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AGRICOLTURAL EMPOWERING

how to use technology to accelerate and enhance natural phenomena

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

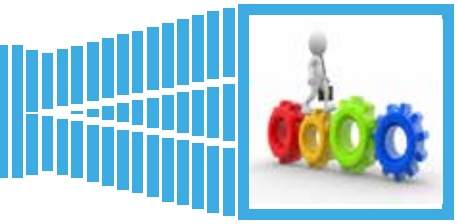
Since we don't have a second home were to go, we need to make our planet more livable without stopping technological development!
Our goal is to make our planet more livable without stopping development.
For this reason we have developed industrial systems that transform the causes of pollution into 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

introduction



Our technologies are perfectly integrated within the agri-food chain.
What if it doesn't exist yet? We invented it!

Water purification

Our treatment plant can take care of any agricultural liquid waste. Based on cavitation, it will work faster than traditional systems, will be extremely compact and will consume a small amount of energy.

Whey and washing water for dairies

We are able to enhance the proteins still present in the milk whey and also in the washing waters of the dairies.
Furthermore, the liquids, after being subjected to cavitation, will lose their polluting charge.
Therefore, from waste to be paid for their conferral, both the whey and the washing water, deprived of the proteins that will be sold on the market as a food or pharmaceutical additive, become water that can be used for watering or to be put into the sewer.

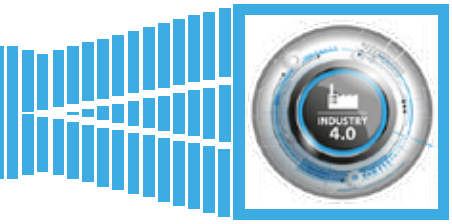
Biogas and Biomethane upgrade

We are able to supply, turnkey, a complete Biogas plant that works at least 5 times faster than traditional plants, extremely compact, capable of producing Biomethane and which does not release microbes into the digestate.

Gasification

We valorise the organic production waste by transforming them into electricity and heat through gasification; an excellent system for disposing of, for example, poultry manure.

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

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

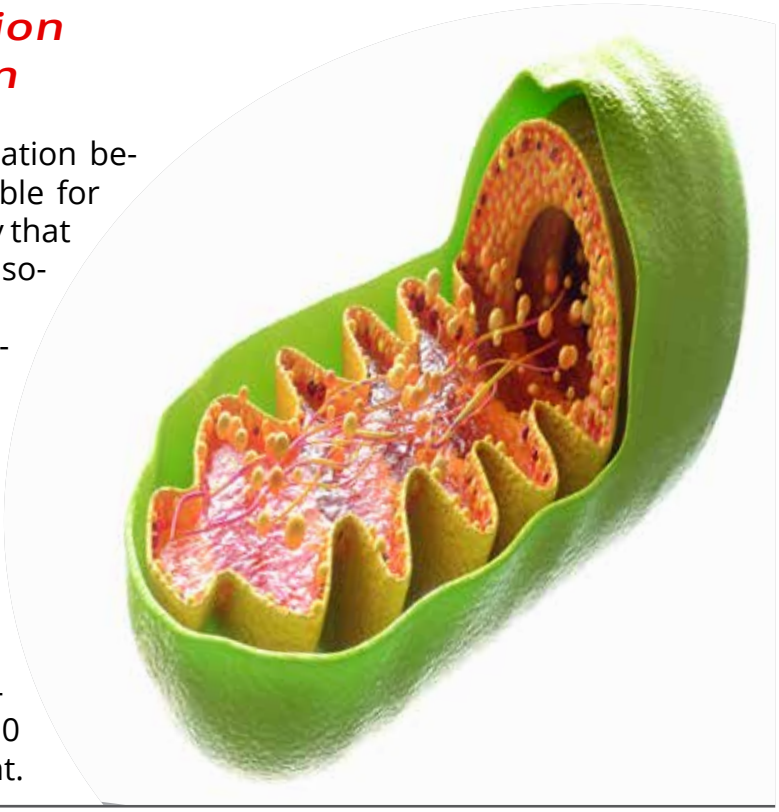
CCIMRDC Italie

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.

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%

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.

