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EMPOWERING DEVICE

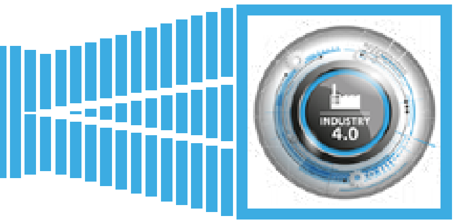
BIODIGESTION

agricoltural waste at the base of the circular economy, earning winking at the environment

01/07/2025 *(dd/mm/year)*

technology introduction

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

Thanks to our process accelerator, the **EMPOWERING DEVICE** Ichemical reactions are greatly facilitated and therefore speeded up.
Furthermore, given that biodigestion is a typical organic process, cavitation also acts at the cellular level greatly favors it.
Our plants can treat organic residues from farming, agriculture, various types of vegetable waste, civil waste (sewers) or even urban wet residues (MSW).
The component that will vary according to the difficulty of treatment will be the initial shredder and screening systems may or may not be inserted.
If necessary, a nitrogen elimination system produced by one of our partners will be inserted.
Furthermore, all our technologies are designed to be easily inserted into existing production processes without however upsetting the pre-existing production flows. In the case of a plant to be built from scratch, it will be possible to opt for systems made up entirely of our products which have the peciluarity not only to drastically cut biogas production times but above all to occupy a fraction of the pre-existing production plants.
Our **Biodigestion Plant** with or without **Biomethane upgrade** has earned us the co-option by the Italian Biogas Consortium as technology suppliers.
Furthermore, our systems do not release microorganisms into the environment as a double step in our process accelerator will achieve the complete sterilization of all forms of animal life present in the biodigested product exiting the “stomach”.

