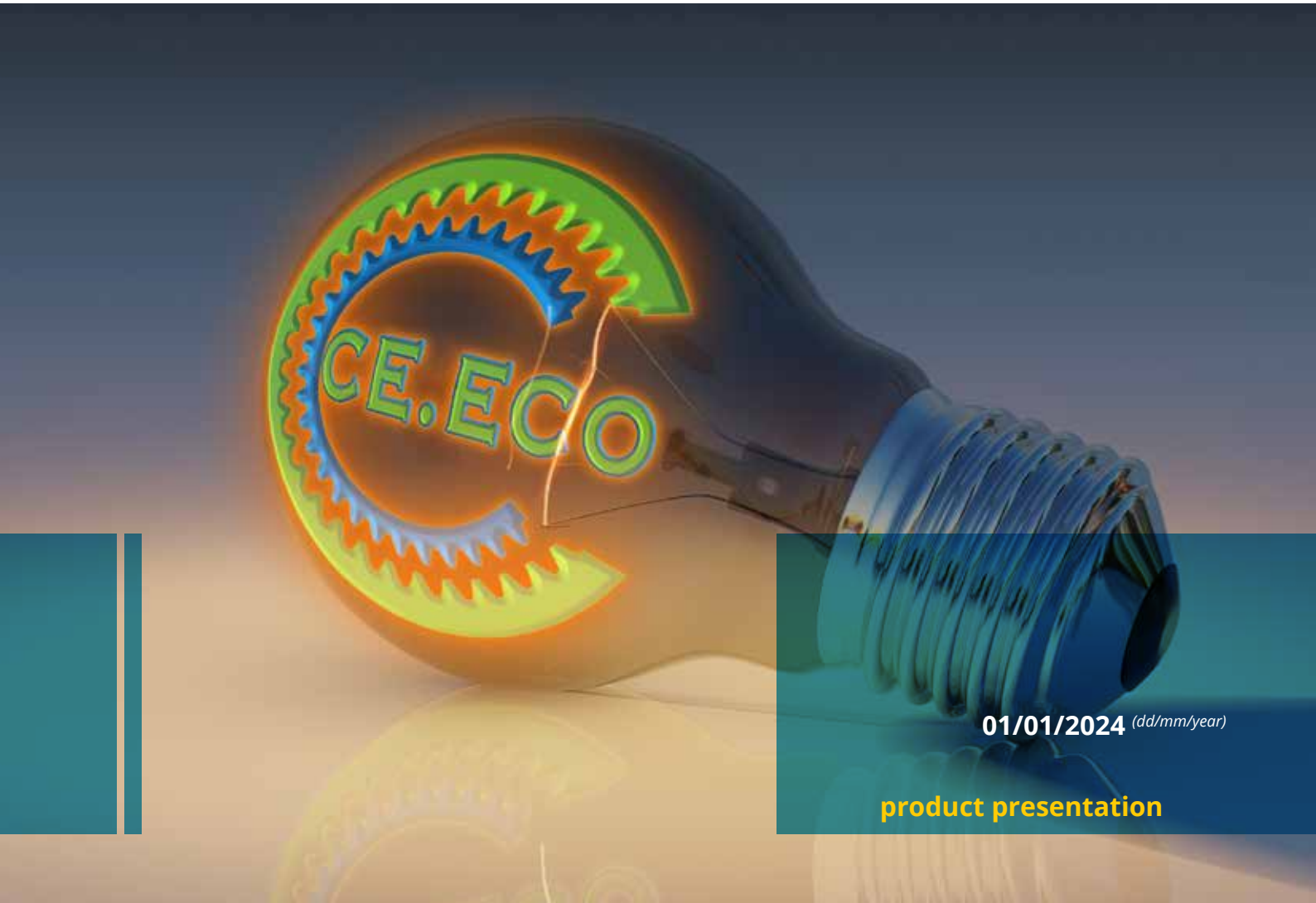
www.ce.eco
info@ce.eco

EMPOWERING DEVICE

INDUSTRIAL WASTE WATER

how to transform a ban on waste disposal into a tempting profit opportunity, with an eye to the environment



01/01/2024 *(dd/mm/year)*

product presentation

something about us

We study and develop, on industrial-scale, systems capable of transforming the causes of pollution into a source of wealth.
Our patents range from the denaturation of asbestos to the treatment of almost every type of waste, from water purification to the production of aluminum without waste.
What's the point of devastating the environment around us to collect a few crumbs of resources when we can use our technologies to live great and achieve anything in a sustainable way?

Smartly sustainability

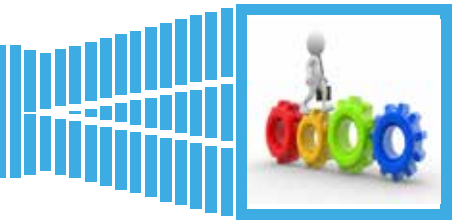
Mission:

- Social progress
- Clean environment
- Wealth production
- Sustainable Development

Our goal

Since we don't have a second home were to go, we need to make our planet more livable without stopping technological development!
Our goal is to make our planet more livable without stopping development.
For this reason we have developed industrial systems that transform the causes of pollution into an immediately usable source of opportunities: low-priced raw materials ready to be reused through further sustainable processes.
Let's protect nature without stopping progress!

index



According to UN-Water, global water use has increased by twice as much as population growth over the last century. Therefore the need to conserve this precious resource is becoming increasingly imperative.

Among the objectives of the 2030 Agenda for Sustainable Development, approved in 2016 by the United Nations Assembly, there is that of “improving water quality and reducing pollution, eliminating discharges, minimizing the release of chemicals and hazardous materials, halving the proportion of untreated wastewater and increasing healthy global recycling and reuse by 2030.”

In the face of the growing global water crisis, it is now increasingly imperative to try to conserve this precious resource.

The 2015 World Economic Forum report also highlighted the global water crisis as the greatest threat our planet will face in the coming years.

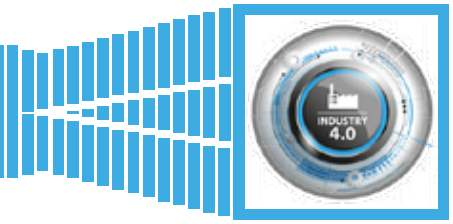
From droughts in the world’s most productive agricultural regions to billions of people unable to access safe water sources, the water crisis is set to hit people and economies in both developed and developing countries .

It has therefore become imperative to reduce the water requirement in production processes and allow efficient not so much recycling but reuse of water

Therefore, it is now up to industry and commercial activities to make the correct investments that allow them to become “water neutral”, but at the same time transforming an expensive process of dutiful - sometimes obligatory - transition into an opportunity to reduce costs by increasing revenues.

Not always adapting to ecological needs must necessarily turn into an economic remittance for business.

who we are...



We born close to the COVID pandemic. We immediately became a meeting point for numerous professionals, research institutions and production companies. All this started in Italy and is now spreading to other countries.

Often our projects precede the times of several years.

Our proprietary technology is totally innovative **but consolidated** and is essentially based on: cavitation, gasification and Coanda effect.