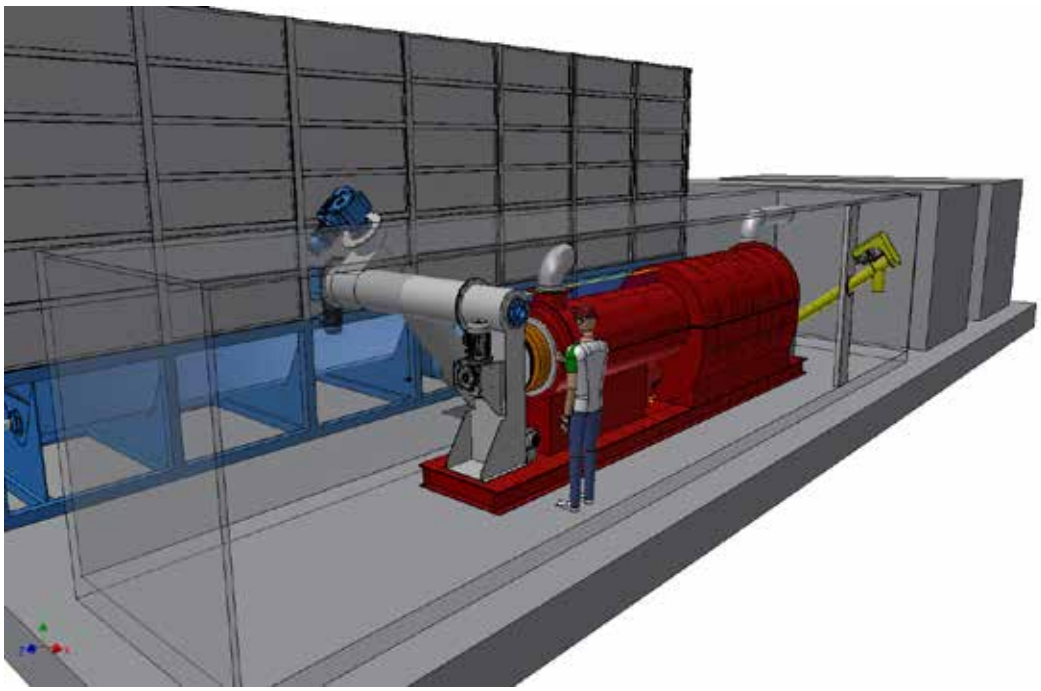
If a process based on **gasification** is necessary, the system that supplies the oxidant for the reactions will be positioned in the central part, the quantity of oxidant will be stoichiometric, the tube will be heated to the reaction temperature, i.e. above 900°C.

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

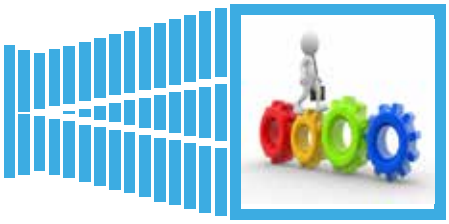


advantages:

- 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.

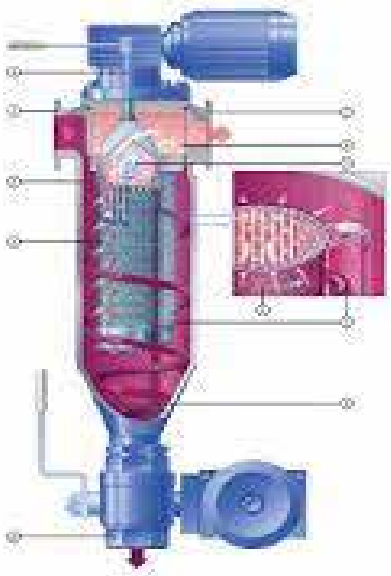
biodigestion



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.

Dairy sector

The whole system is controlled by a specially programmed PLC to minimize the need for human action. This will manage the timings, sensors and solenoid valves present. An APP allows remote control according to the dictates of industry 4.0.



Through a solenoid valve, the whey, the milk serum and the washing water are in turn aspirated through a pump after passing through a membrane filter which has the purpose of retaining the coarser impurities.

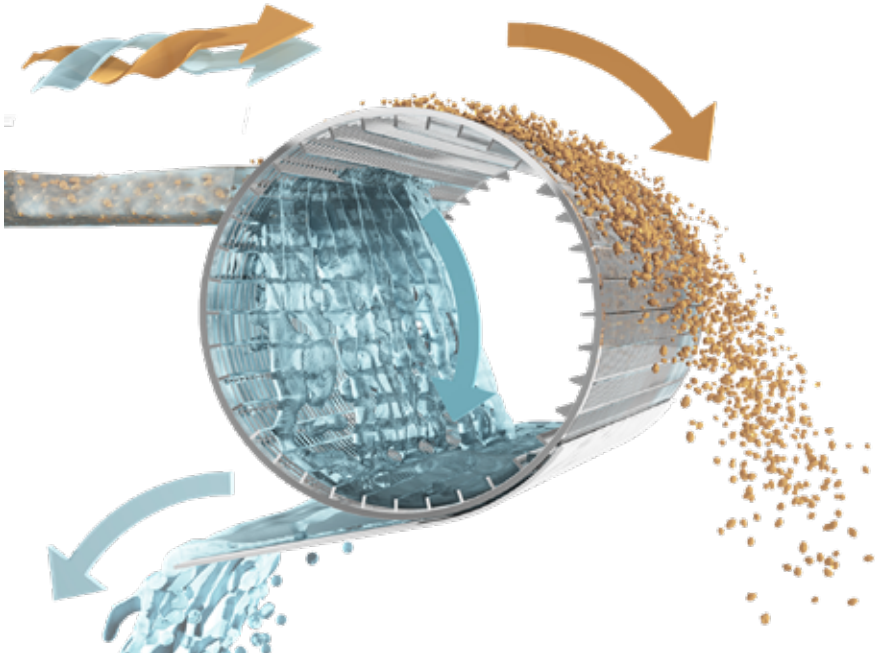
The processing within the **EMPOWERING DEVICE** for all three different matrices will take place through 2 distinct cycles: the first aimed at recovering the food molecules that can be sold while the second will purify the waters.