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

Bruno Vaccari

… and what we do

OUR MAIN GOAL: environment and workers' conditions respect

- 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 core team

Bruno Vaccari

CEO

Sabrina Saccomanni

Lawyer

Fabrizio Di Gennaro

CMO

Antonio Demarcus

CTO

Paolo Guastalvino

Civil works

Gianni Deveronico

Lead electrical engineers

Faris Alwasity

Engineering

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

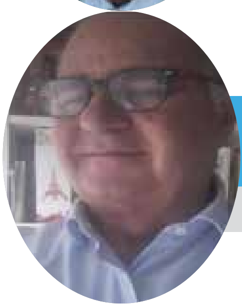
COO Romania

Awa Khady Ndiaye Grenier

COO Guiné-Bissau

Giorgio Masserini

Marketing

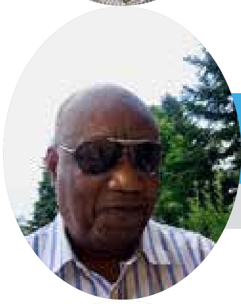


Pantaleo Pedone

Italian energy-intensive

Gianluca Baroni

Hospital Stuff



Stefano Diambu Nkazi

Marketing

Sarr Alioune Badara

Marketing

Jérémie Saltokod

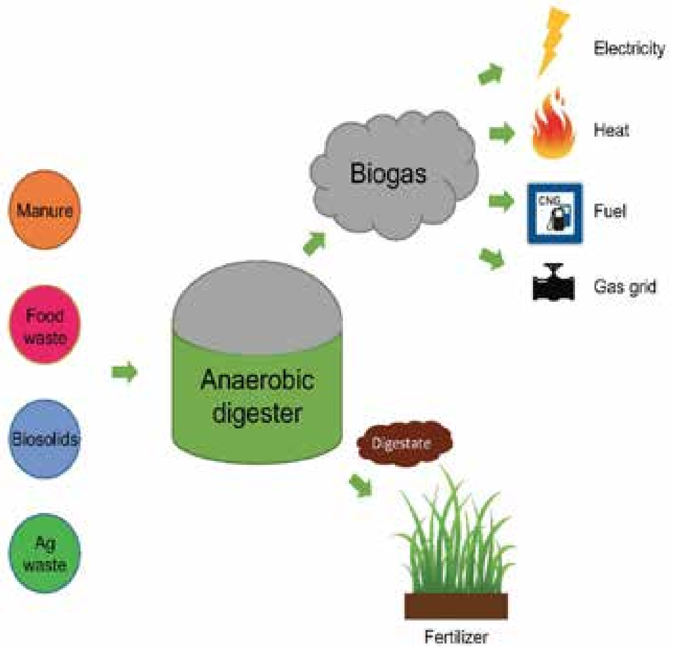
CCIMRDC Italie

biodigestion

The preparation of the substrate consists in obtaining the physical-chemical characteristics considered optimal for introduction into the digester.
This occurs through the introduction of the matrices, possibly diluted by sludge and / or water, with a correct degree of humidity inside the **EMPOWERING DEVICE** which will homogenise all the matrices entered and pre-treat the result obtained, also contributing to the increase of the its temperature.
The permanence time of the matrix inside the biodigestor, normally 14/40 days (mesophilic reactors) or 14/26 days (thermophilic reactors), thanks to the pretreatment in the **EMPOWERING DEVICE** this permanence can be reduced to about one day and therefore reactors can be of extremely smaller dimensions than in the past can be made.
These are fed and, alternatively, emptied in cycles of 6 hours. They are equipped with biogas collection systems. During the pemanence, the material is continuously stirred through an innovative helical device that is moved only by exploiting the rise of the gas from the bottom to the top, without consuming additional electricity. This allows to avoid the presence of dead zones, to homogenize the temperature and the release of the biogas and to avoid the sedimentation of the mud and the formation of superficial films and above all it facilitates the contact between bacteria and substrate.
The biogas obtained can be either upgraded to biomethane or, once purified, used for the low yield production of thermal or electric energy. It is a gaseous mixture composed mainly of methane and carbon dioxide, but also containing small quantities of hydrogen and occasionally traces of hydrogen sulphide.
The material exiting the digester is a liquid sludge (Solid Fraction: 5-25%) not completely stabilized (the organic matter is not completely degraded). It is stabilized through a second passage in the **EMPOWERING DEVICE**, which remove its bacterial load and accelerates its oxidation; subsequently, excess moisture is drained by means of a belt press. Any excess nitrogen can be eliminated chemically, via bacteria or naturally with the compost rest. The liquid fraction thus obtained, having already undergone treatment within the **EMPOWERING DEVICE**, can be used immediately for irrigation purposes or to be returned to the cycle by finding new use in the biodigestor. The dry fraction is used as a biological fertilizer (high quality compost).
The electricity produced by anaerobic digestion is considered totaly green energy because the gas is not released directly into the atmosphere and carbon dioxide derives from an organic source characterized by a short carbon cycle, the biogas with its combustion does not contribute to the increase of atmospheric CO_2 concentrations and, therefore, is considered a low environmental impact energy source.

anaerobic digestion

Anaerobic digestion is a biological process by which, in the absence of oxygen, the organic substance contained in materials of plant and animal origin is transformed into biogas, consisting mainly of methane (CH_4) and carbon dioxide (CO_2). The percentage of methane varies, depending on the type of digested organic substance and the process conditions, from a minimum of 50 to about 80%. The anaerobic microorganisms that carry out this transformation exhibit low growth rates and low reaction rates; hence the need to maintain, as far as possible, optimal conditions of the reaction environment to promote its metabolism.
Anaerobic digestion can be carried out in **mesophilic conditions** (temperatures of about 35 ° C), **thermophilic conditions** (about 55° C) or, more rarely, in cold conditions (**psychrophilic digestion**). The reaction temperature also generally determines the duration of the process (residence or retention time).
The times are on average between 15 and 50 days if the process occurs in mesophilia, between 14 and 16 if it occurs in thermophilia and 60-120 days in psychrophilia. Anaerobic digestion is a very complex process operated by different groups of bacteria acting in series. The transformation takes place with a sequence of successive phases which, to a small extent, tend to overlap. The first two phases can be considered preparation and only in the third phase there is production of biogas. More specifically, in the first phase, the hydrolytic bacteria "break up" the complex organic compounds (ie carbohydrates, proteins and fats) into simpler substances (hydrolysis phase). In the second phase these substances are transformed into
a first stage, in organic acids through acidogenesis reactions and, subsequently, in acetate ($CO\text{-}OH\text{-}CH_3$), carbon dioxide (CO_2) and hydrogen (H_2), through acetogenesis processes (fermentation phase). In the last phase, the most delicate one, the methanogenic bacteria transform the products formed in the previous phase into methane (CH_4) and carbon dioxide, the main constituents of biogas (methanogenesis) The organic substance is then degraded releasing biogas, the energy vector of the process, to a variable extent from 30 to 85%. Low levels of biogas yields can be attributed to several factors: low temperatures; retention times too short for a given temperature; incorrect hydrodynamic management of the reactor (dead zones); significant presence of antibiotic substances.
The biogas yield also depends on the type of biomass used. The next chapter reports an extensive review of organic matrices and the related functional characteristics to anaerobic digestion (AD). In the first instance, the biogas yield and the percentage of methane contained in it are indicated, correlated to the organic composition of the starting materials. The greater methanogenic capacity is attributable to fats (≈ 0.85 m3 / kg), followed by proteins (≈ 0.5 m3 / kg) and finally by carbohydrates (≈ 0.4 m3 / kg).