After having implemented and made the above more effective, we have adapted it to everyday life by creating complete processes whose application increases both the quantity and quality of the products obtained, decreasing energy requirements but paying great attention to the creation of a greater number of jobs compared to those eliminated by mechanization.

In addition to the real innovations, we are specialized in engineering and then applying improvements of technologies, mature in their field, to other areas often obtaining, this way, several real technological leaps simply because we had the courage to do what was before under everyone's eyes but no one dared to put it into practice.

We develop technology both independently and in collaboration with Universities (Sassari, Perugia, Amsterdam, Algarve, etc.) or with other public institutions (for example the National Research Center - CNR, Fundación Circe etc.).

We boast a vast proprietary product portfolio with several pilots viewable, by appointment, and several completely innovative process lines.

Some of our products have been defined extremely innovative and promising at international events by panels composed of scientists from all over the world. Our technology and our demo site have been deemed valid and usable in several Horizon Europe projects.

Our patents and innovations have made us immediately designate as members of technology suppliers within the Italian Biogas Consortium.

We have a framework agreement with RINA Consulting - Centro Sviluppo Materiali S.p.A. which allows us to request their supervision and therefore also to certify the production and engineering phase of our products wherever we choose to produce them. Therefore, choosing us also gives access to all the wealth of experience and technology gained in over 70 years by Centro Sviluppo Materiali which, I remember to everyone, was since its establishing the research and development department of IRI (Institute for Italian Industrial Reconstruction, among the top 10 companies in the world by turnover up to 1992).

Numerous specialized industrial plants, centres of excellence on their specific sectors, have made the production slots we need available to us; we are equipping ourselves with proprietary factories to carry out final assembly and to start specific productions.

We are present with companies in numerous European countries. We are opening companies in several African countries and in Asia. We have projects underway in various European, African and Asian countries. Our international staff represents our essence: motivated people with a wealth of personal experience who believe in what they are doing and who come from many different countries. In every nation in which we appear we respect local customs and traditions, bringing a bit of Italianness to the place and "*stealing*" part of their culture to ensure that no one is a ***Stranger in a Strange Land***.

Dr Bruno Vaccari

… and what we do

- BIOZIMMI
- EMPOWERING DEVICE
- ZEB
- BIODIGESTERS
- FROM HEAT TO ENERGY
- THERMOELECTRIC PANELS
- ASBESTOS DENATURATION
- GASIFICATION & PLASMA
- INERTIFICATION
- WEEE
- UREA & AMMONIA
- FOOD PROCESSES
- HOSPITAL EQUIPMENT
- SOIL WASHING
- WATER TREATMENT
- WTE & WTC
- DESALINIZATION

OUR MAIN GOAL: environment and workers' conditions respect

our core team

Bruno Vaccari

CEO

Sabrina Saccomanni

Lawyer

Fabrizio Di Gennaro

CMO

Antonio Demarcus

CTO

Paolo Guastalvino

Civil works

Gianni Deveronico

Lead electrical engineers

Jennifer Martinel

Accounting

Massimiliano Magni

Engineering

Antonio Piserchia

Communications Expert

Barbara Spelta

Lab

Papa Ndiamé Sylla

COO Senegal

Noel Sciberras

COO Malta

Appiah Fofie Kwasi

COO Ghana

Eugen Raducanu

COO Romania

Awa Khady Ndiaye Grenier

COO Guiné-Bissau

Giorgio Masserini

Marketing

Pantaleo Pedone

Italian energy-intensive

Gianluca Baroni

Hospital Stuff

Stefano Diambu Nkazi

Marketing

Sarr Alioune Badara

Marketing

Jérémie Saltokod

CCIMRDC Italie

EMPOWERING DEVICE

EMPOWERING DEVICE has been fully conceived, developed and implemented by our team and is able to simultaneously manage different types of controlled cavitation, of which 5 of a different nature but which coexist harmoniously to the point that no significant vibrations are detected.
The summation of the effects produced by each cavitation further implements the efficiency of the chemical, physical and biological processes that take place within the apparatus, resulting in a subsequent cut in the already low energy consumption as well as a sharp reduction in processing times.
A prototype with a special set-up, prepared for experimentation and of 1:1 size, has been used by us since the beginning of 2017 to conduct the required tests on the samples of materials brought by our customers.
Our machinery is equipped with test certificates and international operating certifications with different types of liquids on different chemical, physical and biological processes.
What makes our system, today, unique compared to what the market offers in the field of controlled cavitation is the fact that although it is already extremely difficult to control a cavitation, in our system there are controlled cavitation's numerous and of different kinds, at least one of which is sonic.
The machine body has an element, with the functions of a static mixer, called by us "Il Cedro" (the Cedar) for the peculiar conformation of the "leaves" that make up its design.

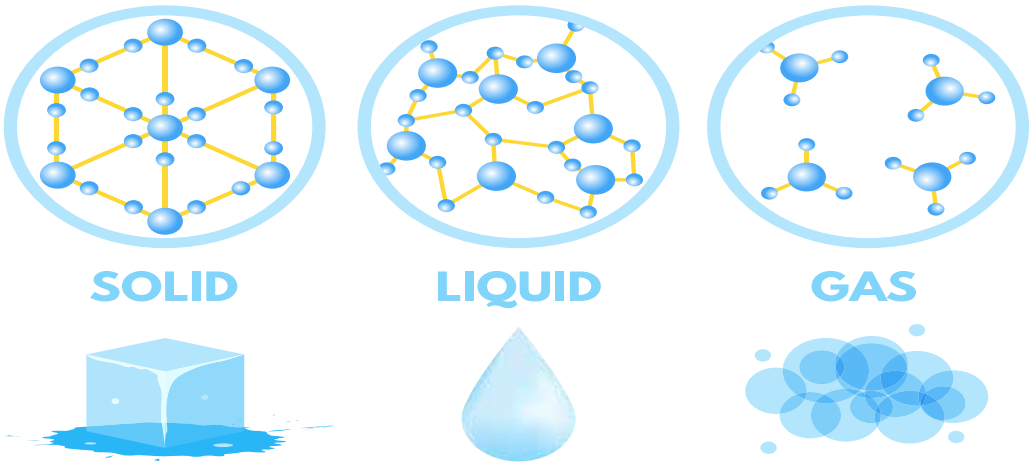
This special monobloc mixer, in the presence of processes that involve the formation of crystalline chemical elements, has the ability to favor the formation of Crystallization Germs, with further acceleration of chemical reactions.
Another significant improvement compared to what has existed so far is represented by the evident lower pressure drops compared to machines equipped with motors of similar installed power, with a sensible and consequent energy savings during operation: the **EMPOWERING DEVICE** requires only a fraction of the electrical energy used by the other cavitators.
This is due to the fact that the machine body of the **EMPOWERING DEVICE** is structured to form a true "diffuser", with the consequent recovery of a percentage of the outlet

pressure.
Furthermore, it has been designed to be easily and quickly reconfigured according to the use: some of its parts can be removed if very dense and / or viscous liquids have to be treated and / or with extensive granularity or they can be added, inlet or outlet, accessory elements suitable for almost any use.
Moreover, in the presence of organic matter, cavitation leads to the consequent partial physical destructuring, a lysis of the cell walls and the consequent release of the intracellular content.
This action translates into a greater availability of cellular juices, an acceleration of hydrolysis processes and, consequently, an acceleration of the anaerobic digestion process as a whole.
In our cavitator, based on experiments conducted and certified by third parties, the rate of bacterial degradation can accelerate from 4/5 times to over 10 times compared to conventional treatments.
The certifications performed by the Rina Group show that the COD of the waste water from a gasifier is reduced by 90% in just 15 minutes.
By using the supplied inverter system, at the start, consumption is less than the 25kWh of rated installed power, similarly during full use; in the absence of an inverter, at least 36kWh would be required to start.
The standard version can treat up to 60 cubic meters of fluid per hour.
Compactness, simplicity of installation and use, are undoubtedly some of the peculiarities of our cavitation apparatus but it is the total flexibility of use that makes it unique.

