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# COCOA!

*how to make the most delicious gift of nature even more precious*


**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?


## 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!

**Smartly sustainability**

## Mission:

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

# index



- acceleration of natural processes without organoleptic alterations
- contained implementation costs
- minimum maintenance: a few hours a year to check seals and bearings
- mature technology as it has already been used for nearly 20 years in various fields
- possibility of killing bacteria, microorganisms, viruses and pathogens

# 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.

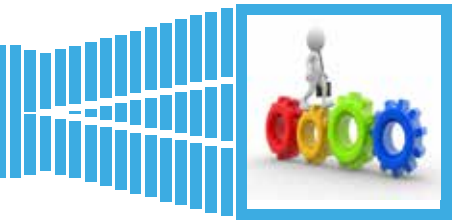
We have a framework agreement with RINA Consulting - Centro Sviluppo Materiali S.p.A. which allows us to request their supervision and therefore also to certify the production and engineering phase of our products wherever we choose to produce them. Therefore, choosing us also gives access to all the 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
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- FROM HEAT TO ENERGY
- THERMOELECTRIC PANELS
- ASBESTOS DENATURATION
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- 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

**Faris Alwasity**

ENGINEERING

**Massimiliano Magni**

ENGINEERING

**Antonio Piserchia**

COMMUNICATIONS EXPERT

**Barbara Spelta**

LAB

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COO Senegal

**Noel Sciberras**

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**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**

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**Jérémie Saltokod**

CCIMRDC Italie

# cocoa tree

The generation of large quantities of organic waste, currently labeled as residual biomass, is the main disadvantage of the agro-industry.

The most abundant and problematic crop residues are those of a lignocellulosic nature.

This type of material represents about 60% of the vegetal biomass, and its disposal usually involves difficulties due to the volume and the **hardly treatable** structure that characterize it.

The food and biofuel industries are associated with the enormous accumulation of this waste, such as sugar cane bagasse, coffee husks and husks, corn cob, rice straw, wheat straw and cocoa by-products. The residual biomass has the particularity of being cheap, renewable and abundant. These facts make it an interesting material in various industrial processes.

Cocoa by-products originate in the manufacturing process: the cocoa beans are removed from the cocoa pod peel, fermented and dried for storage and transport. Apart from the cocoa beans, the fruit is composed of a pod peel, bean shell and pulp, which together represent about 70-80% of the fruit by dry weight. This residual biomass **until now represented a critical environmental problem** for cocoa producing countries. **Cocoa, along with wine, bread and beer, is considered one of the oldest fermented foods consumed in the world.**

Nowadays, cocoa production and its supply chain is one of the most important in the world thanks to its family cultivation and the logistics necessary for the transportation, marketing, production and distribution of raw material and products. derivatives. However, the cocoa processing chain has remained unchanged for 150 years. The steps to transform the seeds into the final products (for example, chocolate, butter and cocoa liqueur) consist of harvesting, fermenting, roasting, shelling, grinding and spraying.

In each of these phases a substantial residual biomass is generated.

The cocoa fruits are harvested after ripening and the pods are opened with a sledgehammer, knife or machete. The use of sharp objects requires considerable experience and skills to avoid damaging the seeds.
A longitudinal cut is made in the peel of the pod to expose the cocoa beans and pulp. The cocoa beans, together with the surrounding mucilaginous pulp, are distributed in piles for further fermentation. The pod shells are then disposed of directly into the ground. The pulp, in contact with metal tools or impurities, is exposed to microorganisms (for example, lactic acid bacteria, acetic acid bacteria, yeasts and filamentous fungi), which promote numerous physical and chemical changes in both the pulp and the beans. Fermentation is usually done for 8 days, exhibiting a heterogeneous group of microorganisms and variable metabolite peaks (i.e., ethanol, lactic acid, acetic acid). In the post-harvest phase, excess juice, which is the result of pulp-pectin degradation at low pH and negative pressure, is drained through cracks in the fermentation boxes and thrown into the ground.
Are then processed on an industrial scale, generating cocoa products (for example, cocoa powder, butter and liqueur). The cocoa beans undergo thermal shock to remove the surrounding shells and are subsequently subjected to a flow of air (sieve), which favors their separation from the purified cotyledons (nibs), allowing for homogeneous roasting.