Once subjected to cavitation at low rpm, in order not to ruin the precious protein molecules and animal fats contained, the waters flow into a tank equipped with a weir where an automatic system will push the **centrifuge cream** into a refrigerated container that will go emptied from time to time, while the waters will be returned to the loop.

At the end of this first cycle, the same waters will be subjected to more intense cavitation to reduce polluting agents.

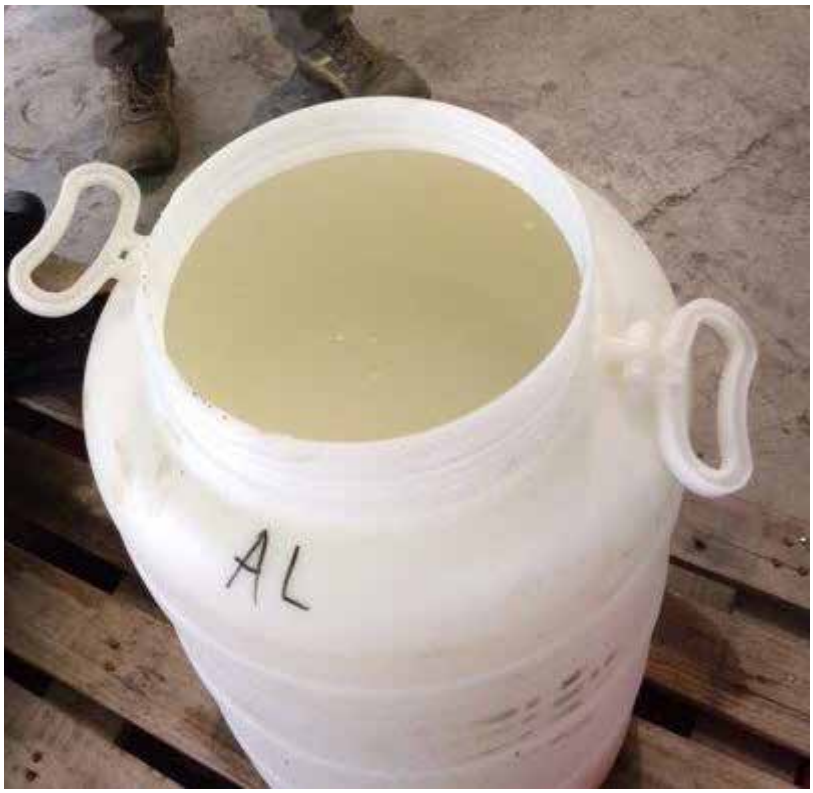
According to the customer's needs, the water can be brought to different purity levels:

- ready to be thrown into the sewer;
- suitable for reuse as washing water;
- adequate to be used for watering;
- drinkable.



The **centrifuge cream** obtained is a whey cream, which, as it is, can be sold, used to make butter or added to the cream.