SAMPLE	COD mg/L
AS IS material	15.380
after cavitation material	1.508
COD reduction percentuage	90,2%

water & cavitation

Water has the ability to convey many substances thanks to its particular chemical and physical properties: very high solvent power, high chemical reactivity and considerable specific heat. Moreover, its molecular capacity, two hydrogen atoms bound to an oxygen atom, allows it to behave like a crystal: not only in the solid state (ice) but also in the liquid state.



Cavitation applied to water acts mainly on this characteristic.
Through the violent implosion of the bubbles, it causes the release of nascent oxygen, allows the elimination of viruses and bacteria present; furthermore, it supports the magnetic conversion of calcite (responsible for the formation of scale) insoluble in soluble aragonite and not able to aggregate in the formation of limestone.
Finally, since the molecular structure of water is not uniform, the distance between the molecules is never the same, nor is the reciprocal attraction force; there are therefore areas or points of emptiness or pockets of gas (oxygen, nitrogen) and foreign bodies, sometimes not totally wet.
As the pressure decreases, the air pockets expand, the liquid evaporates and the steam fills them. The subsequent phase of implosion violates the oxygen, which can thus exert all its oxidative action on the surrounding organic substrate, mimicking the action of hydrogen peroxide.
Another fundamental aspect of cavitation with respect to all other water purification and filtering treatments consists in the fact that with cavitation they are the same water molecules that, after the implosion phase, assume a homogeneous crystalline configuration, which gives the water the original characteristics of the formation from the source.
Therefore, unlike the other treatments applicable to water, nothing is added or removed, such as ion exchange resins for inserting and subtracting ions or magnetic filtering to subtract iron, but on the contrary it is amplified and enhances the natural ability of water to biodegrade and break down pathogens by oxidation.
Furthermore, our equipment also includes an ozonator that further enhances the oxidation of any pollutants present.

how did we get there...

After the prototype phase, which lasted several years, we started carrying out the first field tests with customers using the specimens of the first industrial line in test configuration. In this way we counted on being able to draw inspiration and also benefit from the practical experience gained over the years by the operators of traditional plants.
During a series of tests conducted at customers' premises, we realized that the **EMPOWERING DEVICE** could find application in practical cases that were absolutely unthought of either during the design or even less during the tests: in other words, its potential for application went beyond the situations in which had to apply only the phenomenon of cavitation.
We thought we had been meticulous in selecting and describing the various conceivable applications but during the practical tests we realized, almost suddenly, the real extent of the **EMPOWERING DEVICE**.
To set up the test parameters, we initially based ourselves on the results and then on the settings obtained during the experimental phase carried out with the prototype, also taking into account that the test machines of the first industrial line, at least on paper, would have been around twice as powerful as the prototype. In the light of the facts, compared to the prototype, the power of the machines of the first line proved to be clearly superior and consequently most of the forecast calculations made in the laboratory and in view of the tests proved to be outdated right from the start.

All the initial tests were carried out blindly as we never saw in advance the analyzes of the matrices used for them.
In the **first industrial waste treatment center**, taken by enthusiasm, we thought it appropriate to try as many matrices as possible, always using the same setting.
The fact that the machine was more powerful than expected led us to subject the wastewater to too long cavitation cycles which ended up triggering other unwanted chemical reactions and therefore did not focus on the cavitation *momentum*: the

moment in which the best treatment results on a given wastewater, using a given configuration and with the lowest possible energy consumption.
In the **second industrial waste treatment centre**, having found that the results obtained in the first center had not been as brilliant as we expected, despite the fact that the machinery had proved to be extremely more powerful than estimated, we reduced the number of wastes to be tested, carrying out this time on each of them two tests of progressive duration. An inconclusive choice, but one that took another step forward.
The tests conducted on organic-based liquids continued to return decidedly positive results, with percentage variations compared to the as-is, even almost in the 4-digit range.
The turning point for the development was reached during a test of disposal liquids at a **private purifier**, but always non-organic based, and exceeded during the tests carried out in a **third industrial waste treatment center** where, by now also aware of the actual potential of the device, the tests were conducted on a single wastewater but taking a sample during the test at the end of the times set in the "recipes" programming. The same test was also repeated at different engine revolutions and adding, or not, ozone. All to have the maximum spectrum of obtainable data.
During this last test battery, a huge quantity of surfactants were isolated and suspended which in reality should not have been present: a sign that the machine had excellently isolated the first component to be eliminated for the subsequent treatment. Even the coloration of the treated wastewater, after just a few seconds, was extremely clarified.
What we still lacked was understanding the best process management dynamics and related accessories to be applied to complete the process itself.
We have finally understood that the **EMPOWERING DEVICE** does not find its best application if it is simply considered as a cavitator to be added to an already existing process but expresses its maximum when it itself forms the basis for a new, faster and more perfor-

ming Working process.
Therefore, the first tests on non-organic fluids had gone significantly different from what we expected, not because the machine hadn't worked but precisely because of its perfect functioning: the parameters of the liquid that everyone expected should undergo the first action of the **EMPOWERING DEVICE**, given their inorganic nature, could not actually be treated until other values had been "normalised" such as, by way of example only, the total suspended solids.
The **EMPOWERING DEVICE** therefore functioned, depending on the case, as a flotation unit and particle micronizer, coagulating very small suspended solids, facilitating their subsequent filtration, allowing clarification of the wastewater and thus making subsequent chemical-physical treatments much easier. Other times, however, it has homogenized inhomogeneous waste as best as possible, favoring the subsequent chemical attack carried out with reagents also used for traditional industrial purification but, in this case, consuming only a fraction of the energy required with traditional systems due to the shorter times and smaller spaces.
We were already well aware that the constructive geometry of the **EMPOWERING DEVICE** made it a perfect pressure diffuser, thus reducing energy consumption. After the tests we realized that the constructive geometry also makes it an excellent mixing system in which even the non-organic elements present in the liquid can be treated with extremely reduced energy consumption and times compared to traditional systems, therefore a valid alternative to large tanks of current systems.
Thanks to the tests carried out, we have therefore identified the *momentum*, i.e. the "ideal point" of cavitation, of numerous fluids and, also in this case, we have realized that in many cases the fluids could even be treated in "direct drive", therefore without executing processing cycles but simply entering and exiting the **EMPOWERING DEVICE**.