The grains are roasted at temperatures between 120 and 150 ° C with variable heating ramps depending on the level of ripeness of the grain and the desired final product. The high roasting temperatures favor a series of complex Maillard reactions, which lead to the conversion of free amino acids and the reduction of sugars into aldehydes, pyrazines and higher alcohols which directly influence the development of cocoa aromas.

# sustainability of supply chain

At the beginning of the 21st century, the international media focused on the cocoa supply chain due to irregular employment situations. Subsequently, the international cocoa agreement supported the development of a sustainable cocoa economy (United Nations, 2001). Studies have been carried out to identify child labor activities, gender disparities and unfair working conditions for thousands of workers, especially in Africa.

Another result of the great concern about situations related to cocoa production was the study conducted by the World Bank (2012) on the agricultural sector of cocoa in Ghana, one of the most important world producers.

This report concluded that various phases of the cocoa supply chain, such as production, the market and the environment, were at risk.

These sectors are closely associated with the long-term growth and sustainability of the cocoa supply chain.

Since that time, this issue has become extraordinarily relevant in the debates of policy makers and stakeholders on the global cocoa industrial chain. Some characteristics of the three spheres of sustainability (social, economic and environmental) will be slightly clarified. Firstly, the social element of the sustainability of the cocoa industry is quite relevant, considering that this sector is characterized by an intense family activity, about 40-50 million people work in the cultivation of cocoa.

In the 2015/16 harvest, family-based cocoa cultivation was responsible for a worldwide production of 3.9 million tons and an export of products of approximately $ 47 billion (The International Cocoa Organization, 2018 ; International Trade Center, 2019a).

Based on these numbers, ensuring a decent and equitable livelihood for cocoa farmers remains a priority in the sector, along with the importance of education and ongoing training in cocoa farming communities.

Second, on the economy side, the cocoa industry faces difficulties such as fluctuating cocoa bean prices and speculation, low investment, exorbitant taxes, changes in global economic growth and fluctuations in the US dollar relative to the other major currencies. In addition, political and social instabilities in the main producing countries affect cocoa prices (The International Cocoa Organization, 2012).

Thirdly, the environmental aspects of the cocoa industry present some relevant issues, such as the need for environmental instructions for better management of natural resources (i.e., land and water), regulation of the use of pesticides to reduce negative effects on environment and farmers' health without affecting expected productivity, conservation of local ecosystems and biodiversity and improving the ability to respond to possible climate change and possibly adequately manage the waste generated during cocoa production.

# what can we do

The current cocoa production process has a fairly high level of efficiency in relation to the production of cocoa powder but **zero** with regard to over 80% of vegetable waste generated.
Therefore, by applying our devices to the current process we could improve its efficiency but by completely redesigning the production process, this time basing it on the technology of our systems, we are able not only to improve cocoa production, accelerating it and significantly cutting costs. , but also to fully recover the so-called waste.
By recovery we refer both to water and to that 80% of biomass currently discarded.
The most interesting part of the cocoa tree, it should be emphasized, is not actually the precious fruit from which the cocoa powder is obtained but the set of bioactive compounds that are present, abundantly, even in all the part that is currently discarded. and which can be obtained by bioconversion and extraction.
Furthermore, the surplus part of the biomass can be easily converted into energy, both electrical and thermal, by means of a gasifier or a high efficiency biodigester.
The **thermal energy** will be used for drying the seeds, thus completely cutting the purchase costs of the fuel previously needed, while the **electricity** will not only provide the energy necessary for the process itself and for the producers' plants but the excess can be distributed and sold on the national electricity grid.
The production of cocoa itself will greatly benefit from less intrusive techniques that work at room temperature.
Cocoa butter can be quickly stabilized, just as cocoa liquor can be rapidly enhanced, aged and stopped in evolution.
Consequently, by applying our systems we will eliminate any pollution generated by the process, we will produce an interesting surplus of energy, we will use all the plant biomass and we will recover from the previous waste even interesting quantities of precious extracts.