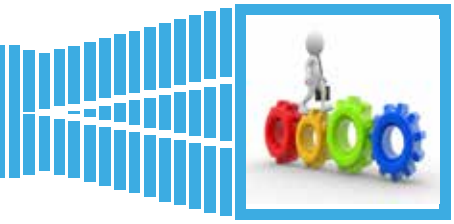
some tests performed



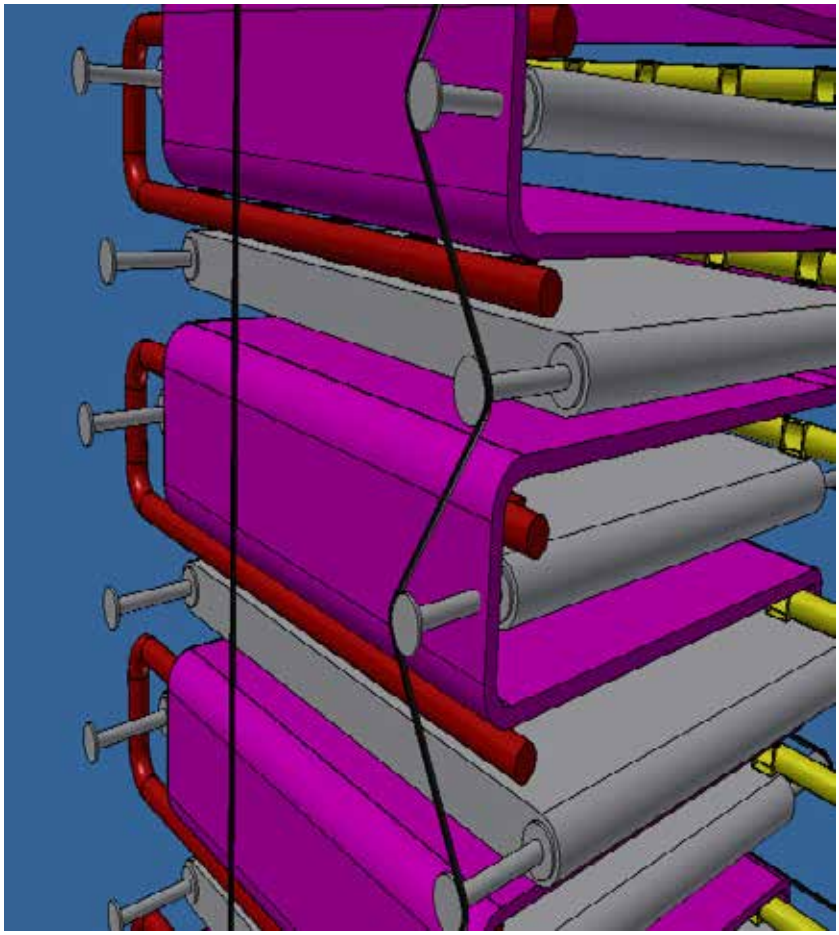
We subjected the samples of milk serum - whey - and washing water of the dairy to cavitation cycles with the initial only aim of reducing the levels of pollutants present and therefore being able to proceed with the disposal of the resulting water so as not to have to return it to landfill.
Each liquid was subjected to a double standard loop cycle lasting 10 minutes.
After the **first loop**, 35% of the proteins and 80% of the animal oils and fats were extracted from the whey and milk serum samples, while 80% of the proteins and 85 % of animal oils and fats were extracted from the washing water of the dairies.
The extraction takes place in an extremely simple way as proteins, oils and fats are placed on the surface of the liquid and therefore can be removed with a simple spatula systems.
Therefore, after the first treatment carried out inside the Empowering Device and useful for the separation of fats both on the whey and milk serum samples and on the washing water of the dairies, we proceeded to subject both fluids again to a new loop inside of our apparatus.
We take note that, once the majority of the fats are removed, during the **second cycle** the waters benefit greatly from an heavy cavitation treatment, because the **EMPOWERING DEVICE** will not take unnecessarily machine time and energy in the pursuit to break down the fat and protein mole-

cules but will immediately take action on the removal of **COD** and **BOD**.
In particular, after the treatment, the whey and milk serum see both values cut by 36% while the washing waters of the dairies see both values cut by 11%.
A result so evident that it stands out at first glance: the effect on the samples subjected to cavitation cycles within the **EMPOWERING DEVICE** was immediately evident, highlighting the possibility of **recovery of unexpected but large quantities of nutrients still present**.
So, the fluids delivered to us as exhausted and therefore, theoretically, intended to be simply recycled as process water after a possible purification, lend themselves instead to become an interesting source of additional income for breeders or dairy businesses thanks to the extraction of the residues produced that can be easily processed, for example, into pharmaceutical and / or food supplements.
For each liquid we took samples of the liquids to be treated and samples of the liquids after subjecting them to cavitation, then we sealed the bottles and sent everything to the laboratory where we had the necessary and appropriate analyzes conducted.
The Laboratory also informed us that was emerged an unforeseen action of our machinery, in each of the liquids subjected to the two cycles and which also affected the dissolved salts: **the treatment produced an interesting increase of the conductivity of the fluids**.

water treatment



Many white water treatment facilities built in past years have proved to be inadequate to support the growing level of wastewater production.
This is often even more exacerbated by seasonal production peaks.
Adapting existing treatment structures, or creating totally new ones with traditional systems, could entail huge costs as traditional plants require enormous treatment tanks, as they require long processing times with a consequent exponential increase in costs, including operational.
Now the technology, also in this field, has made remarkable progress.



Today it is possible to apply special cavitation machines to purifiers capable of speeding up their processes in complete safety, even without having to replace what already exists.
By subjecting the waste waters to cavitation, the transformation and purification process can be completed in extremely short times, from 1/5 to 1/10 of the time previously necessary, and with fewer steps.
Once the water has been recovered and purified, the residual sludge can produce quality compost or biodigested to produce biogas and compost or gasified.
The advantages for plant operators are obvious: an extremely low cost, reduced processing times and decidedly limited space requirements.

desalination

Cavitation triggers multiple effects in salt water; among these it should be noted that first of all it makes the physical bonds of the saline molecules less strong with those of the water: therefore in the subsequent reverse osmosis the saline molecules «detach» more easily from those of the water and will be able to pass the membranes easily.
Therefore much less energy is used than comparable systems.
The Empowering Device combines the effects of cavitation with osmotic membranes and filters that can remove the precipitate or floated substances, obtaining a complete purification of the treated water while removing also oils, pathogens and pollutants.
The use of cavitation ultrasound will also help in cleaning the membrane surface through mechanisms such as acoustic streaming, microstreaming, microstreamer, microjet and shock waves.
The acoustic streaming mechanism improves membrane cleanliness by transmitting acoustic energy through the feed solution to produce a flow of liquid that is obstructed, causing unidirectional waves of liquid flow with a flow velocity reaching up to 10 m / s parallel to the surface of the deposits, which can be of great help in removing dirt.
The cavitation bubbles are attracted to the antinodes of the standing wave and structured in a certain path in which the size of the bubble increases as it travels towards the antinodes located on the surface of the membrane. Once the antinodes reach the surface of the dirty membrane, bubbles are formed which cause a entrainment and detachment effect on the particles deposited on the surface of the membrane.
The shrinking effect of the cavitation bubbles moves the liquid molecules away from the surface of the membrane, while the expansion effect pushes the molecules onto