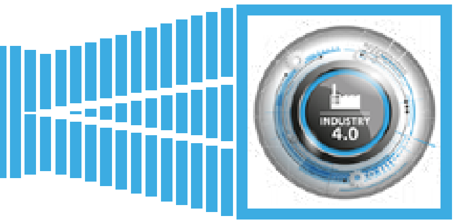
matrices

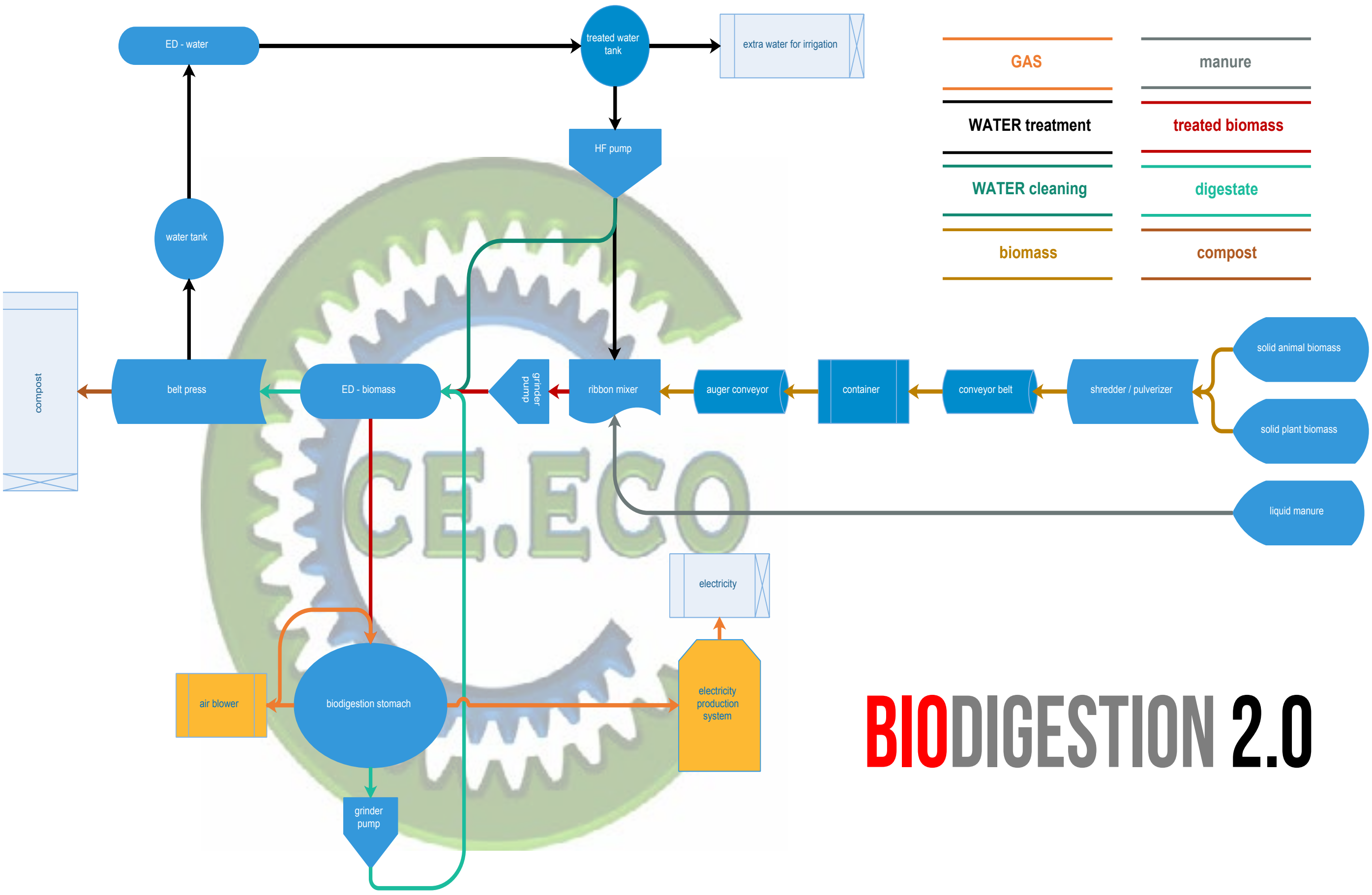
Livestock waste products are the waste products of a farm or, better still, they are the result of the mixture of various materials: zootechnical manure (faeces, urine), washing water, litter, hair, food residues. Manure, and even more zootechnical manure, therefore have an extremely variable composition, not only according to the animal species that originate them (bovine, swine, poultry), but also according to the methods of breeding and management of the manure in its complex. From a physical / managerial point of view, zootechnical manure can be found in both palable (manure) and pumpable (sewage) form depending on the dry matter content. Among livestock manure, sewage has a chemical / physical composition on average more suitable for the most common anaerobic digestion processes.
The use of **dedicated crops** in codigestion has spread over the last few years. Initially available in cases of overproduction, coming from marginal land, partially cultivated or from set-aside land, with the evolution of the supply chain - thanks above all to incentives (green certificates and more) - they are increasingly used in an advantageous way both in large than in small plants. In the first case, in a logic more oriented towards increasing revenues, they are used, in particular, in processes of anaerobic digestion of waste; in the second case, however, they serve to improve the overall efficiency of the process (standardization of the input mixture) and to achieve more appropriate economies of scale.
The **by-products** that can be conveniently used in codigestion in an anaerobic digestion process are many. There are consolidated experiences of plants for the production of biogas from the organic fraction of the waste inserted in the treatment sites of the same. As regards the agricultural sector, however, the interest is more properly oriented to those plants that use, for different reasons, by-products and / or waste from the agro-industrial sector that can be inserted, more appropriately, within agro-energy supply chains. The definition of “by-product” is of considerable importance due to the repercussions it can have in the overall framework of the energy production activity and the related “production waste”.
In order for it to be possible to classify “by-product”, instead of “waste”, the waste, or residue, sent to another production cycle, (eg production of “biogas” or “methane”) this must comply with the following parameters:

