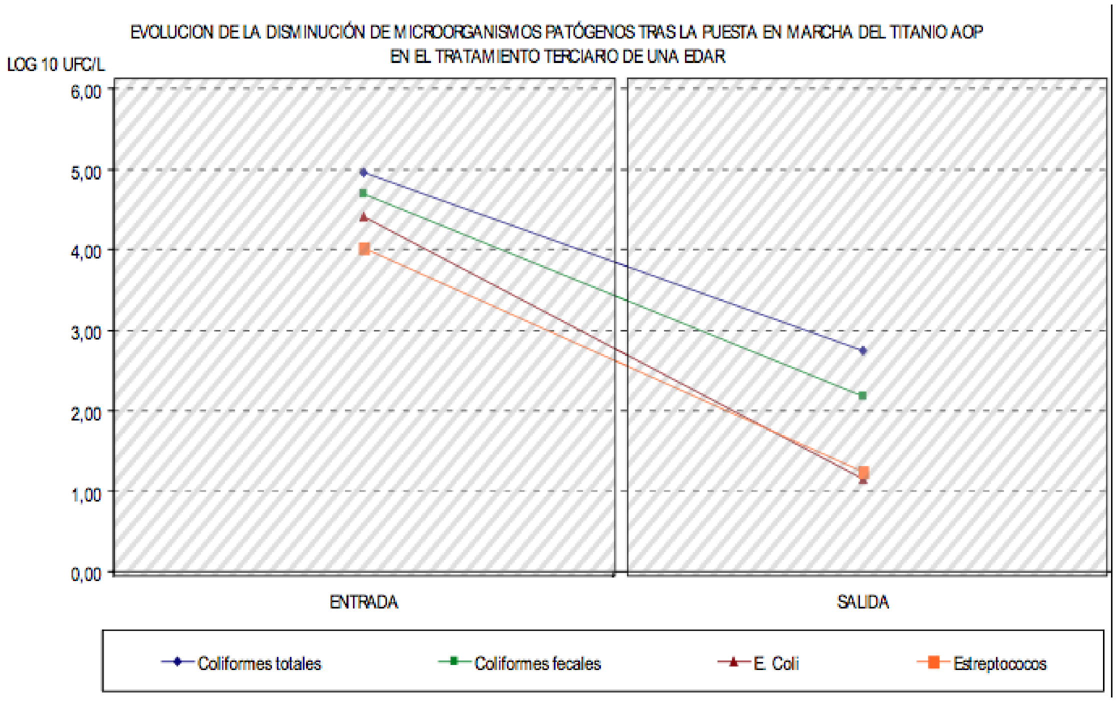
Model	Min flow (m3/h)	Máx flow (m3/h)	Comsumption (w)	Drop pressure (bar)	Voltage (V)
AOP 1	0,4	5	26	< 0,1	230 or 120
AOP 3	1	15	100	< 0,1	230 or 120
AOP 5	2	25	120	< 0,1	230 or 120
AOP 10	4	50	200	< 0,1	230 or 120
AOP 20	8	100	380	< 0,1	230 or 120
AOP 50	20	225	700	< 0,1	230 or 120
AOP 100	40	500	1.300	< 0,1	230 or 120
AOP 200	80	1.000	2.700	< 0,1	230 or 120
AOP 300	120	1.500	3.200	< 0,1	230 or 120

AOP 400	160	2.000	4.600	< 0,1	230 or 120
AOP 500	200	2.500	5.300	< 0,1	230 or 120
AOP 600	240	3.000	6.100	< 0,1	230 or 120
AOP 700	280	3.500	7.000	< 0,1	230 or 120
AOP 800	320	4.000	8.900	< 0,1	230 or 120
AOP 900	360	4.500	10.200	< 0,1	230 or 120
AOP 1.000	400	5.000	11.200	< 0,1	230 or 120

Results obtained:

Depending on the in-coming water quality and the number of cycles, the results h2o.TITANIUM are able to obtain are the next:

- Three (3) logarithmic units of microbiological reduction for each time the water pass thorough the reactor.
- 99.99% of microorganisms' removal.
- Elimination of the biofilm created.
- Odor and colour of water reduction.
- Reduction of the flocculants and other chemicals expenses.
- COD and BOD5 reduction.
- Prevention of microorganisms corrosion



Graph 1 - Microorganism concentration decrease

Applications of h2o.TITANIUM

There are different applications for this process, but there are mainly two that are currently being economically exploited:

1. ***Industrial water treatment and purification:***

h2o.TITANIUM reactors can successfully treat every kind of water streams (industrial, drinkable, salad, etc.) improving its quality and avoiding other systems employed like water chlorination.