the surface of the membrane, causing shear and drag forces necessary for the removal of fouling from the membrane surface.
When the cavitation bubble reaches its minimum size, at the end of the compression cycle, the cavitation bubbles reach a sudden stop causing the liquid molecules, moved towards the bubbles, to reflect with high pressure towards the surface of the membrane.
The increase in high flow when switching from a low to a high CFV (cross flow rate) with the ultrasound facing the support layer confirms that the use of ultrasound in the support layer induces mixing and turbulence zones and thus, it reduces the impact of the ICP and improves the flow of water.
The advantages of this cleaning technique are the absence of use of chemicals, the shutdown of the system and the need to remove the membrane from the system for ex situ cleaning, in order to minimize possible contact of the membrane with the 'air.
Ultrasound affects membrane filtration through three ways: by detaching deposited contaminants and moving particles and molecules away from the membrane interface (i.e. reducing concentration polarization) (cleaning effects), improving water transport across the membrane (effects mass transfer) and increasing the heat transfer of water for thermally operated membrane processes.
Furthermore, by applying cavitation it is possible to collect the precipitated salts by passing the post-shock wave samples through a special filter, the precipitate is crystalline in nature, comprising spherical particles that are larger when derived from groundwater.
The particles contain various elements - such as chlorine, potassium and magnesium - which are consistent with the dissolved content of the original water.
The approach to desalination that we have chosen for the **EMPOWERING DEVICE** is by no means the one that has been tested for a long time in the Russian / Chinese context and considered, at least for a few years, rightly or wrongly, the way forward to apply cavitation to the removal of salt from the sea water.
These exploited the chemical and thermal conditions of cavitation to obtain an intensive evaporation of a solution in the purification phase: the superheated water after an electromagnetic treatment, in the presence of fixed obstacles placed according to a peculiar geometry, went into cavitation.
For us, however, cavitation must be understood as a process that prepares the water for osmotic desalination, also providing for its purification. Then the membranes are inserted inside the **EMPOWERING DEVICE** device becoming an integral part of it.
With both cavitation systems, the **EMPOWERING DEVICE** and the Russian / Chinese system, no chemicals are added to the water but the **EMPOWERING DEVICE**, the **SOFRON16** which represents the largest model, can desalinate over 23,000 m3 / d with a consumption of approximately 0.05 kW per m3 while the other system produced up to 1,200 m3 / d with a consumption of 3 kW per m3.
Furthermore, the **EMPOWERING DEVICE** is modular and therefore allows the installation of multiple systems side by side or overlapping.

cavitation treatment

The waste water are collected from the sewage networks and conveyed through collectors to the treatment plant.
Grilling is used to remove large solid material (pieces of plastic, wood, hygiene products, stones, paper etc.): anything that could otherwise clog pipes and pumps. It act in two steps in sequence: a first larger the second thinner. The collected grating material is washed, pressed and taken to landfill or to a **BIOZIMMI** plant.
In the grit removal tank the sands are separated using natural sedimentation. This is due because the grain size of the precipitated sands is such as not to give rise to suspensions.
In the **EMPOWERING DEVICE** all the eventually present hydrocarbons are captured, therefore begin a strong oxidation of the organic components present in the fluid occurs and the suspended particles (the sludge) are reduced to infinitesimal dimensions breaking the physical bonds with the water and thus promoting a subsequent rapid sedimentation. The fluid is also deprived of the incoming bacterial load and strongly enriched with oxygen.
In the post cavitation sedimentation / settling tank both the gravity separation of the sedimentable solids takes place (the residual sludge of the chemical / biological reactions are made more separable thanks to cavitation so they accumulate on the bed of the tank and can be pushed away by the bottom blade of the crane into the collection hoppers for subsequent treatments) and the metabolic action of specially introduced microorganisms that feed with the organic substances previously totally released and the oxygen dissolved in the sewage.
Therefore, flakes are formed consisting of colonies of bacteria that tend to decant easily, thus making the muddy mass easily eliminated. Further oxygen is supplied by blowing air from the bottom.
If needed, bacteria suitable for eliminating excess nitrogen could also placed inside the tank. In addition to the merging of the sedimentation / settling steps with the microorganisms treatment, the residence time is drastically reduced, thanks to the previous cavitation cycle.
Through an overflow system, as quickly as it is treated, the water is conveyed to a second **EMPOWERING DEVICE** where it is sanitised, eventually flocculated if it is required a greater clarification and, if needed, made drinkable. Alternatively, after the second cavitation passage, the water is purified and can therefore be introduced into a surface watercourse.