- it must be generated by a production process, even if it is not its main object;
- use in another production process must be certain, right from the stage of its production, and integral. The process in which the waste is reused must be previously identified and defined;
- the by-product must have product characteristics and environmental quality such as to ensure that its use does not generate a qualitative and quantitative environmental impact other than that permitted and authorized in the destination plant;
- the above environmental compatibility characteristics must be possessed by the by-product from the moment of its production; treatments or transformations prior to their re-use for this purpose are not permitted;
- the by-product must have an economic market value.

Silage and forage crops	Sudanese grass silage (first cut after the beginning of flowering)
	Lucerne (second mowing)
	Clover / four-leaf clover silage (first mowing after the beginning of flowering)
	Corn stalks and cob leaves (mixture) 2% crude fiber
	Green bread corn, end of flowering
	Corn silage
	Forage
	Spare grass, waxy ripening stage
	Feed silage (vetch, oat, barley), full grain
	Rapeseed oil silage
	Beet leaf silage
	Grain silage (intact plant), full flower
	Wheat silage (intact plant)
	Red clover silage (first cut)
	Corn / triticale bread silage
	Clover silage (2nd cut, from the beginning of flowering)
	Red clover silage (2nd cut)
	Cornbread silage (2nd cut, full grain)
	Forage (the first mowing) start of healthy growth
	Corn silage, ripe, full grain
Crops of roots, grains, seeds	Two-row barley
	Dry corn
	Oats
	Beetroot, potatoes
	Fresh sugar beet
	Sugar beet
	Bread corn
	Sunflower
	Grain
	Peas
	Rapeseed oil
	Potato flakes
	Potato flour
	Fresh potatoes
Vegetables	Waste from plant products
	Onion
	Onion peel
	Carrots
	Cauliflower
	Fresh pumpkin