Main industrial sectors:

Drinkable water industry, town-areas supply, camps	Food Industry:
Water purification industry;	Cooling towers
Nuclear power plants	Automotive industry; cataphoresis painting process.
Beverage industry	Aquariums
Farm fish industry	Swimming pools and pools
Spas and wellness	Textil industry
Paper manufacturing industry	

2. Water purification for human consumption:

By coupling different filters together with the h2o.TITANIUM reactor it is possible to purify completely a certain water source, being then suitable for its consumption, depending always of the raw water quality.

This purification layout is much cheaper (filters suppose less than €150 per year) and effective than its market competitors like reverse osmosis, and has negligible maintenance costs and requires no maintenance-attention to guarantee its optimal performance.

Main water purification for human consumption layout:

Figure -7 Main human consumption purification station

His purification method is being widely recommended because of the technical characteristics listed below:

SOLUTIONS	HOUSEHOLD	*h2o.TITANIUM®_UPA*	INDUSTRIALS
Size	Small	Small	Very big
Design	Sophysticated	Industrial but with stylish	Industrial
Safe water consumption	Only one tap	For a whole house	For a whole house
Installation and maintenance	Simple	Simple	Specialised personnel needed.
Final price	Very cheap	Very cheap	Very expensive
Production flow	8 – 100 Litres/day	12.000 - 24.000 Litres/day	720 – 30.000 Litres/day
Water quality	It depends on the quality of the materials	Purified (even potable depending of the initial quality of the water)	Osmotized water
Salts adition	Essential	NO requested	Essential
Descontamination	Reverse osmosis	Sintered Titanium Dioxide + Filtration	Reverse osmosis
By products	Between 1-4 liters per produced liter	None (0%)	20%-85%

Table 2: Comparison between the different market home-water-purifying alternatives

For the same water flow purified, a Reverse Osmosis system tends to be 5 to 10 times more expensive than an h2o.TITANIUM_UPA proposed whereas a common domestic treatment presents more restrictions regarding the amount of components it can eliminate giving also a very low water flow purified.

S.W.O.T

Strengths:

- Strong system with low maintenance (and not qualified) required.
- Low costs per flow treated compared to the market alternatives for home water treatments.
- High flow purified.

Opportunities:

- Big populations with access to low quality water sources and forced to buy bottled water for home consumption.
- Isolated populations with few water-distribution infrastructures.
- Hotels, hospitals, private houses, etc.

<u>**ANORA - h2o TITANIUM FOUNTAIN**</u>

	**COMPACT PURIFIER UNIT** Housing / Hospitals /Schools/ Villages **500 l/hour connect directly** to water line building /building pipes / hole pumping pipe. FILTERING **1 FILTER FOR µSOLIDS** **1 FILTER FOR KDF PESTICIDES** **1 FILTER CARBON ACTIVE** **1.500 persons /day at a 5 litre/day per person ratio.**	**PRICE**
	NUMBER REACTORS : **1 h2O TITANIUM x 500 litres/hour** **1.500 persons /day at a 5 litre/day per person ratio.**	**unit/5.000€** **+** **LOGISTICS 35 €(200 units in a container)** **+** **CUSTOMS ¿?**

INSTALLATION of ANORA h2o TITANIUM FOUNTAIN. MAINTENANCE

Any of the exposed units is ready for quick installation as the system is compact constructed.

No engineer is needed for installation and start purifying, nor maintenance, but a simple plumber and electrician to connect the pipes and the plug for 20 watts minimum to 350 watts maximum (depending on the model).

No special device power supply is needed; only a domestic cable.

The unit can be connected directly to any water network or to water well pipe or to water intake of a river. In case water well or river contains too much detritus or turbidity will be needed a simple previous water-thinning solids filtering.

Maintenance once a year is needed for changing the lamps. Price of lamps are minimum: less than 50 $/unit and any electrician/plumber can operate it.

Maintenance of filters is needed when pressure device indicates for changing. Price of filters are minimum, less than 50 $/unit and any plumber/electrician can operate it.

OUR CLIENTS

Our H2o Titanium reactors for purifying water has been installed in different facilities of the following clients:

- **Spanish Ministry of Foreign Affairs. Ambassade in Kinshasa. One Unit.**
- **Spanish Ministry of Health. Generalitat Valenciana. Two units Hospital La Fe.**
- **Spanish Ministry of Health. Junta de Extremadura. Thirteen units different Hospitals.**
- **Democratic Republic of Congo. Ministry of Defence. One hundred units for the army.**
- **Kingdom of Sweden. 45 units in particular properties.**
- **Government of Health Colombia. Two big units for 4.000 m3/hour for supply water from river to town.**
- **Norway, Germany and Spain more than one hundred units in food industry.**