The sludge is passed through the **EMPOWERING DEVICE** to remove its bacterial load and in order to sanitise it.
Then, by means of a belt press, it is mechanically dehydrated and concentrated. At this point, free of excess nitrates, rich in carbon and dry, it can be used as quality compost for agriculture purpose or as a basis for producing biogas by biodigestion and therefore used as normal compost or, more simply, eliminated through a gasification process, self-sustainible.

traditional treatment

The waste water are collected from the sewages and conveyed through collectors to the treatment plant.
Grilling is used to remove large solid material (pieces of plastic, wood, hygiene products, stones, paper etc.): anything that could otherwise clog pipes and pumps. It act in two steps in sequence: a first larger the second thinner. The collected grating material is washed, pressed and taken to landfill.
In the sandblasting / de-oiling process, the sands are separated by natural sedimentation, while the separation and re-ascent of the oils and fats on the surface is favored by insufflation of air which, ensuring the formation of limited turbulence, also prevents the sedimentation of organic substances.
In the primary sedimentation tank takes place the gravity separation of the sedimentable solids. The sludge accumulated on the bottom of the tank is pushed by the bottom blade of the crane into the collection hoppers and then it is taken in order to be sent for subsequent treatments. At this point end the mechanical treatments which have removed about 1/3 of the organic load.
The elimination of dissolved and suspended substances takes place in the activated sludge tank. This process is based on the metabolic action of microorganisms that use organic substances and oxygen dissolved in the slurry for their activity and reproduction. In this way flakes are formed which consist of bacteria colonies that can be easily eliminated in the subsequent sedimentation step. For optimal absorption of the substances, a sufficient presence of oxygen is required, which is supplied by blowing air from the bottom of the tank.
The separation of the mud flakes from the aerated mixture is obtained by sedimentation in the final settling tank. A crane collects the sedimented mud. The activated sludge is recirculated in the aeration tank to then be sent to the next treatment. The leaving water from the final sedimentation can be defined purified and, therefore, can be returned to the surface watercourse. In addition to mechanical and biological processes, in order to limit the nutrients, such as nitrogen and phosphorus, shall also needed other treatments, otherwise these can lead to hypertrophy in rivers and lakes. Nitrogen removal occurs with biological processes through special bacteria in the oxidation tanks, while flocculant products are added during the purification process to eliminate phosphorus. The sludge from primary and secondary sedimentation is pumped into the prethickener, where the concentration of solids is increased and the sludge volume is reduced. From the prethickener, the sludge can be sent to a digester, where it remains for about 20 days in an anoxic environment at a temperature of 35° C. Specialized anaerobic bacteria reduce the organic substance and transform it, as a result of their metabolism, into inorganic substances producing as a result of their metabolism a gas with a high methane content (biogas). The produced gas, is stored in a gasometer and used as an energy source for the production of electricity and heating. The mud, digested and almost odorless, is pumped into the post thickener to further reduce humidity.
With mechanical dehydration through a belt press or a centrifuge, the sludge volume is reduced till six times. The dehydrated sludge has a semi-solid consistency which allows it to be easily used in agriculture, composting or landfill disposal.

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.

oil industry

Using controlled hydrodynamic cavitation represents a trump card to reinforce the weak link in the continuous extraction process of extra virgin olive oil thanks to the effects induced within the olive oil paste.

First of all, it can solve the bottleneck of the kneading caused by the technical advancements introduced in the 90s by mechanical crushers, reels, horizontal and vertical centrifuges.

Several scientific studies have shown how cavitation increases the quality, work capacity and efficiency of the extraction plant, ensuring its sustainability. In this case the cavitation apparatus is to be positioned between the crusher and the decanter.

Promising analyzes conducted in the laboratories and in oil mills have shown how basic cavitation systems have managed to increase the extraction yield by about 10% compared to traditional methods while increasing both the total polyphenols by about 10% and the chlorophyll content.

The latter figure is also detectable with the naked eye thanks to an extremely more intense green color compared to oils obtained with traditional methods.

The analyzes also showed an increase in tocopherols of approximately 50% and of carotenoids of approximately 20%.

Finally, the organoleptic evaluations of the oils obtained by cavitation have shown a better harmonic taste than the traditional ones, perceived as more aggressive.

As a result, experimental tests performed on a full-scale mill plant have shown the simultaneous increase in oil yields and polyphenol content in treated olive oil.

The **EMPOWERING DEVICE** can also be used for the treatment of vegetative waters, lowering the **COD** and **BOD** anched by 90%, saving on disposal costs and creating a circular water economy.

winemaking & spirits

EMPOWERING DEVICE can be also used in **winemaking** as it acts on the kinetics of the extraction of phenolic compounds during the maceration of red grapes and on the lysis of the yeast.
Careful laboratory analyzes have shown that the increase in the times of application of cavitation on the matrices corresponds to an increase in the indices of total polyphenols (over 50%) as well as anthocyanins (over 100%). These data were confirmed by subjecting different grape varieties to the same treatment.
With regard to fine lees, experimentation has shown that soluble colloids increase in less time. Total soluble proteins are significantly increased in proportion to the duration of cavitation.
A further test carried out on the lees showed that the soluble colloids present in samples subjected to cavitation were equal in number to those developed after 30 days in samples handled with traditional techniques.
Even racking can therefore be accelerated by cavitation, reducing the time required by up to 60%: about 2 days against the 5 days normally necessary with traditional methods.
Furthermore, at the end of the supply chain, it should be remembered that cavitation acts directly on the fibrous component of the matrices, increasing their methanogenic potential, therefore the pomace, previously mainly destined for pulping as they could not be properly valorized, can be used for energy purposes thus reducing disposal costs.