Fat, oil	Fat
	Glycerine
	Linseed oil
	Rapeseed oil
	Soybean oil
	Sunflower oil
Animal residues	**Pig slurry**
	Pig manure with litter
	Sheep manure
	Lean cattle slurry
	Fresh bovine manure
	Dairy cattle manure
	Dairy cattle manure with feed residues
	Horse manure
	Dry pollen
	Fresh pollen
Food industry residue	Stomach contents
	Soybean peeling residues
	Fresh washed potatoes
	Oat flakes
	Fresh grain of barley
	Bran particles
	Barley grain silage
	Apple core
	Soy flour
	Washed grain
	CGM
	Whey
	Whole cow's milk
	Boiled brewer's yeast
	Dry brewer's yeast
	Dry bread
	Bakery waste
	Dairy waste
	Low-fat, moist food waste
	Food waste with a high level of fat content
	Fresh milk butter
	Casein
	Fat-free milk powder
	Rapeseed meal
	Sunflower paste
	Various food residues





BIODIGESTION 2.0

a typical installation

The following 2 pages show the flow diagram of one of our biodigestion systems without biomethane upgrades.
The plants are housed in specially designed skids and can be buried, with the only care being to leave the upper part above ground.

1. The matrices enter the plant through a shredding and screening system.
2. Then, reduced ald a correct sizing, the matrices are mixed together and are added with water to bring them to the humidity level required by the system (about 85%)
3. A first cavitation cycle, lasting a few minutes, allows the material to be finely crushed and amalgamated as well as to replenish its cell walls.
4. The bolus thus obtained is introduced into the “stomach”, with no moving parts: the mixing is carried out using the gas being formed by exploiting the Coandă effect obtained with special ATEX blowers.
5. At predetermined intervals, a pump sucks in the biogas ...
6. ... and sends it to a compression and filtering system
7. Only to be wrapped up ...
8. ... and fed into a turbine with a heat recovery system of our conception: the combined cycle allows yields of over 55% for the production of electricity
9. which will either be self-consumed or fed into the national grid
10. a solenoid valve, at pre-established intervals, will release the biodigested product from below to direct it to ...
11. ... a further cycle in the cavitator to inert any trace of microorganisms
12. Further solenoid valves ...
13. they will regulate the flow towards a possible booster pump ...
14. ... or by putting it directly into a press belt ...
15. ... from which the solid part forms ...
16. ... the denitrified quality compost to be used for agricultural purposes
17. while a cavitating pump puts the water in which the nitrates remained in a tank, purifying and denitrifying it using UVC and ozone
18. part of the water will be withdrawn for other uses (for example agricultural uses or for washing or, if you decide to achieve a food grade purification, to water livestock)
19. while a part will be reused in the process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EMPOWERING DEVICE

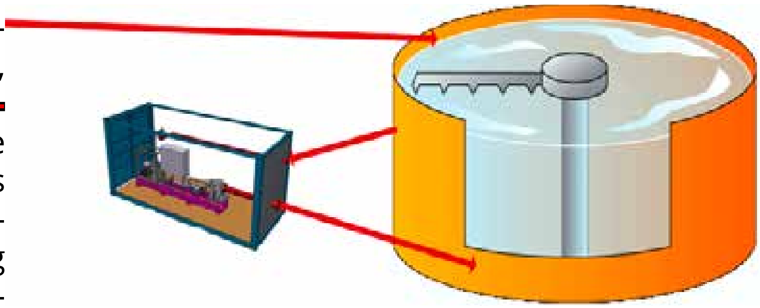
EMPOWERING DEVICE has been fully conceived, developed and implemented by our team and is able to simultaneously manage different types of controlled cavitation, of which 5 of a different nature but which coexist harmoniously to the point that no significant vibrations are detected.
The summation of the 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%