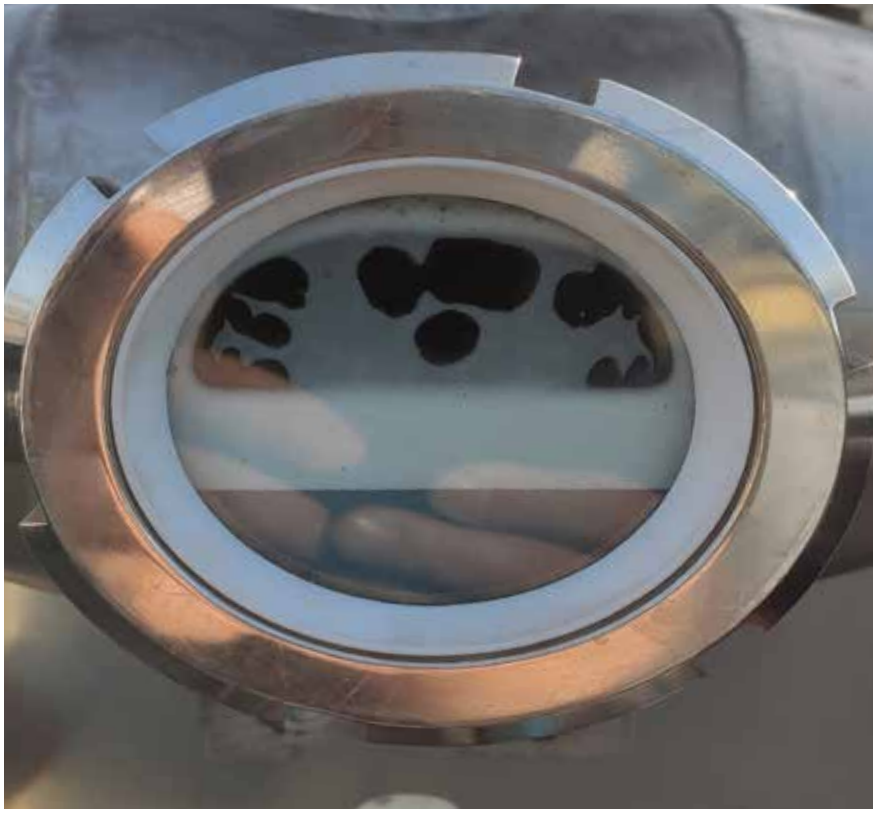
effects on inorganic wastewater

It is known that cavitation allows excellent results to be obtained especially if applied in the presence of organic material as by demolishing the molecules it reduces both the **COD** and **BOD** values. This happens mainly due to the fact that the physical phenomenon of cavitation enhances, even exponentially multiplying, completely natural physical-chemical processes including oxidation.

While the tests conducted with the **EMPOWERING DEVICE** on organic-based liquids immediately returned decidedly positive results, **with percentage variations with respect to such as, sometimes even up to almost 4 figures obtained in a very short time**, those conducted with industrial wastewater required a weighted and accurate setup of the machinery in order to set the best process management dynamics and the related accessories to be applied to complete the process itself.

All this became necessary because the tests on non-organic fluids had gone differently than expected, not because the machine hadn't worked but precisely because of its perfect functioning: the parameters of the liquid that were expected should undergo the first The action of the **EMPOWERING DEVICE**, given their inorganic nature, could not actually be treated until other values had been "normalised" such as, by way of example only, the total suspended solids.

With industrial waters the **EMPOWERING DEVICE** does not find its best application simply in addition to an existing process but manages to express its maximum when it itself forms the basis for a new, faster and more performing continuous processing process . In these applications, the **EMPOWERING DEVICE** acts, depending on the case, as a flotation device and particle micronizer, coagulating very small suspended solids, facilitating their subsequent filtration, allowing clarification of the wastewater and therefore making subsequent chemical-physical treatments much easier. Just as it can best homogenize inhomogeneous waste, favoring the subsequent chemical attack through the same reagents also used for traditional industrial purification but consuming only a fraction of the energy required with traditional systems.



The constructive geometry of the **EMPOWERING DEVICE** makes it not only a perfect pressure diffuser, thus reducing energy consumption, but also an excellent mixing system.

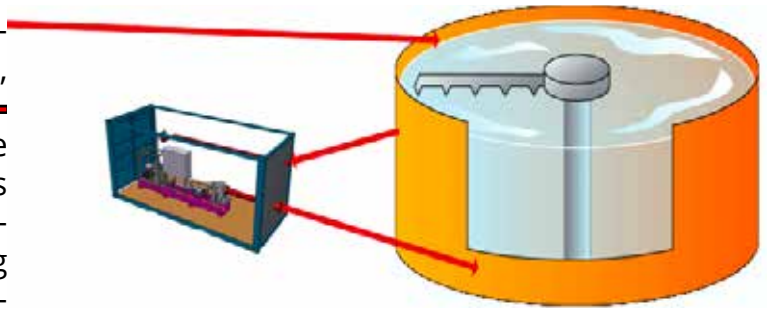
A further efficiency can be ensured by the use of successive **EMPOWERING DEVICE**, as with 2 devices in series the liquid can undergo a first treatment at low revolutions, a filtration, an additive while it is treated at a high number of revolutions in the second machine for then be further filtered thus obtaining, in most cases, a workflow without downtime.
The variety of traditional treatment of non-organic industrial wastewater is very vast, therefore the purification approach is almost always to be studied on a case-by-case basis. What all treatments have in common is that energy consumption, especially electricity, is very high, because they are subjected to numerous energy-intensive treatments, among which the major ones are:

- ➔ the neutralization of the ph;
- ➔ the separation of the precipitated salts;
- ➔ crystallization;
- ➔ the drying of the crystals;
- ➔ the separation of supersaturated crystals and suspended solids or deriving from the chemical reaction of purification processes, often carried out with large centrifuges;
- ➔ the reaction with chemicals that lead to new less dangerous compounds and lower the final disposal costs, when they do not allow a complete recovery of the wastewater;
- ➔ the recovery of industrial solvents, with the use of redistillation columns, from which, however, in addition to the cleaned solvent, from the top, residual substances usually come out from the bottom and must be conveniently disposed of.