EMPOWERING DEVICE, as a particularly effective process accelerator in the presence of oxidations, can significantly accelerate and catalyze the aging of any liquid containing alcohol.
Therefore, in **liqueurs**, it allows all those chemical processes that alter the flavors and for which, often, take years to be carried out, in a few minutes or days.
The natural aging of liquors and spirits is therefore accelerated. This is achieved by extracting aromas and colors from the wood shavings dragged into the fluid that flows through the appliance, as opposed to the traditional static aging of the barrel.

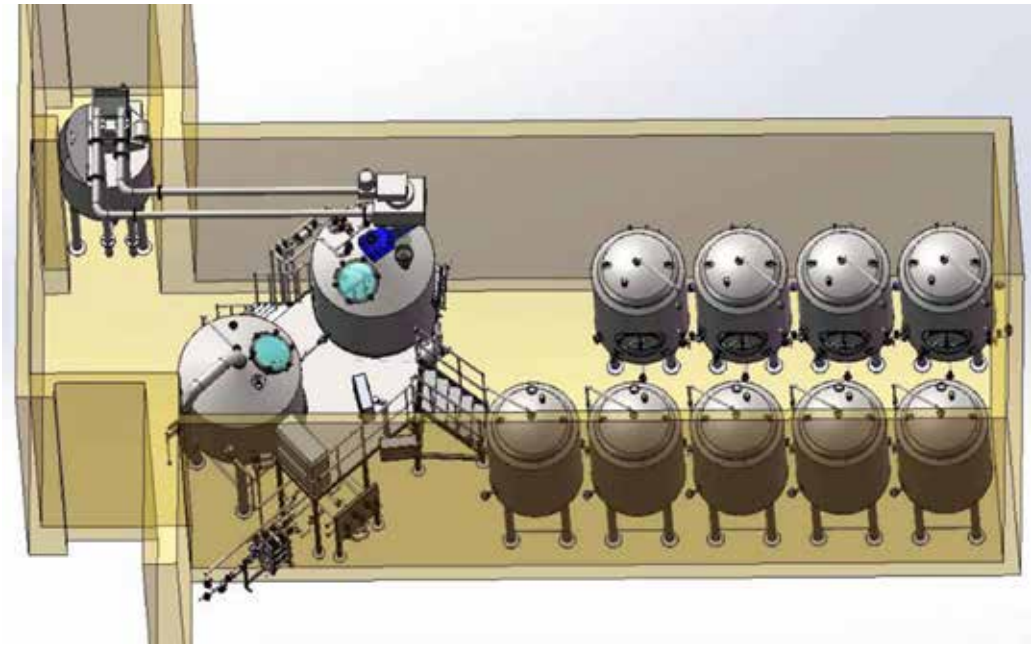
Cavitation can also help in the rapid demolition and removal of natural compounds with a hard taste naturally present in alcohol which also deteriorate as part of traditional aging.
Furthermore, not to be underestimated, the drastic increase in yield due to the loss of evaporation loss associated with traditional aging as well as the possibility for producers who will not have to wait decades to understand how their product will evolve but will be able to conduct aging tests in few minutes.

brewing

In the beer's production, in the last decades there have been incredible improvements in the field of technology, chemistry and fermentation, but the basic principles still unchanged since the early beginning: so there aren't been significant change in more than 5,500 years! Today, cavitation can "shock" them while preserving the quality of the product. We have engineered a "vertical application" of the **EMPOWERING DEVICE** with the consulting service of the CNR of Sassari, the University of Sassari and Rina Consulting - Centro Sviluppo Materiali S.p.A.

The set objective is to achieve 80% savings both in the times and in the energy requirements and to exceed 50% of water savings required for any beer production. These results should be obtained using the same amount of initial raw material, so it will be possible to produce a greater quantity of high quality beer in less time, with less water and also consuming less energy.

The process we have developed is intended to change the production process steps without altering the flavor and allowing the beer's spread also on the vast market of affected by celiac as, with our process, occurs the almost total assimilation of the amino acid proline by the yeasts, thus making the beer obtained usable also by this category of users. Our technology allows us to perform malting, mashing and fermentation is accelerated by cavitation as well as different types of aging and refinement with the exception of those conducted directly in the bottle. A last cavitation cycle will also pasteurize the product making it suitable for long storage.



juices & sauces

Starting from the assumption that the farmer has chosen the best crops and has provided them in the most eco-sustainable way in order to obtain a raw material free of elements harmful to humans and an exaltation of flavors, colors and organoleptic properties, also a single wrong step in the process could nullify any previous effort.

It should also be borne in mind that the reduction of stress suffered during mechanical harvesting and transport to the processing plant in the shortest possible time increases the total quality level and allows for a product that approaches or achieves excellence.