how to place the ED

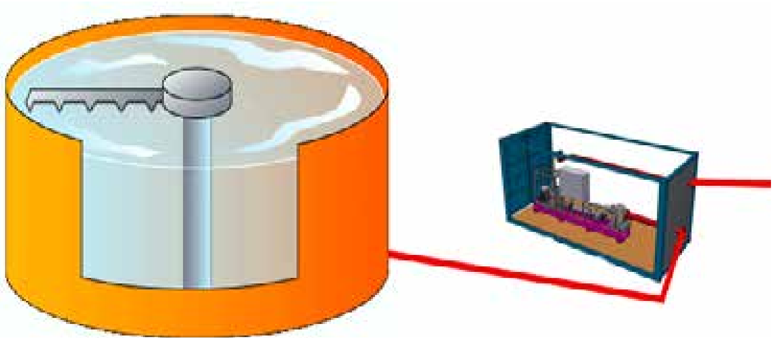
Our process accelerator can be placed, according to the process needs, at the entrance, in recirculation or at the exit of a tank.



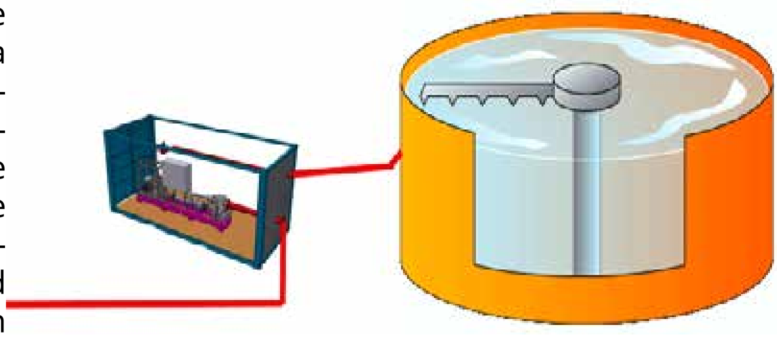
in recirculation: a pump sucks the liquid matrix from the treatment tank, sends it to the **EMPOWERING DEVICE** for treatment and returns it to the treatment tank through a second access pipe. With this configuration, it is possible to treat and improve the functioning of an existing plant, reducing 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.

upgrade to biomethane

The conversion from biogas to biomethane occurs through a purification process (dehydration, desulphurisation, removal of gaseous ammonia, NH_3, mercaptans, dust) and upgrading (removal of carbon dioxide, CO_2).

- Biogas cleaning: removal of water, H_2S and traces of unwanted contaminants (dust, siloxanes, ammonia...);
- Upgrading: removal of CO_2 to reach the quality standards required by the gas network and uses as biofuel;
- Biomethane: refined biogas for injection into the grid or use as a biofuel.

Biogas cleaning is carried out through physical absorption or water scrubbing: one of the most widespread technologies, it can be installed with and without recovery of the washing water and also operates with small sizes.
Absorption can take place in co-current, counter-current or crossed flow towers.
Hydrogen sulphide (H_2S) must be separated before washing because it is corrosive, this will be done via an iron chloride filter.
The upgrade can be achieved via chemical adsorption, membranes or cryogenesis.
Chemical adsorption is usually carried out using amines (MEA and DMEA) or potassium carbonate solution and is a very complex, high-efficiency technology (therefore allowing smaller systems) but does not separate nitrogen (N_2).
This process operates at very low pressures thanks to the high MEA/DMEA-CO_2 affinity.
The solvent can be regenerated with a thermal process.
Membrane technology is simple, it exploits the selectivity of a membrane to different molecules. The difference in partial pressure of different gases across the membrane is the most important parameter. They work at high pressures (25-40 bar) or low pressures (9 bar).
The membranes can be based on polymers or cellulose acetate.
The use of membranes has the positive side of high system flexibility.
On the other hand, the high cost of selective membranes and the need to replace them at short intervals represents the weak point of this technology.
Cryogenic technology uses the boiling point of gases (CO_2 -78 °C, CH_4 -160 °C): the biogas is cooled to the point where the CO_2 condenses and can be separated as a liquid.
This technology has a slightly higher application cost than the others, is energy intensive, but the purity of the gas is higher and requires significantly lower maintenance costs than other upgrade technologies also because no chemicals are used for biogas purification.
In combination with our heat to energy technology, which reduces the energy costs of both the scrubber dedicated to purification and the compressors used for cryogenic separation, it makes the adoption of cryogenics optimal compared to other technologies.

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