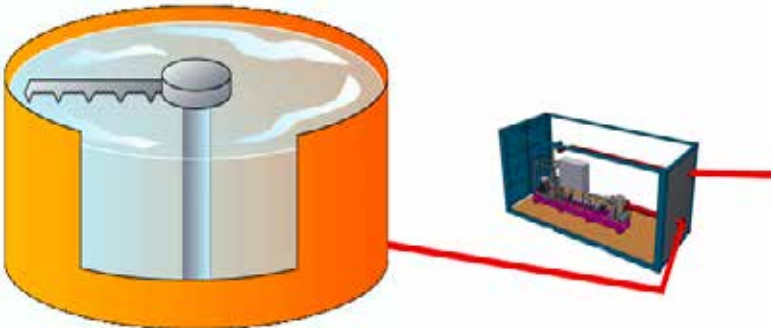
Both in the pH neutralization plant units and in those of specific chemical reactions, the **EMPOWERING DEVICE** is able to eliminate large tanks and make the chemical process continuous and fluid, because it makes it possible to add the neutralizer in line. Without the tanks that must be stirred continuously and for a long time in order not to be stratified and uneven, the pumps for sending the neutralization or reaction reactor are also eliminated, as well as the pumps for relaunching the finished product, allowing huge energy savings and compactness of the plant.
The visual impact of the system profile is thus drastically reduced by hiding it from the eyes of the neighboring inhabitants who will therefore tend to complain less about the existence of the system itself.
Knowing the characteristics of an incoming wastewater contained in a silo, even horizontal, via a fully remote-controlled PLC according to the dictates of **Industry 4.0**, a system of solenoid valves and booster pumps will lead it through one, two, three or successive steps to inside the cavitators placed in line with special filters designed to eliminate certain aspects of the wastewater to be treated in order to then add it or not with chemicals, ozone or anything else needed before being sent to a storage silo of the treaty where the wastewater, now processed and inerted, it will then be ready to be disposed of.
On the basis of the “families” of origin of the wastewater, specific recipes are set up in order to automate the process as much as possible.

how to place the ED

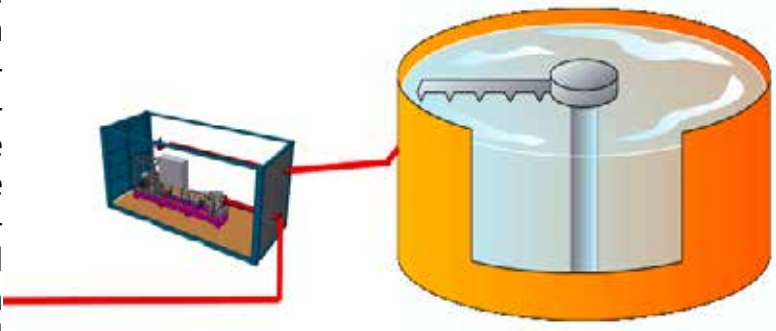
Our process accelerator, as well as constituting the fulcrum for completely innovative plants, can be placed, according to needs, at the inlet, in recirculation or at the outlet of a pre-existing tank or tank.



in recirculation: a pump sucks the liquid matrix from the treatment tank, sends it to the **EMPOWERING DEVICE** for treatment and returns it to the treatment tank through a second access pipe. With this configuration, it is possible to treat and improve the functioning of an existing plant, reducing any accumulations of fibrous fractions of the non-degraded matrix quickly enough.
PRO: Implementation costs are reduced to a minimum and existing plants can process significantly higher quantities of matrices before being scaled down or supported by further plants. This location has the disadvantage that part of the fluid will be treated several times.



at the exit of the primary treatment tank: configuration similar to the previous one, the main difference consists in treating the product only once and discharge it into a second tank where it shall receive a subsequent treatment.
PRO: In addition to maximizing the efficiency of the second tank where the matrix will receive a subsequent treatment, this location allows the inertization of the microbial charges of the matrix. This location has the disadvantage that the time used to treat the fluid in the first tank still be the same.

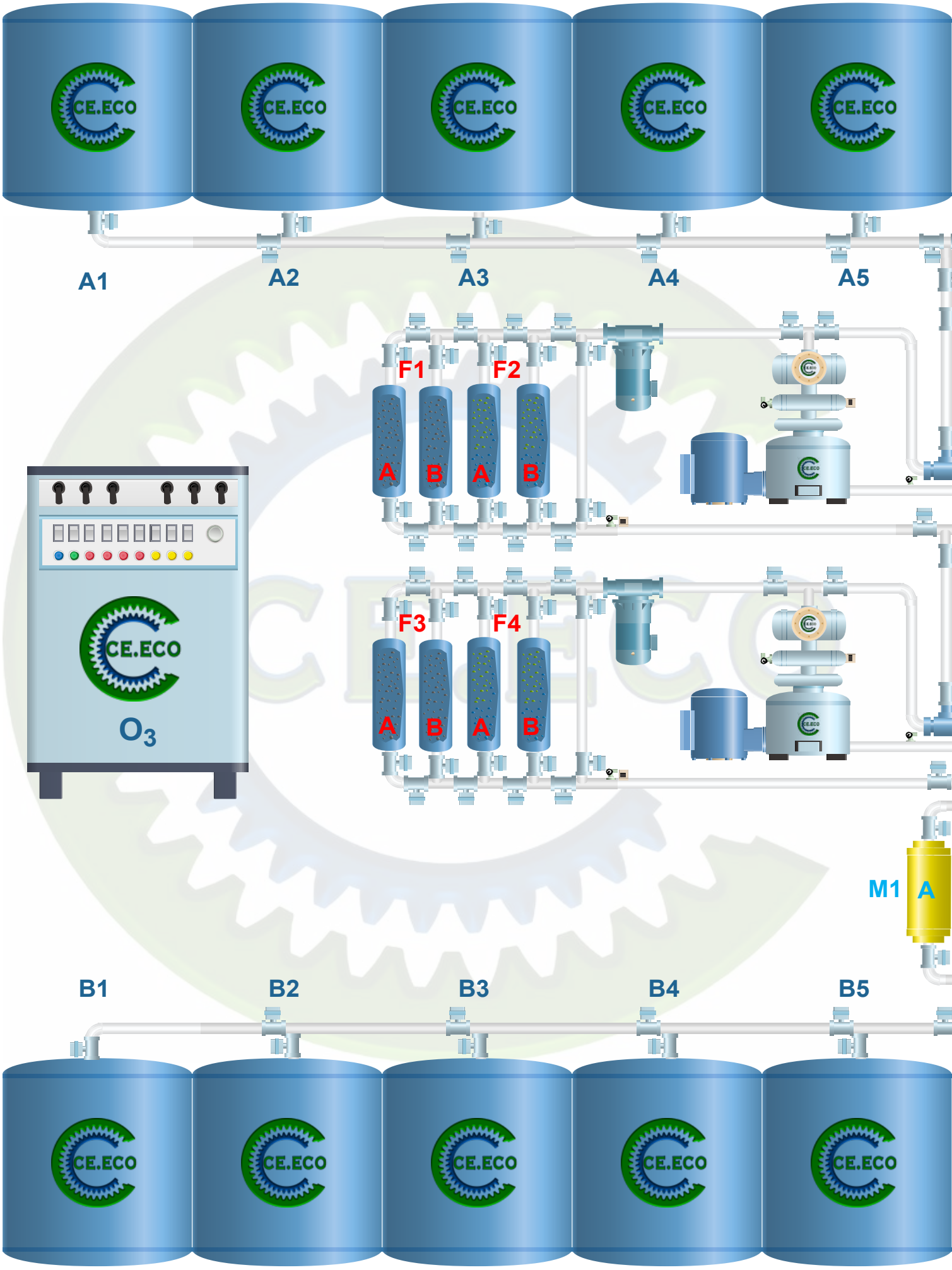


for the input matrix treatment: the matrix at the load can be mixed with a hydraulic vector and sent to the cavitator for disintegration before loading. Depending on the type of plants, the type of matrices used and the intensity of the treatment to be obtained, the technology can be applied on the whole loaded matrix or only on a part (EXAMPLE in biomasses typically those characterized by fibrous matrices and particularly complex to degrade).
PRO: In this configuration, the efficiency of the cavitator is maximized if cavitation is applied to the whole matrix. This location can bring the greatest advantages.