To obtain an excellent final product and the goal of each transformation, to do this it is necessary to control and optimize all the production phases.

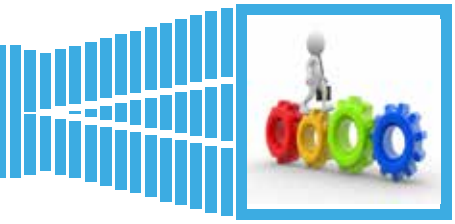
The industrial transformation process of agricultural products into juices and sauces can be schematically divided into three phases: preliminary, product and processing specification, packaging.

The **preliminary phase** consists in the receipt of the raw material, its qualitative evaluation, weighing, unloading operations, sending to the lines, washing and sorting; receiving the packaging materials and ingredients and sending them to the packaging lines.

The **specific phase** varies for each individual product and for the required final result and starts after the washing and sorting operation.

The **final phase** concerns the packaging in the desired shape (drums, cardboard, glass, etc.), labeling of the containers used and their storage pending sale.

cocoa



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.

poultry manure

With poultry manure we define the set of waste resulting from the breeding of poultry. Since this kind of manure is produced in large quantities, its disposal and / or use represents a topic of great importance for the whole human being: its correct disposal and / or use represents a social commitment.
The poultry manure is made up of poultry farm waste, therefore from poultries manure itself, from their litter, from feathers but also from animal waste, from carcasses of dead birds, and broken eggs.
Due to the high nutritional value of this compound, droppings are traditionally used in agriculture as organic fertilizers as they allow important nutrients to be returned to the fields: on average, 3% nitrogen, 2% phosphoric anhydride and 1.5% potassium are present in the droppings.
Unfortunately, however, the overuse can be extremely dangerous for human health as it often contain a very high percentage of nitrogen in organic form (60-80%) which, once spread as fertilizer, almost entirely turns into ammonia and salts ammoniacal.
Ammonia is dispersed into the atmosphere, however, its contribuits to the formation of fine dust while ammonia salts are transformed into nitrates, highly soluble in water, and therefore capable of contaminating surface waterways and, in the worst case scenario, of contaminating aquifer water.
Its excessive use can have also phytotoxic effects, as it can cause excessive soil salinity.
Therefore, it is obvious and more than evident that the current demographic level and the modern typology of intensive poultry farming contribute greatly to the production of much more droppings than any farm can accommodate.
This surplus should preferably be treated “fresh from production” to avoid further problems related to large storage such as: proliferation of insects, unpleasant odors, spread of pathogenic germs, etc.

from problem to resource

The search for a possible use of poultry manure for energy purposes stems from the fact that there is an "overproduction" on farms compared to the quantities that can be used in agriculture as soil improvers. In the industrialized world, large plants powered exclusively by poultry manure have been built in recent years, sometimes, however, their construction has been the subject of controversy, often ad hoc created by self-styled environmentalists who delayed their implementation by taking advantage of the sensitivity of the public opinion that remains influenced by sensational cases such as avian influenza, feed contaminated with dioxins, etc.
The usefulness of their construction is evident both at a managerial and environmental level. From an economic point of view, the costs of poultry manure disposal and energy supply within poultry farms could be reduced by making them "closed cycle" or "circular economy" farms, while from an environmental point of view, environmental costs would be avoided, related to the transport of the poultry manure itself for its disposal and to the use of the relative non-environmentally sustainable fuels (diesel, oil, etc.) within the farms.
Today, thanks to years of experimentation and prototyping and according to the results obtained, after evaluating the energy yields, the chimney emissions and the ash composition deriving from co-combustion and gasification of poultry manure in the boiler their use for this purpose has now optimized both energy yields and the reduction of polluting emissions.

gasification: emissions & ashes

The concentration of hydrochloric acid in the exhaust fumes is well below the emission limit for this type of emission.
Carbon monoxide, thanks to the rotating tubular geometry of the gasifier, does not exceed the reference emission levels.
The concentrations of hydrofluoric acid are always below the limits of instrumental detection and therefore do not cause concern.
Even nitrogen oxides (NOx) always presents concentrations below the legal limits, therefore not being a critical parameter.
The concentration of sulfur oxides (SOx) is not even comparable to the legal limit while the total organic carbon concentration largely respects the limits.
Even in the case of polycyclic aromatic hydrocarbons, the limit value is not exceeded.
The concentration of dioxins in the absence of smoke treatment sometimes reach the legal limit; however, by applying our fume wash, this value is also pulled down together with any dust released into the atmosphere.
The sums given by the concentrations of cadmium and thallium and the concentrations of mercury have modest values and below the limits.
Finally, the sums of metal concentrations do not exceed any legal limit.
Therefore, the energy use of the poultry manure makes it clear that between the combustion and the gasification of the poultry manure it is the latter that turns out to be the best alternative since it involves lower, often null, emissions of carbon monoxide (CO), dust, nitrogen oxides (NOx) and sulfur oxides (SOx) which affect in particular the greenhouse effect, the acidification of rains and soils, the formation of photochemical smog, and ecotoxicity.

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