# beyond cocoa

One way to improve the sustainability of this very important food chain is to properly manage the residual biomass produced through the processing of the cocoa fruit. Actions to improve this aspect would lead to fewer phytosanitary problems and at the same time produce new incomes for farmers, given the consequent valorisation of residual biomass which has so far been little used. The implementation of biotechnological tools and extraction techniques could be a relevant and effective way to obtain value-added products from the residues of the cocoa production chain.

Enhancement of residues / by-products of the cocoa chain.

In recent decades, technological advances in cocoa cultivation have not accompanied the increase in the consumption rate and international demand has raised socio-environmental concerns, which are now attracting the interest of various players in the cocoa production and supply chain. More interest has recently been given to the use of cocoa by-products.

Biofuels, chemicals, biological hydrogen, energy, animal feed products and biomaterials have been produced in recent years after meticulous research into the potential of residual biomass from sugar cane, palm oil, cassava, maize, coffee and rice, including the others.

Today it is crucial to recover most of the biomass produced during cocoa processing.

By definition, bioactive compounds are essential and non-essential nutritional constituents found in small quantitiès in food and confer benefits to human health.

These compounds have been evaluated to demonstrate their anti-inflammatory effects, protective properties against cardiovascular disease and other bioactive characteristics.

The cultivation and use of cocoa for nutritional and medicinal purposes dates back to over 3000 years ago, with the first news relating to the Mayan and Aztec civilizations.

The presence of bioactive compounds in cocoa beans and their products (for example, chocolate, butter, oil) was deemed essential.

These compounds (mainly polyphenols) are responsible for the antioxidant, antitumor, antimicrobial and antiviral activities of cocoa-based products.

However, the applicability of the residual cocoa biomass has only been slightly studied.

These bio-compounds or value-added molecules can be obtained by bioconversion and extraction.

The table summarizes the main products and biocompounds obtained through both routes using the residual biomass of the cocoa supply chain.

| By-product | extract / fraction | Application | Result |
|---|---|---|---|
| shell of the pods | Methanol extracts | Functional food | The extracts showed a protective activity against ischemic damage; the bioactive compounds are polymeric polyphenols (e.g. procyanidins). |
| shell of the pods | Ethanol extract | Antimicrobial potential | Mouthwash (final concentration of 1 mg / mL in 0.1%) with antimicrobial activity, highly effective reducing by 32.25% S. mutansconta in contaminated toothbrushes. |
| shell of the pods | supercritical carbon dioxide extract | food industry | Theobromine and caffeine |
| shell of the pods | cocoa bean shell powder | environmental decontamination | Natural adsorbent to trap pollutants such as heavy metal ions, gases or industrial dyes. |
| shell of the pods | Acetone: extracted ethanol | dental health | The extracts showed 2- and 12-fold greater inhibitory activity against glucosyltransferase and similar polyphenol content compared to two other commercially available products. |
| shell of the pods | Dietary fiber | antioxidant potential | Product with intrinsic antioxidant activity and physico-chemical properties similar to commercial dietary fiber. |
| shell of the pods | Extract of ethanol or acetone | Antimicrobial activity in vitro and in vivo | total mutant streptococcus and plaque deposition when used as a mouthwash on 68% of tested subjects; Minimum inhibitory concentration against E. coli, Staphylococcus |
| shell of the pods | Ethanol extract | Antimicrobial and antiglucosyltransferase activity | aureus, Salmonella and Bacillus cereus Decrease in the growth rate of streptococcus tension; reduced the synthesis of insoluble glucan through the action of the enzyme glucosyltransferase. |
| shell of the pods | dust | Precursor of carbon monoliths without binders. Antimicrobial activity | The carbon monolith, which when activated, has a higher volume of micropores and good mechanical performance. Mouthwash with cocoa bean peel extract can be used in children as an alternative to the mouthwash, chlorhexidine as it has similar antimicrobial properties and avoids the side effects of the latter. |
| shell of pods, peel and pulp | Dietary fiber | Antioxidant potential | Antioxidant activity of cocoa pod peel with significantly higher total phenolic content on methanol: ethanol extract compared to other by-products. |
| Pod peel | Ethanol extract | Antioxidant potential | Antioxidant activity and collagenase inhibition activity |
| Pod peel | NaOH extract | Antiviral, antibacterial and radical scavenging | Anti-HIV, anti-influenza activity and enhancement of vitamin C radical scavenging |
| Pod peel | organic extract | Potassium fertilizer | dry mass of the aerial parts |
| Pod peel | pectin | Gel forms pectin highly | use of pectin from cocoa peel as an additive |
| Pod peel | Dietary fiber | acetylated | Non-starch polysaccharide and total phenolic content |