ED-based plant

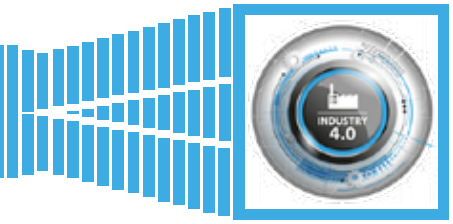
The following pages show a water treatment plant developed around a pair of **EMPOWERING DEVICE**.
The water produced by the plant or taken to a treatment center equipped with our system, after being taken from the storage silos (**A1-A10**) undergoes an initial cavitation treatment (**ED1**) with or without the addition of chemicals (**C1-C2**) and ozone (O_3).
Subsequently the fluid, re-launched if necessary with a pump, can either be filtered (**F1-F2**) or, through a bypass, continue its course.
Each filter can be duplicated in parallel (**A-B**) in such a way that if the sensors should notice a decrease in efficiency, the personnel will be immediately warned to intervene on the cartridge to be regenerated or replaced.
Based on the needs, the fluid may undergo a subsequent cavitation in the second **EMPOWERING DEVICE** (**ED2**) which will be equipped exactly like the first: pumps for chemicals (**C3-C4**), ozone (O_3), filters (**F3-F4**) duplicated in parallel (**A-B**), bypass and booster pump.
Similarly for what happens at the exit from the first **EMPOWERING DEVICE** the fluid can at this point be sent back to the first or second cavitator to undergo further treatments or, if it is now considered purified, sent directly or via osmotic membranes (**M1**) duplicated in parallel (**A-B**), towards the final storage silos (**B1-B10**). Even with the membranes, should the sensors detect a decrease in efficiency, the staff will be immediately warned to intervene on the cartridge to be regenerated or replaced.
From the definitive storage silos, after sample analysis, following the provisions and limits of the law, the water will either be discharged into the sewer or into a ditch or even reused to water the surrounding fields.

EXAMPLE: Neutralization of dirty hydrochloric acid. We start from a pH of 1-1.5. Caustic soda is then added to bring the pH to 7 and to be able to dispose of the final system, where salt (sodium chloride) and water are generated. With the **EMPOWERING DEVICE** we avoid the agitated tank of dirty HCl and sending it to the reactor because the cavitator can take it directly from the tanks. The dirt immediately spreads throughout the mass thanks to the controlled cavitation, the necessary NaOH is added in line in the same cavitator; the neutralized and homogenized wastewater from the **EMPOWERING DEVICE** can pass directly to the self-cleaning desalination membranes, which are also favored by upstream cavitation as a cavitated wastewater is able to pass the membranes with less resistance and therefore using less energy.
The same happens for the centrifuges for the separation of supersaturated salts, or of the solid components resulting from the purification processes through energy-intensive reactions: they are all fully replaceable with the **EMPOWERING DEVICE** equipped with membranes and/or filters


A1
A2
A3
A4
A5
F1
F2
A
B
A
B
F3
F4
A
B
A
B
O3
M1
A
B1
B2
B3
B4
B5


A6
A7
A8
A9
A10
C1 C2
ED1
C3 C4
ED2
B
B6
B7
B8
B9
B10
CE.ECO
ED1
ED2
A
B
F & M
C & O

What? industrial wastewater!



In the **EMPOWERING DEVICE** the recipes are preset based on the identification of the incoming wastewater and, therefore, are initially divided into the macro families of Bases and Acids and then go down in depth based on the specifications of the analyzes of the AS-IS.
Based on the input parameters, based on the pre-set recipes, the system will suggest the number of steps as well as the filters and chemicals to be used and when to use them. With the aim of obtaining clean water from industrial waste that can be reused or discharged into a ditch according to the parameters of the law.
All the piping as well as the parts of the machinery in contact with the wastewater are made of 316L steel to guarantee their durability.
In wastewater treatment centers there are extremely heterogeneous types of matrices but, having to hypothesize a plant, the choice falls on a plant versatile enough to be suitable for most wastewaters: with 3 cavitators in series we can treat up to 10 cubic meters of wastewater continuously per hour with a medium-high degree of pollution (**COD** over 30,000). If the wastewater is less polluted we will be able to bypass some passages reducing time and consumption and, in the same way, if the wastewater is even more polluted, we will be able to use additional passages in the cavitators, however going to decrease the overall yield.
It is assumed to have the storage tanks at about 10 meters from the first cavitator and the destination tanks of the treated liquid at about 15 meters from the last cavitator; with this extension the entire wastewater treatment process will last approximately 3 minutes and 18 seconds.
The operator will then proceed to enter the characteristics of the wastewater into the system.
Upon start-up, a pump will take from the storage tank set in the system the correct quantity of wastewater to be circulated to start the treatment, sending it to the first **EMPOWERING DEVICE** (cavitator 1) where it will undergo 54 seconds of cavitation at 3,000 rpm (medium cycle – 6 complete loops) with simultaneous dosing of about 0.45 grams of ozone (equivalent to 6 grams per cubic metre): in this way the wastewater will undergo a first cycle of flocculation. A booster pump will make it pass, without loss of pressure and flow rate, a first sand filter where the suspended solids and floccules will instead be retained almost completely. The sand filter is self-cleaning and in non-muddy wastewater it removes an average of 0.0004 tons of material per treated cubic meter (supposed landfill disposal cost of €0.07 per cubic meter of treated wastewater).
Once the filter has passed, the wastewater will be sent to the second **EMPOWERING DEVICE** (cavitator 2) to be subjected to a second cavitation cycle again lasting 54 seconds at 3,000 rpm (medium cycle - 6 complete loops) where, taking advantage of the strongly acidic environment 15 grams of iron sulphate per cubic meter will be added - approximately 0.015 euros - and more ozone, approximately 0.45 grams of ozone (equivalent to 6 grams per cubic meter) or a greater

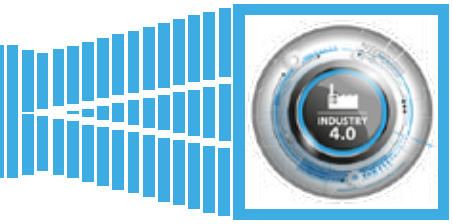
	kg	cost
sludge per treated m3	0,0005	0,090 €
iron ($FeSO_4$)	15	0,015 €
PH normalization (soda or hydrochloric acid)	2,8	1,680 €
total:		1,785 €

quantity from an external source based on the wastewater subjected to treatment, in order to obtain a Fenton reaction of hyperoxidation by which most of the polluting agents present will be eliminated.
A second booster pump will make it pass, without loss of pressure and flow rate, a second sand filter where the suspended solids and residual floccules will instead be totally retained. The sand filter is self-cleaning and in non-muddy wastewater it removes an average of 0.0001 tons of material per treated cubic meter (supposed landfill disposal cost of €0.02 per cubic meter of treated wastewater). Once the second filter has passed, it will be sent to the third **EMPOWERING DEVICE** (cavitator 3) to be subjected to a third cavitation cycle again lasting 54 seconds at 3,000 rpm (medium cycle - 6 complete loops) where soda will be introduced to make the PH and other ozone, about 0.45 grams of ozone (equivalent to 6 grams per cubic meter); to bring the PH value from 1 to 7, approximately 2.8 kg of soda are needed – or 1.68 euros per treated cubic metre.

	seconds	kW	notes
withdrawal from tank with pump	9	0,600	
first ED	54	2,640	no chemicals used
internal relaunch ED	4,5	0,000	counted in the ED
filtration	0	0,000	sand one
second ED	54	2,640	iron sulphate
internal relaunch ED	4,5	0,000	counted in the ED
filtration	0	0,000	sand one
third ED	54	2,640	soda to raise PH
internal relaunch ED	4,5	0,000	counted in the ED
filtration	0	0,000	graphene one
relaunch	4,5	0,300	
membrane	0	0,000	salt removal
relaunch	9	0,600	
destination tank	0	0,000	
	198	**9,420**	**kW per m3 treated**
		0,21 €	**kW cost**
	0:03:18	**1,98 €**	**cost per treated m3**

With the exception of more important quantities of ozone to be taken from devices external to the system and therefore not counted, the chemicals to be used and the sludge to be disposed of per cubic meter add up to around 1.78 euros per ton:
Therefore, the treatment cost per cubic meter of a medium-high level of pollution sample fluid with an **EMPOWERING DEVICE** will be approximately € 3.76 compared to more than € 15.00 for a traditional treatment system. Equally reduced is the purchase cost of the proposed system compared to a traditional system.

What? industrial laundry!



Cavitation finds an excellent field of application in the laundries: one of the activities that consumes the most water in absolute proportion to guarantee, especially in periods of health emergency, a correct level of cleaning and sterilization.
The water used by laundries is actually not extremely polluted and the purification plants which they are obliged to equip themselves with in order to be able to discharge it into the sewer system within the table limits can be replaced with devices which allow total reuse of the water, except for fraction lost by evaporation.
By subjecting unpurified water deriving from a normal process of use within an industrial laundry to cavitation, the treatment unleashes a powerful floating effect capable of increasing the total suspended solids by **953%**; this is due to the micro-jets and hydroxyl radicals which aggregate some materials present such as, for example, the fibres.
The solids, subject to flotation, separate from the liquids and, at that point, can be easily filtered, leaving the water ready for a subsequent processing cycle aimed at completing the purifi-

	AS IS		54" cavitation	difference
pH	10	>	10	0%
Electrical conductivity mS/cm at 20°C	2,16	>	2,15	0%
Total suspended solids mg/L	**95**	>	**1000**	**953%**
COD (Chemical Oxygen Demand) mg/L O_2	510	>	490	-4%
BOD5 mg/L O2	210	>	200	-5%
Total hardness °f	<10	>	<10	=
Salinity as NaCl (by calculation) mg/L NaCl	412	>	429	4%
Phosphates mg/L PO4	<0,5	>	<0,5	=
Chlorides mg/L Cl-	250	>	260	4%
Nitric nitrogen mg/L N-NO_3	1,6	>	1,7	6%
Cationic surfactants mg/L	1	>	1,4	40%
Nonionic surfactants mg/L	41	>	41	=

cation treatment.
COD and **BOD** decrease after treatment due to oxidation, but the decrease occurs in a non-significant way as the literal explosion of suspended solids does not allow these values to drop adequately.
The physical effect has reduced the alkyl chains present, destroying more complex organic molecules, reducing them into simpler molecules and, therefore, treatable more easily and in a shorter amount of time.
The **EMPOWERING DEVICE** manages to unleash the maximum desired effect in 54 seconds: subjecting the waters of the washing process to a cavitation treatment of longer dura-

tion, without any corrective action, is not economically viable.
The quantity of ozone administered is sufficient but doubling it allows a faster oxidation of the nitric nitrogen present.
Once the suspended solids, partly also responsible for the levels of **COD** and **BOD**, have been eliminated through filtration with a sand filter, it appears appropriate to subject the wastewater to a second rapid but intense cavitation cycle in order to break down the last pollutants and obtain thus a fully reusable water in the production cycle.
The water, deprived of the solids, is added with a few mg/l of ferrous sulphate at the filter outlet and via a dosing pump to then complete the purification process with a second cavitation treatment, lasting 36 or 54 seconds (respectively a "short" or "medium" processing cycle in the non-demonstrative machinery), which, also making use of the action of the ozone and the UV lamps present in the apparatus, would enhance the Fenton reaction: the ferrous ion (2) is oxidized by the peroxide of hydrogen to ferric ion (3) with the formation of a hydroxyl radical and a hydroxide ion. Iron (3) is then reduced by another hydrogen peroxide molecule to iron (2) with the formation of a peroxy radical and a proton:

$$(1)\ Fe_2+ + H_2O_2 \longrightarrow Fe_3+ + OH\cdot + OH-$$
$$(2)\ Fe_3+ + H_2O_2 \longrightarrow Fe_2+ + OOH\cdot + H+$$

As can be seen from the two previous formulas, the net products are water and the two hydroxyl and peroxidic radicals, which are the same ones that are formed during cavitation. In these conditions all the organic material is oxidized and the water, after a second filtration, can be reintroduced into the production cycle, except for that which should evaporate naturally.
For a process of this kind, the adoption of the **EMPOWERING DEVICE TWIN-SET** model is recommended: in this way it is possible to process the wastewater on a continuous process line, cutting the cost of accessories and avoiding bottlenecks in the processing. Given the processing peaks, storage tanks for the treated water are also recommended, capable of storing an adequate quantity necessary to make up for the peak usage of the day.

costs with cavitation				**traditional purification costs**	
per m3	**annuals**	85.000	m3 treated per year	**annuals**	**per m3**
1,00 €	8.500,00 €	water bill		85.000,00 €	1,00 €
180,00 €	7.650,00 €	disposal & treatment		425.000,00 €	5,00 €
- €	30.000,00 €	filters & chemicals		- €	- €
3,80 kWh	64.600,00 €	plant purification energy cost		136.000,00 €	8,00 kWh
	26.400,00 €	maintenance cost		26.400,00 €	
	119.100,00 €	total annual cost		672.400,00 €	
	1,61 €	gross cost of m3 treated		7,91 €	