The extraction of these substances with the **EMPOWERING DEVICE** offers real added value, but it should be borne in mind that the processing must be almost immediate and cannot be carried out on a large scale; a thoughtful and diversified production of these substances could however bring great added value to the industrial production of cocoa.

Furthermore, with traditional extraction systems, large quantities of waste are created from exhausted solvents, solvents that, thanks to our technologies, we can recycle, consequently lowering production costs, as well as the environmental impact.

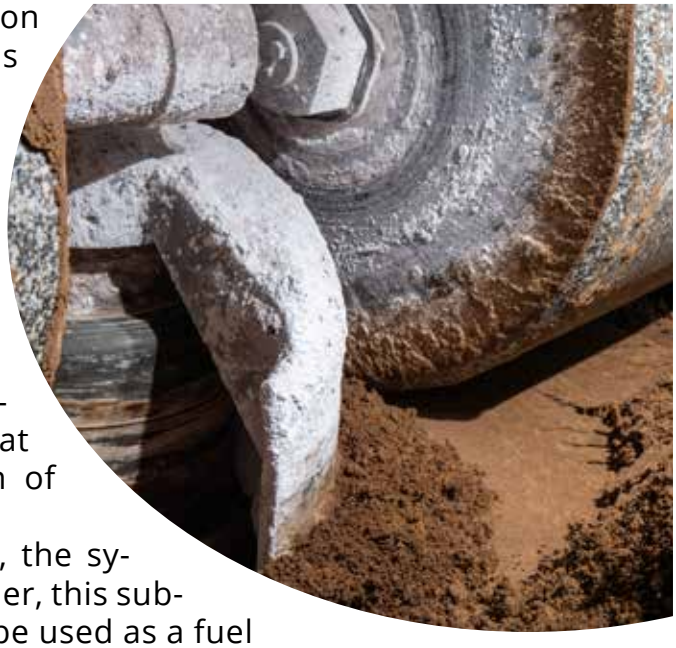
Cocoa beans are mainly used for the food production of chocolate and cocoa derivatives, including cocoa mass, butter, powder and liqueurs. These products are widely consumed and appreciated all over the world, showing a growth rate of consumption in the European Union and North America (respectively 1.7 and 3.6% per annum) (FAO, 2003). According to the latest report from the International Cocoa Organization (2018), the production of cocoa beans during the 2015/16 harvest was estimated at 3.9 million tons. At the same time, it is estimated that 16 million tons of residual biomass have been produced, taking into account the aforementioned dry weight of the fruit (80%).

Therefore, through the processing of cocoa, about 80% of cocoa fruits are discarded as residual biomass, including cocoa pod husks, cocoa bean shells and industrial waters.

Farmers regularly discard these residues / by-products during the initial stages of cocoa bean processing, occupying large areas and creating social and environmental problems. Alternatively, this residual biomass is used as a fertilizer for the cocoa tree. However, its disposal occurs without proper treatment, causing putrid odors and plant diseases.

Furthermore, cocoa peels can be used for energy production, this biomass has a value from 12 to 18 MJ / kg, a very interesting value, whi-

ch makes it suitable not only for the production of energy but also for the production of syngas and subsequently to other chemicals.
In fact, once the syngas has been produced through our gasifiers it will be possible to transform it into methanol, an interesting, non-polluting energy vector with a large market also as a solvent or basic chemical product.
Our technology allows us to have large yields of methanol with a space-saving system compared to alcoholic fermentation systems that use this type of biomass for the production of methanol.
Alternatively, by simply changing the catalyst, the system will be able to produce DME, demethylether, this substance also has a large market and could also be used as a fuel in LPG vehicles without modifying the system.



The syngas produced can be used for the production of electricity and heat, through our **From Heat to Energy** sub-system.
The waste water subjected to treatment through the **EMPOWERING DEVICE** can be fully recovered and reused, the sludge produced can be gasified or used to recover chemicals present in solution.
Once the beans are extracted they will be used for the production of cocoa, the system we propose is a “traditional processing” system, but with some modifications that improve the quality and yield of the product.

Our technology can be used for the production and treatment of cocoa mass; in fact, through the **EMPOWERING DEVICE** the material will be homogenized into smaller particles and sterilized, without altering the aromatic substances of the product.
Once the paste has been produced, it will be treated through a series of presses for the separation of the butter from the cocoa powder.

# 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

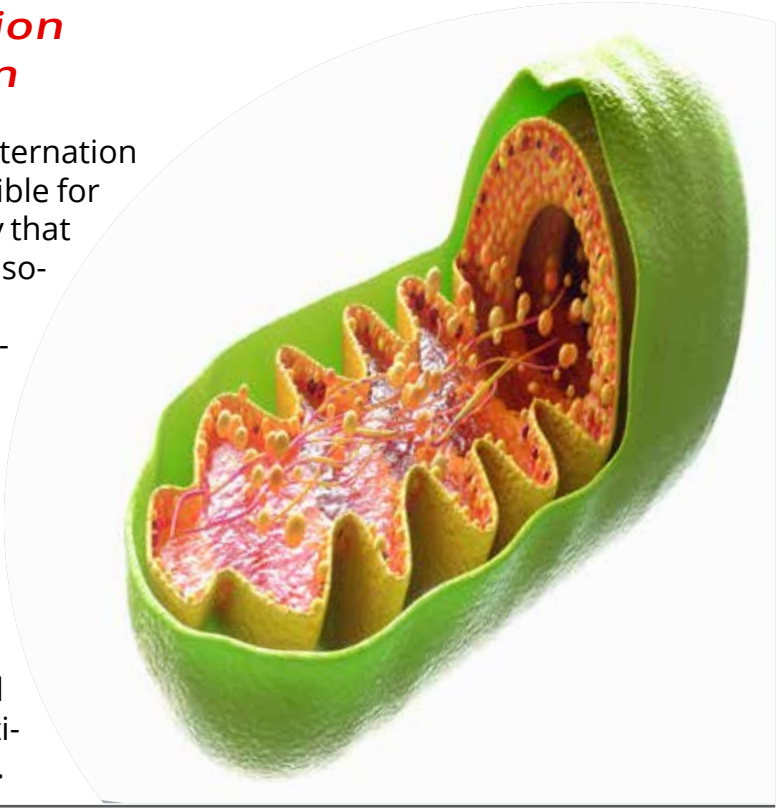
pressure.
Furthermore, it has been designed to be easily and quickly reconfigured according to the use: some of its parts can be removed if very dense and / or viscous liquids have to be treated and / or with extensive granularity or they can be added, inlet or outlet, accessory elements suitable for 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% |

# why is it so innovative?

The enormous forces staked during the cavitation phenomenon allow an extremely effective mixing and far better than that the one obtained with conventional technologies as the reduction in microscopic parts of what is present inside the fluid subjected to cavitation increases the area surface contact.
Furthermore, the forces released by the cavitation process are far greater than those present in normal mixing and, therefore, the results obtained are on enormously higher scales than those normally measurable by the application of traditional technologies.
Controlled cavitation can be applied to all processes of extraction of natural substances and treatment / conservation of emulsions or liquids, without damaging the original active ingredients of the original substance unlike what happens with other conventional methods of extraction, pasteurization and fermentation.
With our equipment we are able to provide an evident economic advantage on all possible chemical processes and therefore on:

- ***Process intensification***
- ***Gas / Liquid Mixing***
- ***Liquid / Liquid Mixing***
- ***Liquid / Solid Mixing***
- ***Hydration of Gels and Rubber***
- ***Emulsification***
- ***Homogenization***
- ***Pasteurization***



This is made possible because the alternation between low and high pressure is responsible for an intense mechanical and thermal activity that is exerted on each element present in the solution.
In the presence of organic materials, cavitation results in 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 the hydrolysis processes and, consequently, an acceleration of the anaerobic digestion process as a whole. In this case, the rate of bacterial degradation can accelerate up to over 10 times compared to conventional treatment.

Therefore, the destruction / rupture of cellular structures leads to a marked improvement in the biodegradability of organic matrices.
Our apparatus, in addition to being able to work completely independently, can be easily inserted online in any pre-existing industrial cycle: our apparatus can replace a pre-existing chemical process or multiplies a pre-existingit process by accelerating and strengthening it by over several times.
Having said all this, the areas of application of our apparatus turn out to be all those in which there is the presence of a chemical process of any kind.
The advantage for the users of our machinery can be summarized as follows:

- ➔ *cut in production costs;*
- ➔ *reduction of costs related to the expansion of production;*
- ➔ *reduction of process times;*
- ➔ *increase in the quantities of treatable matrix;*
- ➔ *reduction of costs related to disposal.*

With regard to **hydration**, this thanks to cavitation can be continuous, consistent and competitive, at the same time reducing the amount of matrix necessary to obtain the same desired level of viscosity. With regard to aeration, this is always uniform with both small and large volumes of gas and, therefore, it is optimal for both viscous liquids and rubber.
With regard to **pasteurization** and **homogenization** cavitation prevents the formation of incrustations on the walls of the apparatus, cutting the downtime required for cleaning. Furthermore, the lower degradation of the proteins present allows the lengthening of the storage periods and even the creation of entirely new products.
With regard to **emulsification**, cavitation prevents the formation of air pockets trapped inside the fluid thus maintaining the quality of the products always constant. In addition, the possibility of continuous processing allows easy control of the degree of emulsification.

# pasteurization

The persistence of microbiological activity in food liquids is one of the critical aspects of the production processes, given the considerable risk of development not only of metabolites with negative impact on the organoleptic and qualitative properties, but above all for the potential release of compounds toxic to human health.
The microbiological stabilization process of food drinks therefore requires extreme care and attention in order to break down the totality of microorganisms such as yeasts or bacteria present in solution.
Thanks to recent studies conducted by the main government bodies, cavitation has proven to be the simplest, most flexible and controllable technology as well as the most energy efficient, while the potential advantages of its application to the pasteurization and homogenization of food liquids, aimed at their introduction to the consumption, derives not so much from energy efficiency, comparable with that of an ordinary electrical resistance, but from the homogeneity of the heating obtained. The combined effect of the average temperature of the liquid and the localized, diffuse and homogeneous release of large quantities of thermal and mechanical energy, allows to reach the required food safety parameters, at average temperatures significantly lower than those of traditional processes. As a direct consequence, there is a marked energy saving and superior ability to control critical issues in the food process and product quality.
A research conducted by the Italian CNR has aimed to inactivate Saccharomyces cerevisiae, the yeasts most commonly used in the food industry for the fermentation of wine and beer, but at the same time responsible for the alterations and deterioration of the juices fruit and milk, as well as among the microorganisms most resistant to thermal and mechanical shocks.
Cavitation applied in food areas has several benefits:

- bacteria and microorganisms are eliminated at lower temperatures than traditional systems;
- less energy consumption for the same results obtained;
- preservation of the organoleptic and nutritional qualities of the products.

It can be applied at the entrance, at the exit or on the whole process. The use in the queue also minimizes any risk of oxidative processes.
The synergistic application of thermal and cavitation processes allows the temperature associated with the mortality of yeasts to be lowered by several degrees in an aqueous solution, therefore, in addition to the obvious benefits in terms of the quality of liquid foods, energy savings are quite significant: at least 2.7% for every 1 ° C drop in the maximum process temperature.

# gasifiers

Our system consists of a fluidized bed rotary furnace combined with a plasma placed in the queue for the vitrification of the aggregates. Schematically the rotating tube can be divided into three zones: in these three different reactions can take place. Furthermore, the system that supplies the oxidant for the reactions can be installed at will in one area or another allowing the differentiation of application mentioned above. The type of oxidizer can be air, oxygen or water vapor and the entire tube can be brought to operating temperature using gas torches.

If a process based on **combustion** was necessary, we would place the system that provides the oxidant for the reactions in the first part of the tube thus providing an excess quantity of air and thus favoring the combustion of the organic material - understood as a substance carbon base. Depending on the needs, the system that supplies the oxidant for the reactions could instead be placed in the final part of the tube: by heating the tube it allows pyrolysis to be obtained in the first part, reduction in the central part and combustion in the final part. The resulting products of the entire process are ashes which will be vitrified and then inertized using a plasma placed at the end. The heat generated can be used for the production of electricity. If the air is supplied in the first part, all the heat is supplied by the material to be treated.

If a process based on **pyrolysis** is necessary, the tube will be heated using gas torches and brought to a temperature of 500-600°C depending on the material to be treated. The resulting products are bio-oil (similar to diesel produced with the Fisher-Tropsch reaction), coal and gas, the latter can be used to heat the system. In this case there is no oxidizing agent and the organic molecules are split thermally.

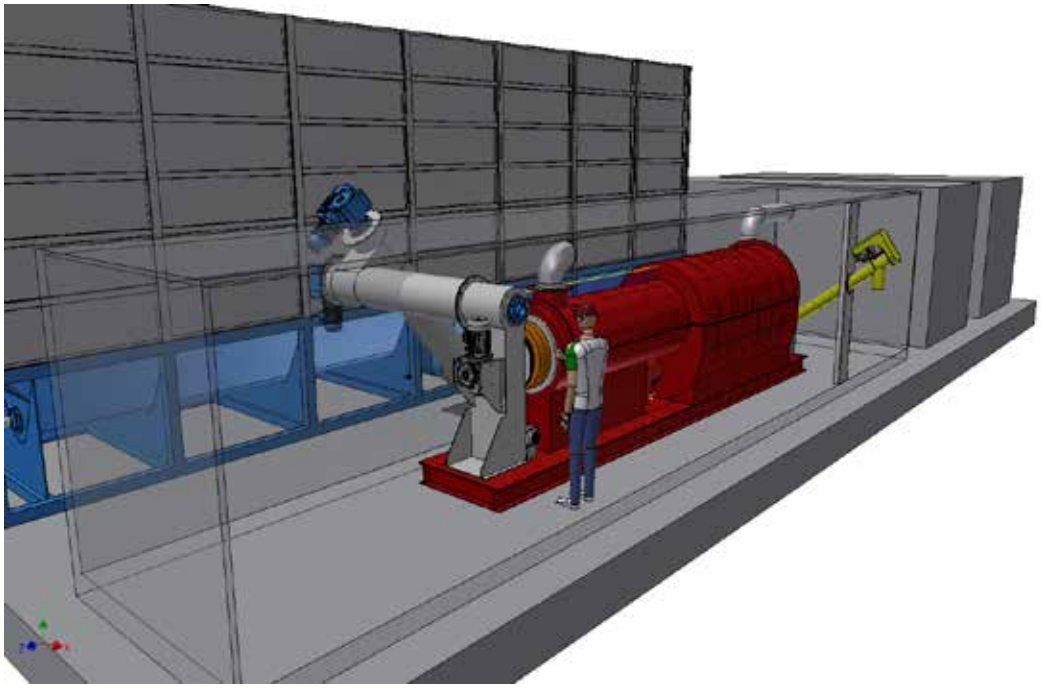

If a process based on **gasification** is necessary, the system that supplies the oxidant for the reactions will be positioned in the central part, the quantity of oxidant will be stoichiometric, the tube will be heated to the reaction temperature, i.e. above 900°C.

With this treatment process the main product obtainable is syngas.

The degree of purity of the gas depends on the oxidizer used. By using air, the gas that will form will have a high percentage of nitrogen which will lower its calorific value; using steam, the gas that will be formed will have both high calorific value and purity, allowing easy use of the gas for the synthesis of chemicals; using oxygen instead, the gas formed will have median values.

In the first part of the tube we will have pyrolysis of the material, in the central part there will be partial oxidation and in the final part there

will be a reduction of the gas produced.
The system is particularly flexible, this allows it to treat multiple materials and the ashes produced are vitrified and inertized through a plasma which transforms them into lava. In addition to eliminating the ash problem, this purifies the syngas and increases the percentage of hydrogen present through dry reforming of the methane present in the mixture.
The bed is fluidized by the rotation of the cylinder and by the particular geometry of the system which provides the oxidant for the reactions which, exploiting the Coanda affection, creates a vortex which in addition to pushing the gas forward, offers a more intimate contact with the oxidant itself and, therefore, better efficiency of the system. The rotating drum and the dispenser guarantee the fluidity of the system, ensuring temperature homogeneity; in fact, temperature gradients could create serious problems such as the creation of harmful substances such as, for example, dioxins and furans.
Unlike other systems that can be used for treatments, these are systems of decidedly small dimensions but with very high energy efficiency: in fact the combination of various jumps and the use of high efficiency turbines, as well as the use of our thermoelectric system for the recovery of waste heat allows obtaining an electrical efficiency of up to 65%.
The small dimensions, far from representing a limitation of the rotary kiln, are one of its strong points: since the systems are modular, only the equipment necessary for the treatment will be used.
The system developed by us, when compared with other systems, has numerous advantages. First of all, each plant is containerized and therefore modular and expandable according to treatment needs; at the same time, however, it can be used for small quantities of material, maintaining high efficiency from both an energy and environmental point of view. During chemical reactions we have a very high control which guarantees the formation of unwanted molecules.
The gasifiers take advantage of the molecular dissociation, called pyrolysis, used to directly convert the organic materials present in the waste into gas, by heating, in the presence of small quantities of oxygen.
The processed materials are completely destroyed because their molecules are dissociated. This process allows, if compared with the direct burning, a number of significant



advantages:

- increased fuel usability;
- use of relatively simple and tested technological solutions;
- higher energy efficiency;
- definitive Destruction of such waste;
- No contributions in special landfills;
- No harmful emissions;
- Production of steam and then of demineralized water from its condensation, with easy addition of saline charge additives for water purification;
- Possible production of Chemicals, primarily methanol, usable in automotive engines or sold on the market;
- Low visual impact.

The synthesis gas, even when of a low calorific value, once filtered and purified, can be used for the feeding of a cogenerator, thus enhancing the calorific value of the organic matrix used and can be contain costs simultaneously producing electrical and thermal energy, or it can be used for the production of reusable chemicals.
We also have **small size gasifiers**, with a lower system capacity than the one of a single standard reactor. These represent the ideal size for the needs of the so-called **circular economy**.
Our gasifiers have been developed in collaboration with the **RINA Consulting - Centro Sviluppo Materiali spa**, a subsidiary of RINA Group, also on the basis of their previous studies. In their industrial area in Rome - Italy -, there is a pilot that can be visited, fully equipped also with a plasma torch.
Our gasification system involves the use of drying systems for pre-treating the incoming material or matrix. The dryer is fed through the process' heat and allows to bring the input humidity of the matrix by the value of the conferral (normally value between 70% and 30%) to, approximately, 10%. The matrix is dried in this way, is transported inside the reactor, where it is raised to temperatures ranging from 400 to 650° C, by recovering the heat generated by the same syngas and by the same gasification process that takes place in the last part of the reactor where the temperature rises up to 1,200° C. The matrix / waste is thus subjected, rapidly, to total drying, pyrolysis and consequent gasification.
Said produced gas (syngas) will be sent, after having been properly washed and purified, to the turbine. In the absence of a plasma torch it is not possible to reach the zero emissions level but, in any case, these will be below the levels allowed by the various national regulations.
The use of syngas will produce thermal kW and electric kW. Part of the produced electricity will be used for the process.
Thermal energy can in turn be partially transformed into electricity.
Once the gasification process has taken place, the only resulting waste product is the ash, on average about 5-10% of the matrix entering the gasifiers.

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