EMPOWERING DEVICE

models	bio	test	standard
from x cm	130	130	130
from y cm	300	300	300
from z cm	261	261	261
square meter	3,90	3,90	3,90
square foot	41,98	41,98	41,98
cubic meter	10,18	10,18	10,18
cubic yard	13,31	13,31	13,31
max flow rate m3 / h	120	40	120
liters / minute	*2.000*	*667*	*2.000*
liters / second	*33,33*	*11,11*	*33,33*
maximum max m3 / day	557	427	2.880
minimum ozone grams / m3	0,3	0,8	0,3
maximum ozone grams / m3	46,5	60,8	9,0
atex	X	X	X
ped	X	-	X
teflon	-	-	X
selfpowerable	X	X	X
water purification	-	X	X
desalination	-	X	X
industrial waters	-	X	X
food liquids	-	X	X
edible oils	-	X	X
other oils	-	X	X
chemical industries	-	X	X
leachates	-	X	X
extractive industries	X	X	X
sludge	X	-	-

twin-set	twin-max	trio	sofron4	sofron8	sofron12	sofron16
310	310	310	310	350	370	400
310	310	310	400	400	400	400
261	261	261	350	350	350	350
9,61	9,61	9,61	12,40	14,00	14,80	16,00
103,44	103,44	103,44	133,47	150,69	159,31	172,22
25,08	25,08	25,08	43,40	49,00	51,80	56,00
32,81	32,81	32,81	56,77	64,09	67,75	73,25
120	240	360	480	960	1440	1920
2.000	*4.000*	*6.000*	*8.000*	*16.000*	*24.000*	*32.000*
33,33	*66,67*	*100,00*	*133,33*	*266,67*	*400,00*	*533,33*
2.880	5.760	8.640	11.520	23.040	34.560	46.080
0,5	0,3	0,3	0,3	0,3	0,3	0,3
18,0	9,0	9,0	9,0	9,0	9,0	9,0
also available in version:						
X	X	X	X	X	X	X
X	X	X	X	X	X	X
X	X	X	X	X	X	X
X	X	X	X	X	X	X
designed for:						
X	X	X	X	X	X	X
X	-	-	X	X	X	X
X	X	X	-	-	-	-
X	X	X	X	X	X	X
X	X	X	-	-	-	-
X	X	X	-	-	-	-
X	X	X	-	-	-	-
X	X	X	-	-	-	-
X	X	X	-	-	-	-
-	-	-	-	-	-	-

EMPOWERING DEVICE

STANDARD

model parameters	max flow rate m3 / h	120
	liters / minute	*2.000*
	liters / second	*33,33*
	liters internal circuit	240
	liters storage tank	0
	days of operation	364
	ozone grams / h	60
	annual maintenance	6,2%
rated power kW	engine	15,0
	main pump	5,5
	ozone system	1,0
	PLC & sensors	0,4
	UV system	*0,7*
	booster pump - opt.	*5,5*
	other optional	*0,0*
	Actual kWh	7,8
system equipment	ozonators	2
	UV system	1
	graphene filter IN	0
	graphene filter OUT	1
	membrane	1
	insufflator	0
	dosing pump	0
	weir	0
	refrigerator	0
extra	atex	no
	ped	no
	teflon	no
	renewable energy	no
	energy storage	no

rpm **1.500**

	continuous	short	medium	long	prolonged	accurate	scrupulous
processing cycles	1	3	6	9	12	15	18
seconds needed	7,2	21,6	43,2	64,8	86,4	108	129,6
processes per hour	500,0	166,7	83,3	55,6	41,7	33,3	27,8
liters per second	33,3	11,1	5,6	3,7	2,8	2,2	1,9
max m3 / hour	120,0	40,0	20,0	13,3	10,0	8,0	6,7
m3 / hour - desalinated	60,0	20,0	10,0	6,7	5,0	4,0	3,3
max m3 / day	2880,0	960,0	480,0	320,0	240,0	192,0	160,0
seconds for 1 m3	30	90	180	270	360	450	540
kW processing	0,016	0,047	0,093	0,140	0,187	0,234	0,280
kW / m3	0,065	0,195	0,389	0,584	0,779	0,973	1,168
ozone gr./ processing	0,12	0,36	0,72	1,08	1,44	1,8	2,16
ozone grams / m3	0,50	1,50	3,00	4,50	6,00	7,50	9,00
1000,00 *kW / m3 min.*	0,062	0,185	0,370	0,555	0,740	0,925	1,110
2000,00 *kW / m3 min.*	0,084	0,252	0,505	0,757	1,009	1,261	1,514
3000,00 *kW / m3 min.*	0,178	0,535	1,070	1,605	2,140	2,675	3,210

desalinates water for approx 7.200 *inhabitants (150 l / d)*

system size 3,90 *m2*

modular and stackable

→ *x* 130 *cm*

↑ *y* 300 *cm*

↗ *z* 261 *cm*

dimensions of energy subsystems - *m2*

the set configuration

sterilization level	*maximum*
targeted removal of pollutants	*maximum*
desalination	*suitable*
oil separation	*suitable*
alimentary use	*to verify*
self-powered	-
use dangerous and / or explosive environments	*to verify*

EMPOWERING DEVICE

TWIN-SET

rpm **1.500**

model parameters	max flow rate m3 / h	120
	liters / minute	*2.000*
	liters / second	*33,33*
	liters internal circuit	390
	liters storage tank	0
	days of operation	364
	ozone grams / h	120
	annual maintenance	6,2%
rated power kW	engine	30,0
	main pump	11,0
	ozone system	2,0
	PLC & sensors	0,8
	UV system	*0,7*
	booster pump - opt.	*11,0*
	other optional	*0,0*
	Actual kWh	21,5
system equipment	ozonators	4
	UV system	1
	graphene filter IN	0
	graphene filter OUT	1
	membrane	1
	insufflator	0
	dosing pump	0
	weir	0
	refrigerator	0
extra	atex	no
	ped	no
	teflon	no
	renewable energy	no
	energy storage	si

	continuous	short	medium	long	prolonged	accurate	scrupulous
processing cycles	1	3	6	9	12	15	18
seconds needed	11,7	35,1	70,2	105,3	140,4	175,5	210,6
processes per hour	307,7	102,6	51,3	34,2	25,6	20,5	17,1
liters per second	33,3	11,1	5,6	3,7	2,8	2,2	1,9
max m3 / hour	120,0	40,0	20,0	13,3	10,0	8,0	6,7
m3 / hour - desalinated	60,0	20,0	10,0	6,7	5,0	4,0	3,3
max m3 / day	2880,0	960,0	480,0	320,0	240,0	192,0	160,0
seconds for 1 m3	30	90	180	270	360	450	540
kW processing	0,070	0,209	0,419	0,628	0,838	1,047	1,257
kW / m3	0,179	0,537	1,074	1,611	2,149	2,686	3,223
ozone gr./ processing	0,39	1,17	2,34	3,51	4,68	5,85	7,02
ozone grams / m3	1,00	3,00	6,00	9,00	12,00	15,00	18,00
1000,00 *kW / m3 min.*	0,123	0,370	0,740	1,110	1,480	1,850	2,220
2000,00 *kW / m3 min.*	0,203	0,609	1,218	1,827	2,436	3,045	3,654
3000,00 *kW / m3 min.*	0,357	1,070	2,140	3,210	4,280	5,350	6,420

desalinates water for approx 7.200 *inhabitants (150 l / d)*

system size 9,61 *m2*

modular and stackable

→ *x* 310 *cm*

↑ *y* 310 *cm*

↗ *z* 261 *cm*

dimensions of energy subsystems - *m2*

the set configuration

sterilization level	*maximum*
targeted removal of pollutants	*maximum*
desalination	*suitable*
oil separation	*suitable*
alimentary use	*to verify*
self-powered	-
use dangerous and / or explosive environments	*to verify*

Chemical Empowering
AG
Alpenstrasse 16, 6300 Zug — Switzerland
SRL
Via La Louviere 4, 06034 Foligno — Italy

MAIN PARTNERS: