

The SIAD Group

SIAD is an international chemical group active for almost 100 years in the fields of technical gases, engineering, healthcare and homecare, LPG and natural gas, energy solutions and environmental management services.

SOC. ITAL. ACETILENE DE MASSA POROSA TIPO RIGI BREV. "SESTINI,

Values

Research, Technology and Innovation

Experience, Geographical Tradition and sector

diversification

Sections

Technical Gases

SIAD - Production and distribution of industrial. specialty, food-grade and medical gases. Present in 16 European countries with manufacturing and trading companies. Tecnoservizi Ambientali - Services aimed at achieving environmental sustainability through the recovery and/or the disposal of hazardous and non-hazardous industrial waste.

and Strength

Healthcare

Medigas Italia / Magaldi Life - Innovative services and products for home and hospital care.

Worldwide presence





Commitment to Quality. Safety and the Environment



Reliability, Professionalism and Expertise



Attention to social and cultural issues

Engineering

SIAD Macchine Impianti - Design, production and installation of cryogenic air separation units, cryogenic nitrogen generators, natural gas liquefaction systems, reciprocating compressors for process gas and air, plus instrument air packages.

ESA Pyronics - Systems, solutions and components for industrial combustion.

Tecno Project Industriale - Systems for the production, recovery, extraction, liquefaction and vaporization of carbon dioxide and biogas upgrading systems.

Biogas upgrading plants to purify biogas produced by anaerobic digestion from organic waste, processing scrap and by-products, effluent from livestock farming, crop wastes and other biomass and plants for polishing and liquefaction of biomethane, bioLNG and bioCO₂. Pentatec - Gas analysis systems.

LPG and Natural Gas

Istrabenz plini Group - Production and sale of liquefied petroleum gas and methane gas for civil and industrial use.

For further information: thesiadgroup.com

SIAD Group technologies dedicated to the environment

The Group plays an active role in the environmental field, with research and development of dedicated technologies

Gases and mixtures

Benefits

The activities of SIAD and the other Group companies are characterised by the greatest attention to environmental and safety aspects, as evidenced by the Safety and Environmental Management System certifications. But that is not all.

The SIAD Group plays an active role in safeguarding the environment and protecting safety, with research and development of products and technologies dedicated to them.

Certifications

SIAD has decided to introduce and apply Quality, Safety and Environmental Management Systems (SGQ, SGS, SGA) in its company areas, which comply with the international standards UNI EN ISO 9001, UNI EN ISO 14001 and BS OHSAS 18001 respectively, and to obtain certification.

Supply methods

Any type of supply, anywhere

SIAD, thanks to branches and the network of agencies, reaches anywhere in Italy and abroad where it has a presence. Supplies can be made both in cryogenic tanks and cylinders, small or large, always with the same guarantee and consistent quality and service.

Flexigas

High-flexibility service ensuring the continuous availability of high-purity liquid gas with always constant dispensing characteristics that can be adapted to the individual requirements of various production processes.

Platinum

Each gas-related issue managed directly by SIAD. Distribution, handling and control of systems are no longer an issue.

Gas distribution systems

SIAD designs and manufactures "turnkey" gas distribution systems with high quality and safety criteria, complying with the highest standards.

SOLIDITY

Almost 100 years of history, always in profit and constant growth in revenues.

SIAD Group has deep roots in Italy and a strong aptitude for internationalization: operating in 16 countries in the gas sector and a further 38 countries through Service Centers for Engineering, all our growth is achieved in accordance with the Group's core values.

INNOVATION

Unique projects, tailor-made responses: we have always been committed to developing solutions that meet the needs of customers, who are privileged partners in a shared journey of progressive improvement. Synergies, inspiration and technological cross-fertilization with other sectors of industry lie at the root SIAD Group's innovation processes.

AUTHENTICITY

For SIAD Group personnel, fostering good relations with the customer is central to their work. We invest in skills and reliability, and aim to forge direct relationships with all our stakeholders. By listening and communicating, we always serve our customers and respond to their needs quickly and effectively, and the use of online channels makes the approach even more transparent and innovative.

The services we offer

SIAD Online

The 24/7 Online reserved area enables Customers to place orders, download invoices, transport documents, gas technical sheets and certifications. All just a click away, wherever and whenever you want.

Process certification

SIAD processes are certified according to the main UNI EN ISO directives. Its integrated management system meets the most stringent quality, reliability and traceability requirements.

Training courses for the safe use of gases

Experience in using our products allows SIAD to hold training courses for the safe management of gases together with the most accredited training centers.

DIFFERENCE

Tradition, spirit of innovation and high-quality research are interwoven with a strong bond to our territory and a range of solidarity initiatives. Wide-ranging sources of stimulus and the high level of diversification of our projects, activities and interests play a key role in making SIAD the only Group of its kind on the Italian and world stage.



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The SIAD Group's offer



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NEW TECHNOLOGIES

Development of new technologies to be made available for territorial defense



State-of-the-art environmental chemistry and biology laboratory

LABORATORIES

INVESTMENTS Continuous investment in field tests

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INFORMATION

SIAD Online reserved area, all information available

REACTIVITY

Fast intervention, convenient solutions

24-hour ASSISTANCE

Field service by qualified personnel

PRESENCE IN THE TERRITORY 0 km Location throughout the territory

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PIPELINE

Dense pipeline network with the same guarantee and consistency of quality and service.

Treatment and purification with pure oxygen



The SIAD Group and its commitment to the environment

Environmental protection and the sustainability of industrial processes have for many years been priority goals that have committed the SIAD Group to the research and development of new systems for treating waste water and sludge, including their possible utilization.

Biological processes for the removal of pollutants in waste water of different origins, have achieved significant successes thanks to the increasing use of "*pure oxygen*" (*O*₂), instead of air, for the upgrading of many existing plants and for new constructions designed according to the classic "*activated sludge*" scheme, up to the more recent "*membrane*" *processes (MBR)* and *ozonation*.



The effectiveness of oxygen fed into biological oxidation tanks in terms of improved purification performance and operational flexibility is now well established.

The advantages of using O₂ are appreciated in plants in need of robust "*revamping*" and when "*difficult effluents*" have to be purified, with environmental protection with minimal impact due to the complete absence of aerosols and unpleasant smells.

Since the 1980s, SIAD, a leading company in the production and distribution of technical and special gases, has been equipped with a structure dedicated to the development of biological waste water treatment systems with oxygen and ozone, and with an Environmental Biology and Chemistry Laboratory for the control of effluents and for carrying out the necessary tests to identify the best waste water and sewage sludge treatment processes.

Pure oxygen: key element for waste water treatment

Biological purification of civil and/or industrial waste water exploits the presence of a naturally existing microbial pool (biomass) in the sewage that assimilates pollutants by oxidizing them and transforming them into new biomass (anabolism) and energy (catabolism).

Following its first experiences with O₂ purification plants in "closed tanks", SIAD patented the MIXFLO® system for pure oxygen supply in "open tanks", which has been optimized to such an extent that it is still the reference system in its various fields of application: it is used in all types of tanks, with "external" and/or "submersible" units. SIAD has developed and consolidated its knowhow in various biological oxidation processes, from the most traditional to the most modern:

- Activated sludge: this is the most common process, in which biomass grows suspended in treatment tanks, aggregating into structures called *sludge flakes* using oxygen to carry out its vital activities.
- MBR (Membrane Bio-Reactor): this is a plant in which the activated sludge process is combined with ultrafiltration.



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SBR (Sequential Batch Reactor): a simplified version of the "semi-batch" activated sludge process.

MBBR (Moving Bed Biofilm Reactor): the process exploits the presence of plastic carriers characterized by a high internal surface area, where a highly specialized biomass grows and develops in the form of a biofilm. In this way, high performances can be achieved in removing pollutants in small volumes.



Traditional purification plants generally use air to supply the necessary oxygen to the biological oxidation tanks.

However, the use of "pure oxygen" compared to the air process is advantageous for the following reasons:

- It eliminates the emissions of aerosols, VOCs and/or unpleasant smells due to the stripping of air exiting the tanks.
- It allows high concentrations of dissolved oxygen to be achieved and maintained and thus promotes greater activity of microorganisms.
- It reduces the production of excess sludge, that is, the biomass formed during the purification process and which must be disposed of as waste.
- ✓ It allows the on-site production of ozone for enhanced purification performance and, through the recovery of residual O₂, if is of particular economic and management benefit.

- It provides a high degree of flexibility in operation, being able to easily adapt the oxygen dosage according to process demand, especially in the case of peak load and/or seasonal operation.
- It easily makes it possible to upgrade existing plants, increasing the amount of pollutant that can be treated per cubic metre of tank, as well as to achieve the increasingly stringent analytical limits for the main regulatory reference parameters (organic and nitrogenous substances, suspended solids, etc.) for the delivery of purified effluent to the consortium sewage system or to surface waters.

Our pure oxygen and ozone dissolution systems generally have a much higher energy transfer efficiency (mass transfer) than air systems, allowing a 50-70% reduction in power consumption.

Representation of biological flake

AR SYSTEMS Low concentration of dissolved oxygen Anaerobic zone Endogenous respiration zone Substrate oxygenation zone

The sludge line

It is a mixture of suspended solids, organic and inorganic, and biomass derived mainly from primary sedimentation pre-treatment *(primary sludge)* and from biological tanks *(excess sludge)*.

Excess sludge, which is one of the main cost items in the operation of a sewage treatment plant, is considered a real waste and must be suitably treated to remove part of the residual organic matter in order to reduce its solids content by weight and microbial load, including "pathogens".

This is possible thanks to digestion or stabilisation processes, which can be in the aerobic and/or anaerobic phase (with biogas production).

Aerobic digestion is achieved through prolonged aeration, in which the biomass is maintained under endogenous respiration conditions: in the absence of an external supply of dissolved and available organic matter (COD), the bacteria begin to consume the nutrients stored in the sludge flake, reducing its mass. This results in a decrease in putrescibility and partial mineralization of the sludge, reducing the amount of dry matter to be disposed of.

For aerobic digestion, the use of pure oxygen compared to air is also much more advantageous for the following reasons:



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- It makes it possible to increase the working temperature of the biological reactor for its operation under thermophilic conditions, resulting in shorter reaction times and/or greater stabilization with the same available volume.
- It allows even highly concentrated sludge to be effectively oxygenated.
- It drastically reduces the generation of aerosols and bad smells from the tank.
- It reduces foam formation.
- It often improves the performance of the sludge dehydration system.



The MIXFLO[®] system is SIAD's proprietary technology that is able to transfer a gas into a liquid with high efficiency

The MIXFLO[®] system was conceived in the early 1980s when SIAD set itself the objective of developing an autonomous, flexible, highperformance, energy-efficient system to oxygenate "open" tanks of any shape in order to activate biological purification.

The MIXFLO® system is based on a *liquid - liquid* mixing principle that achieves a high oxygen transfer efficiency in the liquid phase, typically exceeding 90%. The system consists of a centrifugal pump, a tubular dissolver and one or more liquid-liquid ejectors.



What are the advantages of the SIAD MIXFLO[®] system?

- It is an autonomous system In most cases, the SIAD MIXFLO® system, in addition to meeting the oxygen demand of the mixed liquor (oxidation and nitrification phases), is often able to maintain adequate mixing in the entire oxidation basin, avoiding the installation of additional mixers, which would otherwise be appropriately placed
- It minimizes atmospheric emissions The SIAD MIXFLO[®] system limits the movement of the liquid surface as it quantitatively dissolves the O₂ through the action of a pressure contact between O_a and the effluent, which is reintroduced near the bottom of the tank by means of liquid-liquid ejectors. This drastically limits atmospheric emissions of CO₂, climate-altering gases, VOCs, aerosols and unpleasant smells. The comparison of emissions between the use of O₂ with microbubble-blown air is in the ratio of about 1 to 200: for every m³ of O_a transferred to the biomass with the SIAD MIXFLO[®] system, only ~0.1 m³ of O₂ is emitted compared to more than ~20 m³ of spent gases emitted with air systems. The eventual covering of the oxidation tanks requires purification of the outgoing gases: the positive consequence of using O₂ instead of air results in a small, easy-to-operate spent gas treatment plant



The oxygen is fed into the delivery pipe to the pump; the pressure of the liquid and the use of pure oxygen help to achieve high dissolved oxygen concentrations (in accordance with Henry's law).

> Pump The centrifugal pump draws and pressurizes a portion of the "mixed liquor" from the treatment tank.

Mixing ·

The outflow from the liquid-liquid ejectors further mixes with the volume contained in the treatment basin, promoting rapid diffusion of dissolved oxygen.

High efficiency

The SIAD MIXFLO[®] system achieves an oxygen dissolution efficiency of $\eta > 90\%$ in the range from 3 to 4.5 kgO₂/kWh depending on the many parameters governing the solubility of the gases in the effluent (T (°C), salinity, SST, hydraulic head etc.)

✓ Great flexibility

The SIAD MIXFLO[®] system adapts perfectly to any existing open or closed tank type and any geometry. In addition, our technology is well suited to all purification processes: activated sludge and MBR processes, aerobic digestion of excess sludge, chemical oxidations (with O_2 and O_3), ozonolysis treatments, pH control with CO_2 , guaranteeing in all cases high dissolution yields of the gases used

✓ Sustainability and low running costs Pure oxygen, also produced on site by means of VPSA, is delivered by the SIAD MIXFLO[®] system automatically on the basis of signals from dissolved oxygen and/or redox potential analyzers, suitably positioned in the reference tanks, allowing the O₂ dosage to be adapted and optimized to the actual demand of the oxidation processes.

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Tubular oxygenator

Oxygen and mixed liquor are conveyed to a tubular dissolver, which provides the contact time and degree of turbulence required for the dissolution of the gases in the liquid. This results in a flow rate of strongly oxygenated mixed liquor.

Liquid-liquid ejector

The oxygenated mixed liquor is fed back into the tank through liquidliquid ejectors, devices designed to accelerate the pressurized flow and draw large quantities of sewage from the surrounding areas into the tank via the *Venturi* effect. This favors the mixing of the oxygen-rich phase with the remaining mixed liquor in the tank.

#INNOVATION

SUBMERSIBLE MIXFLO®

The MIXFLO[®] system is also available in a submersible version pre-mounted on a skid for installation in treatment tanks.

This solution reduces intervention time in the field and enables the rapid start-up of oxygen supply.





Ozone is a strong oxidant traditionally used to remove organic or metallic contaminants and as a sterilizing agent for microorganisms

The continuous search for new technologies for environmental protection has led SIAD, since the early 1990s, to consider ozone as one of the most effective chemical reagents useful in the treatment of civil and industrial effluents that are particularly difficult to purify.

On the strength of its experience in the biological treatment of water and sludge and the continuous research carried out by its Environmental Biology and Chemistry laboratory, SIAD has been able to develop and propose O_3 systems as an effective solution to a variety of industrial purification problems and to refine its "ozonolysis" techniques applied to "water and sludge" lines.

The efficiency and flexibility of the SIAD MIXFLO₃ ozone dosing system, and the collaboration with leading ozone generator manufacturers, have been decisive factors in the growth of our know-how, which is today strengthened by several processes and many fully operational ozone treatment plants.







After ozone treatment

What is ozone?

Naturally occurring through the action of ultraviolet rays on the upper layers of the atmosphere, ozone (O_3) is an allotropic form of oxygen and due to its unstable characteristics must be produced in the field, immediately before its use. Oxygen, fed into appropriate generators, is partially transformed into ozone (6 -15% in weight) by the action of high-voltage, medium-high-frequency electrical discharges applied to tubes inside a forcedcirculation water heat exchanger. With current technology, "ozonators" availability

on the market goes from a few g/h up to 200 kg O_3 /h, with specific electricity consumption of 6.5 to 13 kWh per kg of O_3 generated, depending on the concentration of O_3 produced from O_2 .





Ozone treatments: from drinking water to purification

Ozone is one of the strongest oxidants found in nature, second in oxidation potential only to fluorine. A major advantage over other reagents is its low environmental impact, as unreacted ozone is completely reconverted into oxygen. The reactivity of ozone in water is also characterized by kinetics so fast that the O_3 treatment cycle is completed in an average time of 5-30 minutes.

Ozone in the treatment of drinking water Historically, ozone has been used for the treatment of drinking water, in particular for the removal of organic or metallic pollutants (iron, manganese, etc.) and as a biocide agent for the elimination of microorganisms.

The disinfection rate of ozone is superior to other reagents, such as chlorine compounds, and is independent of the presence of ammonia and the pH value of the water. Furthermore, even when overdosed, ozone does not generate substances that are harmful to humans as is the case with chlorine (AOX, THM). Compared to other chemical oxidizing agents, such as peracetic acid, ozone improves the organoleptic characteristics of the effluent due to the absence of persistent residues, both organic and inorganic.

Ozone in the treatment of waste water

The chemical properties of ozone, qualified as a "readily available strong oxidant", make it today the reagent of choice for the removal of numerous undesirable compounds in waste water, also used in combination with biological processes as preor post-treatment. In addition to its traditional use for water disinfection, SIAD has developed other applications of ozone for the removal of many pollutants such as:

- ✓ Surfactants and detergents
- Refractory COD
- Cyanides
- Phenols
- Nitrites, sulfites and sulfides also in complex matrices
- Colors
- ✓ MTBE, BTEX
- Micropollutants (MIE, POPs)
- Complexing agents.

Ozone can also be used to increase the BOD/COD ratio of effluents with organic content resistant to biological action, typical for example in supernatants from anaerobic digestion, depending on subsequent biological treatment with O_2 recovered from the ozonation compartment.

Contact times ranging from a few seconds up to 30 minutes allow ozone treatment in almost all cases with closed reactors even under pressure. A recent application of ozone is the removal of Emerging Micropollutants (MIE) in tertiary processes in municipal, industrial and consortium waste water treatment plants.

The action of ozone on complex compounds of pharmaceutical and cosmetic origin has proved effective in breaking down most residual pollutants. SIAD has contributed to the in-depth study of this topic in many research projects, funded projects and collaborations with universities, research institutes and industrial partners (notable example the PerFORM Water 2030 program).

Ozonolysis

The disposal of sewage sludge is often the largest management cost item of a waste water treatment plant, and a real difficulty due to the scarcity of landfills or terminal sites, including the tortuous route, in our country, of incineration.

The watchword is therefore to produce as little sludge as possible.

To *"minimize"* their production, it is possible to combine biological treatment with a process of *"ozonolysis and cryptic growth"* of sludge.

Ozonolysis consists of a weakening of the cell membrane of microorganisms resulting in the release of stored nutrients (carbon, nitrogen and phosphorus). The released intracellular material is readily assimilated by the biological process, thus reducing the specific production of excess sludge. Ozonolysis can be integrated into the water line and/or the sludge line.

When the technology is applied in the water line, an aliquot of the recirculation sludge is treated with O_3 , which is then fed back into the biological compartment (denitrification and/or oxidation/nitrification).

When operating in a sludge line, two different configurations are available, depending on the digestion process, which can be thermophilic aerobic or anaerobic. In the latter case, the reduction of sludge to be disposed of is combined with the enhancement of biogas production. Recent results obtained through the development of SIAD MIXFLO₃ type pressurized ozone reactors give the "ozonolysis" technique an interesting value in terms of process economy and environmental sustainability. In fact, it is possible to reuse all the O₂ that does not participate in the ozonation reaction within the oxidation and aerobic digestion compartments, obtaining a twofold advantage: energy savings and the drastic decrease, if not zeroing, of atmospheric emissions of aerosols, VOCs, particulate matter, unpleasant smells, and climate-altering gases.



The company's own *Green Deal* program has guided SIAD to the desire to file a new Patent that contemplates the wide and increasing use of ozone from oxygen, self-produced with VPSA and recovered as a valuable oxidant in each plant section instead of the traditional use of microbubble insufflated air at the bottom of the tank. The following pages provide a graphic representation of the patent idea and the application already implemented in some notable examples.









The cryogenic system for reducing volatile compounds in gaseous effluents



In the area of cryo-condensation technologies, SIAD has designed and built the FREEZE-FLO system to purify gaseous effluents (typically for flow ranges between 0.1 and 100 Nm³/h) contaminated with volatile organic compounds (VOCs).

The system is based on the cryogenic condensation process and uses liquid nitrogen to carry out strong indirect cooling of the effluent.

The FREEZE-FLO system adapts well to the diverse needs of users, thanks to its modularity, and enables remarkable performance at low cost.

FREEZE-FLO SYSTEM The FREEZE-FLO system consists of a counter-current exchanger. In the shell, through indirect contact with nitrogen the effluent cools to temperatures where liquid/vapor or solid/vapor phase equilibrium of VOCs is established.



taking advantage of a "chiller" circuit, so as to optimize the process by reducing the risks of ice formation and the costs of liquid nitrogen supply.

The FREEZE-FLO system consists of a countercurrent exchanger with indirect liquid nitrogen flow. As shown in the illustration, the effluent flows through the column from bottom to top. During contact, condensate is formed, which is discharged and collected in an appropriate tank.

The indirect cooling configuration allows the nitrogen stream exiting the cryo-condensation column to be reused, for example as an inerting agent for reactors, process mixers and storage tanks, optimizing operating costs.

If necessary, pretreatment with a refrigerant, if available at the plant, or taking advantage of a "chiller" circuit, allows the process to be optimized, reducing the risks of water ice formation and the costs of liquid nitrogen supply.

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Double column Freeze-Flo system
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The gaseous nitrogen leaving the exchanger can be reused as an inerting agent in, for example, reactors, process mixers and storage tank, optimizing operating costs.

VOCS

The condensed VOCs are collected at the base of the column and conveyed to an appropriate tank





Operating principles

The cryogenic condensation process involves reducing the temperature of the polluted effluent to cryogenic temperatures, around -100° C, using liquid nitrogen (T = -198° C) as the cooling medium. This makes it possible to achieve the minimum temperature to ensure liquid/vapor or solid/vapor equilibrium of the volatile organic compounds contained in the effluent.

It is therefore possible to separate by condensation or solidification many organic compounds contained in gaseous streams, such as those shown in the table.

As the table below shows, VOCs are harmful to human health and the environment, and their emission into the atmosphere must comply with legal limits.

COMPOUND	CLASS	LEGAL LIMIT* (MG/NM ³)	TEMPERATURE REQUIRED (°C)
Methylacrylate	Class I	5	-98
Acetaldehyde	Class II	20	-134
Methyl chloride	Class II	20	-106
Formaldehyde	Class II	20	-138
Dichloropropane	Class III	150	-71
Styrene	Class III	150	-41
Propyl alcohol	Class IV	300	-39
Methylacetate	Class IV	300	-79
Pentane	Class V	600	-94
Acetone	Class V	600	-78
Butane	Class V	600	-116
Ethyl acetate	Class V	600	-63

Legal limits* for organic compounds in the form of gas, vapor or powder and temperatures required to comply. *Legislative Decree 3 April 2006, n. 152

Applications

The FREEZE-FLO system makes it possible to contain atmospheric emissions of unwanted compounds, typically organic solvents.

This issue is typical in the chemical, pharmaceutical, petrochemical, manufacturing and, in specific cases, food industries. In fact, in all these sectors many processes generate gaseous streams rich in VOCs (volatile organic compounds), which are a primary source of gaseous stream pollution.

Some of the possible target pollutants of the SIAD FREEZE-FLO system are:

- Chlorinated solvents
- **Ketones**
- Alcohols
- Methyl chloride
- Acetone
- Ethyl acetate
- Methanol
- **Toluol**
- Methyl-Ethyl-Ketones (MEK)
- Cyclohexane.

Advantages

- Significant reduction of specific pollutants, containing VOC emissions in treated effluent
- Collection of condensed solvent mixtures and/ or recovery of pure solvents for reuse
- Implementation of the potential of treatment plants for gaseous streams intended for incineration, reducing their pollutant volumes or concentrations
- Reuse of the entire process nitrogen for protection activities, inerting, boosting etc.
- Compliance with legal parameters for many volatile compounds, possibly by supplementing the plant with chiller precooling and/or finishing sections with activated carbons.

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VGC and activated carbons

For gaseous effluents with flow rates greater than 100 Nm³/h, other plant solutions, based on the same condensation technology, can be adopted. In partnership with the best manufacturers of activated carbon adsorption and vent gas condensation (VGC) plants, SIAD acts as a provider of know-how and up-to-date plant configurations that can solve even the most severe problems of purification of gaseous effluents polluted by solvents and organic compounds.

With combined plants, based on the techniques of adsorption and cryogenic condensation, legal values for atmospheric emissions of gaseous effluents up to 1000 Nm³/h can be met for VGC plants alone, and much larger flow rates in the case of adsorption plants on dedicated activated carbon and/or media, complete with the nitrogen regeneration section.

As with FREEZE-FLO systems, the management costs associated with VGC plants can be reduced by reusing process nitrogen for other conventional applications typical of the chemical-pharmaceutical industry.

In addition to the economic advantage, cryogenic treatment with liquid nitrogen is one of the safest processes because it uses an inert gas at low temperatures. In fact, during the passage through cryogenic exchangers, gaseous pollutant mixtures encounter only surfaces below ignition temperatures, so no dangerous ignition sources can be generated by friction or electrostatic charge buildup, and they are also in an environment without any available oxygen.



VGC Plant

Environmental Biology and Chemistry Laboratory

The Environmental Biology and Chemistry Laboratory is an applied research center in the environmental sector and brings together the experience of thirty years of studies on the operation of waste water purification and groundwater treatment plants

The feasibility study of treatment processes is carried out by means of experiments with laboratory, pilot, and full-scale plants, and evaluations are supported by chemical and biological analytical investigations.

The Laboratory collaborates with Universities and Research Centers on projects aimed at studying new processes and technologies for solving increasingly complex environmental problems. The experience gained over the years in the environmental sector makes the Laboratory the ideal partner for the development of new projects and technologies, with a specific commitment to the protection of the environment. Through its Environmental Biology and Chemistry Laboratory, SIAD provides a service dedicated to the following areas of activity:

- ✓ Waste water treatment
- Contaminated sites reclamation
- Environmental monitoring.





Waste water treatment

The study of chemical, physical and biological processes and the degradation kinetics of pollutants is the basic tool to provide useful information in case of:

- **U**pgrading
- Process optimization
- Plant malfunctions
- Effluent quality improvement for the purpose of regulatory compliance.









SERVICES OFFERED TO THE CUSTOMER

- Analytical characterization of effluent for BAT definition
- Respirometry tests for the evaluation of biodegradable components
- Biological removal tests with activated sludge and attached biomass processes
- Chemical oxidation tests with ozone for removal of organic matter, micropollutants, color, surfactants, microbial load, increased biodegradability...
- Advanced chemical oxidation tests (AOP: O₃, H₂O₂, UV, catalysts...) for removal of substances or recalcitrants
- Sludge ozonation tests (water line and sludge line) for minimizing sludge production and increasing biogas production (anaerobic digestion sludge)
- BMP tests: evaluation of methane production by biodegradation of liquid and solid organic substances under anaerobic conditions
- Clariflocculation tests with chemicals
- Sludge separation and quality tests: settleability, filterability, Foam index, Foaming potential...
- ✓ Adsorption tests on activated carbon
- Disinfection tests with UV rays, ozone, hypochlorite, peracetic acid, etc.
- PH correction and stripping tests
- ✓ Tests on Customer's request.

Waste water treatment - Excess sludge treatment

Excess sludge is the result of the entire waste water purification process and is the solid matter resulting from the various purification treatments. In turn, this sludge must be treated before its disposal or reuse.

To reduce the high organic matter content, the biological process of digestion or biological stabilization is a viable alternative to chemicalphysical processes.

The biological process of digestion can take place under **aerobic** or **anaerobic** conditions.

The laboratory has the equipment to evaluate both solutions.









FURTHER READING - DIGESTION OF EXCESS SLUDGE

AEROBIC

- Aerobic digestion test with pure oxygen in respirometry
- Assessment of oxygen demand (g0,/gTSSr)
- Assessment of contact times
- Assessment of solids removal efficiency (TSS VSS)
- Assessment of the release of C-N-P.

ANAEROBIC (BMP)

- Biochemical Methane Production Potential (BMP) of liquid and solid matrices/by-products
- Anaerobic microbial activity tests
- Measurement of the anaerobic biodegradability of a substrate
- Assessment of the stage-specific degradative capacity of anaerobic digestion
- Comparative studies on the effects of substrate lysis pretreatments with special reference to ozonolysis and the effects at various dosages.

Environmental monitoring

The analytical approach combined with the experimental approach is the indispensable tool for evaluating the efficiency and effectiveness of the purification treatments under investigation. For this reason, the Laboratory has the equipment for sampling different environmental matrices and laboratory equipment and instruments to perform chemical, microbiological, biological, biomolecular analysis and toxicity tests.

For example:

- Chemical and instrumental analysis for the characterization of samples of water, sludge, gas, air
- Analysis of sludge from biological tanks of sewage treatment plants, under the microscope (activated sludge, biofilm, granular biomass). The study of the structure and biological components (microfauna, filamentous bacteria...) allow us to assess the *health status* of a biological process and to prevent or solve possible dysfunctions, for example: *bulking, foaming, intoxication*
- Analysis of emissions into the air from a sewage treatment plant in its components: bioaerosols, particulate matter, VOCs and GHGs.



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Contaminated sites reclamation

Pure oxygen, ozone and reducing gases



The SIAD Group has for years been at the forefront of providing effective answers to problems related to the reclamation of contaminated sites

The SIAD Environmental Biology and Chemistry Laboratory has developed and patented microinjection gas technologies for aquifer reclamation: pure oxygen (GROUND $\text{BIO}_2^{\text{(B)}}$) and reducing gases (GROUND ReD), also mixed with inert gases (GROUND $\text{MIX}^{\text{(B)}}$), for aquifer reclamation.

Oxygen and reducing gases dissolved in water enable the stimulation of aerobic and anaerobic biodegradation processes for the removal of organic contamination by indigenous microorganisms (bioremediation).

Gas action can also be expressed for the chemical removal of inorganic contaminants such as dissolved metals: oxidation/precipitation of Fe-As-Mn and reduction of CrVI.

FURTHER READING

DESIGN

Noble gases such as tracers, (GROUND MIX[®]) mixed with oxidizing or reducing gases are used to determine the radius of influence and to size groundwater gas micro-injection systems.

Tracer gases are also used to assess the radius of influence of other reclamation technologies (GROUND SPY®). Tracer gas analysis is performed in the laboratory in the case of aqueous samples or directly on site using field gas chromatographs.

Advantages

The characteristics of groundwater micro-gas injection technologies make them an environmentally sustainable alternative to other reclamation systems.

These are the main advantages:

- on-site treatment
- minimum impact on the site
- simple to install and manage
- no or negligible demand for electricity
- no waste production
- absence of stripping phenomena
- possibility of carrying out reclamaton while keeping the site operating.

Through its Environmental Biology and Chemistry Laboratory, SIAD offers a complete service to the Customer: from theoretical and practical evaluation of the application of groundwater gas injection technologies and their installation and operation, to data processing and overall evaluation of reclamation progress and the effectiveness, in removing site-specific contamination, of the processes in operation.

CUSTOMER SERVICE Laboratory Activities

- Respirometry tests on groundwater to verify biological activity under different operating conditions
- Setting up microcosms to evaluate pollutant removal kinetics
- Chemical oxidation tests (oxygen, ozone, hydrogen peroxide, KMnO4...)
- Chemical and microbiological analyses in support of laboratory and field testing activities, including instrumental tracer gas analyses
- Microbiological analyses, including analyses for specific indigenous degrading bacteria (e.g., toluene oxidizers, etc.)
- Process evaluation with biomolecular investigations and isotopic analysis.











Field activities

- Installation and management of test fields to verify the feasibility of groundwater microinjection/gas injection processes
- Evaluation of the radius of influence of groundwater gas micro-injection technologies
- Installation and management of groundwater micro-gas injection facilities
- Tracer gas testing in the unsaturated to assess the radius of influence of reclamation technologies
- On-site testing of groundwater treatment with pilot plants using chemical and/or biological processes.



OZONE IN RECLAMATION

Ozone promotes chemical oxidation of refractory organic contaminants and increases the biodegradable fraction available for subsequent bioremediation.



Drinking water dearsenification plant and pH correction with CO₂

Arsenic removal plants

A particular application of carbon dioxide is for the removal of arsenic from groundwater: this operation typically uses iron oxide filters, which most effectively exert their adsorption action against arsenic when the water to be treated has a pH around 6.5.

Since the pH of groundwater is generally higher, its value should be corrected to ensure maximum removal efficiency.

Carbon dioxide is a very advantageous compound to achieve this result because, in addition to avoiding risks of over-acidification, it is an absolutely natural and non-toxic substance; moreover, since carbon dioxide does not enrich the water in chlorides, it avoids the formation of free chlorine (and therefore of the typical unpleasant smell) if disinfection treatment with hypochlorite is planned downstream from arsenic removal.

pH correction with CO₂

Dissolving in water, carbon dioxide forms carbonic acid and can lower the pH of basic effluents. The use of CO₂ thus makes it possible to solve problems associated with all treatment processes that involve raising water pH values, including, in particular, clariflocculation treatments for the removal of colloidal compounds or metals.

Carbon dioxide is an extremely soluble gas that can be dissolved by different systems; in particular, it is possible to use high-efficiency dissolution plants with the MIXFLO[®] system.

Unlike conventional chemical compounds used for regulating water pH, such as hydrochloric and sulfuric acid, carbon dioxide poses no risks of overacidification and does not increase the load of chlorides or sulfates of the treated water.



Inertization and flotation plants with nitrogen

Groundwater and soils to be reclaimed are often contaminated with easily flammable substances such as light hydrocarbons, BTEX and solvents in general: in these cases it is necessary to inert any water storage tanks, or any tanks for storing recovered pollutant compounds.

Inerting technology is based on the partial or total replacement of the oxygen present in the system to be inerted, whether a room, tank, or entire plant, with inert gases such as nitrogen or carbon dioxide; inerting a closed system eliminates the danger of fire or explosion due to the presence of potentially explosive atmospheres.

Flotation is a process widely used for the removal of suspended solids or hydrocarbons from water; it is achieved by dissolving pressurized air or gas in the water to be treated, which rises in small bubbles and drags the suspended particles with it. When reclaiming petrochemical settlements, the nature of the hydrocarbons to be separated may force the use of closed flotation plants: in this case, nitrogen must be used as the gas for contaminant separation to avoid the formation of potentially explosive atmospheres within the plant.

Based on its well-established experience in a variety of industries, SIAD is able to design and manufacture inerting systems that guarantee the highest safety standards

Aqua Freed[®] treatment for barrier well regeneration

The process involves the use of carbon dioxide in the liquid and gaseous phase

It is normal for the filters and drainage of any well to become fouled over time by mineral deposits or the growth of bacterial colonies, or occluded by the accumulation of fine sands and silts, which obstruct the flow of water causing a loss of hydraulic efficiency.

Barrier wells are particularly prone to losses of efficiency because they are intended to draw water with contamination problems and therefore often rich in organics, which promote biofilm formation, and iron and manganese, which are deposited in the well system as oxides.

The loss of hydraulic efficiency results in a decrease in the flow rate drawn by the well and thus the possibility that it will no longer be able to prevent the spread of contamination downstream. The Aqua Freed[®] process uses carbon dioxide to remove fouling and occlusions in order to restore the drawing capacity of barrier wells.

Carbon dioxide solubilizes in water to form carbonic acid, which triggers an initial phenomenon of dissolution of inorganic fouling (dissolution of carbonates to bicarbonates) and chemical attack on the microorganisms present, which are unable to survive in conditions other than their natural habitat

The low surface tension of CO₂, allows easy penetration into the cracks of fouling by dislodging it from the filter walls

The liquid carbon dioxide insufflated into the well promotes such turbulence and buoyancy as it transitions to the gaseous state that it considerably affects not only the interior of the well, but also the drainage and groundwater portion for several meters beyond the well itself. The strength of the use of carbon dioxide is precisely its synergistic chemical-physical action, which enables a more complete removal of scale and occlusions, particularly in the case of ferrobacteria; in addition, the high penetration capacity of carbon dioxide into the drainage and the surrounding aquifer makes the treatment deeper and consequently more durable.

At the same time, since the turbulence effect described above is achieved by simple state change of carbon dioxide, from liquid to gas, Aqua Freed[®] treatment does not violently stress the well structure, and is therefore suitable for any type of pipeline and filter. Finally, it is necessary to emphasize that injected carbon dioxide is an absolutely nontoxic compound, which does not present any problem of groundwater pollution or sewage disposal, but is eliminated naturally within a few hours.

The Aqua Freed[®] process is a solution to address issues of loss of hydraulic efficiency in wells. The process is based on the injection of liquid and gaseous carbon dioxide into the well and can eliminate causes of fouling and clogging for a number of reasons, briefly summarized below.

AQUA FREED® TREATMENT PHASES

The treatment



Our technicians study the data

and the condition of the well and

determine the correct positioning

of the "packer". The pump is then

extracted and the "packer" is

lowered to the required depth.

Start-up

By exerting a powerful sealing action against the wall of the well, the "packer" makes it possible to introduce liquid and gaseous carbon dioxide into the well and the surrounding geological formations.



The same system is also used to treat wells for landfill biogas extraction: again, the wells can become occluded or encrusted, making gas recovery difficult.

This situation results in a decrease in the flow rate of biogas and thus in the energy it produces and an increased safety risk due to the possible accumulation of pockets of inadequately captured biogas within the landfill body.

Conclusion



At process conditions, the carbon dioxide triggers a combined chemical, physical and mechanical action. This action dissolves encrustations and removes any fine materials that may be blocking drainage and the aquifer.

Return to service



After treatment, the well is restored and tested, the pump is reinstalled and the well can return to service.

Combustion technologies for metal recovery



ESA collaborates with leading companies in the metal recycling and recovery industry, providing innovative solutions with low environmental impact

ESA can provide complete solutions for combustion plants to recycle various metals using air or oxygen: customized burners up to 20MW, fire controls, skids and instrumentation.

Main recyclable metals

✓ Aluminum Oxy fuel and regenerative air burners for

products with different types of furnaces

Lead

Oxy fuel burners for metal recovery through battery melting

Copper

Burners for copper recycling by melting copper cathodes in shaft-type furnaces.



Within the SIAD Group, ESA focuses on industrial combustion and is a technology leader, providing a full range of certified products, and solutions for multiple sectors.

The company boasts the largest privately owned Combustion Test Center in Europe, with 7 test furnaces of up to 4 MW.

The company operates from its headquarters in Curno (BG) and has subsidiaries in Belgium, in Charleroi, and in India, in Pune.

For more information: esa@esacombustion.it



Example of oxy fuel supply skid.





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Expertise in biogas upgrading plants for the production of biomethane and $\rm CO_2$ liquefaction

TPI has extensive experience at international level in **membrane upgrading** of biogas from Municipal Solid Waste Organic Fraction (MSWOF) and agricultural origin, thanks to its installations **for more than 30 000 Nmc/h biogas treatment capacity.** TPI deeply knows biogas-related treatment problems, and applies solutions thanks also to the remote control in order to reach a **8 700 h/y production.** Moreover, TPI's special skills coming from its 30-year activity expertise at international level, allows to **recover extremely high-quality CO**₂ at optimized operational costs.

Technology and know-how

The advanced technology built into biogas upgrading plants allows the separation of a large number of components, which are appropriately filtered so that the biomethane obtained can be certified as an advanced biofuel, in compliance with the requirements of the *Natural Gas Network* of each country.

Advantages

- Efficient and reliable plants, result of the experience gained on significant biogas flows
- Know-how in biogas purification pretreatments for high biomethane quality and reliable plant operation with both low operating cost and low environmental impact solutions
- Outstanding after-sale assistance, thanks to remote control integrated with analytical instrumentation developed by Pentatec.

Biogas upgrading systems with 3-stage HPSM membrane

Several technologies exist for biogas treatment and refinement. Tecno Project Industriale offers the best ones available. One of this entails the use of very-high selective polymeric membranes (HPSM) to obtain significant flows of refined gas and high yields without the use of chemical agents.

Efficiency and versatility

The HPSM plants developed and industrialized by TPI enable them to obtain high levels of purity with recovery efficiency in excess of 99%, compliant with sustainability requirements for CIC reward, thus making the pure biomethane suitable for distribution to the national gas network.

Main features

- ✓ High pressure operating system
- CO₂ can be easily recovered with a suitable TPI system, thus recovering the little biomethane (<0.5%) in offgas
- Simple and reliable system
- ✓ Biomethane delivery pressure from 10 to 20 bar
- Biogas flow rate from 50 Nm³/h to 3 000 Nm³/h or more.



For more information: info@tecnoproject.com

Biogas upgrading systems with selective solvent

The selective solvents system operates at low pressure and requires heat in the form of steam for solvent regeneration. Separation achieved by means of this process is extremely efficient. This solution is also ideal in situations where network injection occurs at low pressure.

Efficiency and versatility

The plant technology is based on the use of a dedicated solvent enriched with specific additives suitable for the treatment of biogas, that also allows the removal of CO_2 without any special pre-treatment process. The biomethane obtained by this process is of an extremely high purity (more than 99%). Compared to conventional amines, solvent consumption is greatly reduced.

Main features

- Flow rate from 500 Nm³/h
- ✓ High purity of CH,
- ✓ High purity of CO_₂
- ✓ Ideal for ensuing bio-LNG production.





CO, purification and liquefaction plant

CO₂ Recovery and liquefaction

TPI plants for CO_2 Recovery and liquefaction are optimized to ensure automatic and trouble free operations, granting a continuous production of 99,998% pure CO_2 in compliance with the **ISBT** and **EIGA** guidelines.

Main features

- Complete tailor made design according to client request
- High flexibility
- Low consumptions
- Compact design and optimization
- 24/7 remote service.

PENTATEC

Pentatec is the Tecno Project Industriale company specialized in analytical sytems for quality gas control on industrial applications (breweries, softdrinks, technical gas) and biomethane.

In particular, Pentatec supplies instrumentation, makes analysis, monitoring and certification of gas flows. Thanks to its wide experience in biomethane, it is able to support biogas plant operation with inlet biogas analysis and monitoring, especially micropollutants, and biomethane upgrading output quality control, thus giving guarantee of production reliability and quality compliance with biomethane grid requirements.

For more information: commerciale@pentatecsrl.com

Biomethane liquefaction

To complement its experience, in the biomethane supply chain, Tecno Project Industriale provides three proven technologies for liquefaction.

The liquefaction process

Biomethane at ambient pressure liquefies at -160°C, a temperature that can be reached through cryogenic technology, which has already been widely established by TPI.

- **SMART LIN-LNG**: biomethane liquefaction achieved by the process of evaporating liquid nitrogen
- **LNG Pocket:** biomethane liquefaction achieved directly by multistage compression, cooling and adiabatic expansion techniques.
- SMART TB-LNG: liquefaction achieved by heat exchanger integrated in a closed cycle with expansion turbines and boosters.

Purpose

The application of the produced bio-LNG allows remote storage and transportation of a fully renewable fuel such as methane.



SMART LIN-LNG biomethane liquefaction plant



biomethane liquefaction plant

Technologies and advantages

- Consolidated technologies enhanced by the strong cryogenic expertise of TPI and SIAD Macchine Impianti
- Highly reliable and efficient machines for the treatment of nitrogen (compressors and turbines)
- Simple plant management process and control system in all stages of operation
- Integration with upgrading systems and maximum productivity and efficiency.
- Safe plants with a low environmental impact.

RANGE OF "SMART LNG" PLANTS AND	BIO-LNG PRODUCTION		
"LNG POCKET" PLANTS	Nm³/h	TPD	kg/h
SMART LIN-LNG Plant using nitrogen as a cooling factor	50 ÷ 280	1 ÷ 5	40 ÷ 208
LNG Pocket Direct compression, cooling, expansion and liquefaction	280 ÷ 560	5 ÷ 10	208 ÷ 415
SMART TB-LNG Nitrogen recycling plants with expansion turbines and booster	560 ÷ 1 400	10 ÷ 25	415 ÷ 1 040

Individual capacities are considered indicative and increased depending on conditions

For more details: info@tecnoproject.com

CO₂ and nitrogen compressors



Safety, reliability, efficiency, availability, maintainability and connectivity: these are the most important features assured by SIAD MI compressors

Based on its extensive experience in handling all types of gases and mixtures, SIAD Macchine Impianti (SIAD MI) has created innovative solutions for compressing all gases in the upgrading and liquefaction process: biogas, biomethane, carbon dioxide and nitrogen. Each of the compressor plants is designed to ensure the highest standards of gas guality and the lowest environmental impact, ensuring the best performance in terms of efficiency, consumption and maintainability.

SIAD MI compressors are designed and manufactured according to lean methodology, which combines modular design with the integration of digital systems, minimizing waste and maximizing performance.



WASTE WATER TREATMENT PLANTS **Repeated success for SIAD MI compressors**

SIAD MI has countless references for the supply of oil-free high-pressure air compressors for waste water treatment plants with the "wet air oxidation - WAO" process.

SIAD MI is at the forefront for the development of efficient, sustainable and always-connected oil-free solutions designed to customer specifications.

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Connective compression everywhere SIADMI4U

Finally, SIAD MI also offers a wide range of mutually integrated services, including a digital platform for remote monitoring and diagnosis in real time of its plants and compressors, called "SIADMI4U", as well as after-sales services through the Global Service Division and its Service Centers which guarantee an immediate response to all customers, worldwide.

For more details: siadmi compr@siad.eu



Everything changes, sustainability remains, our experience serving the environment

Tecnoservizi Ambientali has been part of the SIAD Group since 2004 and has been involved in environmental sustainability, offering technical consulting services for the rationalization of critical raw materials, it has its own storage facility and offers recovery and/or disposal services for hazardous and non-hazardous industrial waste.

The company is distinguished by its special knowhow of environmental recovery technologies throughout Europe and its constant scouting of advanced solutions on behalf of its clients. It has extensive experience in handling crossborder paperwork directly from production sites or from the Cortenuova site where waste is stored, controlled and sent to European facilities, the final recipients.

Our plant

The authorizations of reference are: AIA nr.7248/2011 and resolution no.442/2016, with the latter authorized for operations in R3, R4, R5, R6, R8, R12, R13 and in D13, D14, D15.

The site covers an area of 17,000 square meters and is authorized to treat approx. 85,000 tons/year of incoming waste.

The company is registered in the Register of Environmental Operators for the categories: 4F - 5F -8B and 9D.

✓ Mixing of waste

Possibility of mixing waste, exempt and nonexempt, to be sent later to final facilities in Italy and/or abroad

Storage area

Preliminary storage in R13/D15 and subsequent sending for recovery/disposal in selected and certified final facilities in Europe

In-house analysis laboratory

The company has a laboratory equipped both for quality control of incoming and outgoing waste and for conducting research and development aimed at recovering valuable material present in the waste and then proposing solutions to close the production cycle.



Our services

Waste management services for the integrated biomethane supply chain

We offer:

- ✓ Supply of mobile filters for rent
- Supply of virgin activated carbon and waste pickup service
- Management of logistical rotation of filters
- Activities of emptying and loading filters both at the customer's site and at the plant
- Technical advice for sizing the filter unit.

Recovery of transition metals from spent catalysts

- Recovery of catalysts containing Ni, Ni Mo, Co Mo, Ni V transition metals at NHA, Aue, Germany.
- Spent catalysts are assessed according to the concentration of metals present and valued according to LME.

Production cycle analysis and assessment

Analysis services are carried out for the protection of environmental KPIs, such as production cycle assessment, PEF/OEF (Environmental Product Footprint/Organization Environmental Footprint, Life Cycle Assessment, LCA) calculations with unified methods for quantifying the environmental impacts of products and organizations.

	TECNOSERVIZI AMBIENTALI PLANT	
	Spent active carbon storage	
tacive cation	Fresh active carbon storage	
load of sper-	Filter loading and emptying	
	Notification management and logistics	



FURTHER READING

REFRIGERANT END-OF-LIFE

All spent refrigerant gases cannot be released into the atmosphere but must be collected to be disposed of or regenerated as they are classified as special and hazardous waste.

SIAD offers refrigerant gas collection and disposal services throughout Italy by partnering with Tecnoservizi Ambientali S.r.I. (TA), a Group company that specializes in industrial waste management. TA is included in a special Program Agreement with the Ministry of the Environment, allowing these wastes to be collected and sent to their end-of-life, closing the loop. Cylinder disposal and spent gas recovery Management of all types of gases:

- ✓ obsolete acetylene cylinders
- ✓ air gases
- ✓ toxic gases.

Disposal/recovery of spent CFC, HFC and HCFC refrigerants

- Reclamation of refrigeration systems
- ✓ Supply of empty cylinders for rent, approved and reclaimed, in order to make every step of the process, from emptying to disposal, easier and safer.

Management of contaminated environmental matrices (soil, subsoil, and groundwater) Tecnoservizi Ambientali, also registered under category 9D of the Register of Environmental Operators, offers technical/regulatory and project consulting services for the management of various environmental issues arising from the contamination of environmental matrices (soil, subsoil and groundwater) that can be found at active, decommissioned industrial and commercial sites and at fuel sales outlets.

WASTE DESCRIPTION	PRODUCTION INDUSTRIES	TYPE OF PLANT
Acetylene cylinders	 Production and distribution of technical gases Various industries 	- Integral recovery plant - Exclusive plant abroad
Hydrogenation catalysts	- Oils and greases - Petrochemical - Chemical	- Metal (Ni) recovery from spent catalysts - Customer-exclusive plant abroad
CFC, HCFC, HFC and SF_{6}	- Collection in cylinders and tanks from user industries	- Chemical recovery and incineration
Expired reagents, laboratory kits	- Laboratories	- Incinerator for solids and liquids - Plant in Italy and abroad
Catalysts containing transition metals	- Refineries - Petrochemical	- Integral recovery of metals and inert material - Customer-exclusive plant abroad
Solvents/Solvent Mixture	- Refineries - Chemical	- Recovery plant - Plant in Italy and abroad
High-caloric solvents	- Chemical - Pharmaceutical - Petrochemical	- Cement plant/Incinerator - Plant in Italy and abroad
Extinguishing powders	- Industry in the sector	- Recovery/disposal - Plant abroad
Liquid pitches, including those with high chlorine and fluorine content	- Chemical - Petrochemical - Pharmaceutical	- Chlorine recovery/disposal - Customer-exclusive plant abroad
Metal powders	- Metallurgy - Wire drawing mill - Foundry	- Metal recovery - Exclusive plants in Italy and abroad
Activated carbons	- Refineries - Biomethane and biogas plants	- Exclusive recovery/disposal plant abroad
Water with low calorific value	- Chemical industry - Pharmaceutical industry	- Incineration
Solid and liquid waste with high calorific value	- Industry	- Energy recovery

Post Combustion for VOC

ESA provides solutions for Post Combustion processes to reduce volatile compounds released into the atmosphere during combustion processes

Post-combustion represents a purification process that uses an exothermic reaction to destroy various hazardous air pollutants found in discharges emitted from various industrial processes.

The process takes place in a combustion chamber where the effluents, through the action of heat, are reduced to harmless substances such as carbon dioxide (CO₂) and water vapor (H₂O).





Post Combustion Processes

J ESA NM Nozzle Mix Burners Provided with a short flame, allowing adaptation to the size of RTOs. Possible use of preheated air up to 500°C. Available up to 20 MW

EMB Multi-mouth Burners They allow the generation of a very short flame even with high powers. Available up to 20 MW.



Opposite is an NM burner installed on a post-burner. Above, its particular flame.



Natural refrigerant gases are the real green alternative to F-Gases, because of their outstandingly low environmental impact, excellent energy performance and availability



COOOL[®] can be used in a wide range of industrial and non-industrial applications, such as supermarket cabinets, containers and climate-controlled residential systems.



NATURAL REFRIGERANTS IN AUTO AIR CONDITIONING

Several car manufacturers have developed alternative air conditioning systems, replacing R-134a, banned by the MAC regulation, with R-744 natural refrigerant solutions: although the gas has less environmental impact, it requires more compression energy, so it can only be applied in cars in certain categories.

Recent technologies related to electric mobility use R-744 in a heat pump inside electric vehicles. The batteries are maintained at the optimal working T°, and the recovered heat is mixed to regulate the passenger compartment. Increasingly stringent regulations have promoted the use of refrigerants with the lowest environmental impact.

Modern technology allows the exploitation of the thermodynamic characteristics of naturally available non-fluorinated fluids.

Carbon dioxide, hydrocarbons and **ammonia** are capturing a growing share in their respective target markets.

The specific characteristics of these gases require dedicated plant design and specific training for personnel involved in their use.

Natural refrigerants are classified as:

- **CO**₂ (R-744)
- Hydrocarbons (R-290 / R-600A etc...)







Carbon Dioxide R-744

COOOL[®] R-744 is a natural refrigerant gas, with multiple applications in commercial refrigeration, the food industry and refrigerated logistics.

The GWP is taken as the benchmark $(CO_2 \text{ is assigned GWP} = 1)$ for all other gases. It requires high-pressure cylinders and higher working pressures than other refrigerants, so plants must be designed ad hoc.

In addition to good heat transfer properties, the high volumetric cooling capacity allows the use of small-capacity compressors with excellent efficiencies at low and medium temperatures.

Propane Natural Refrigerant

Propane R-290

Hydrocarbons were among the first refrigerants to be used in industrial and then domestic applications.

In addition to their excellent heat transfer properties, hydrocarbons allow the use of mineral lubricating oils, which avoids moisture-related problems with synthetic lubricants. All hydrocarbons are flammable, so far the main

applications have involved limited charges. High gas charge applications are also becoming more common, for example, for new specially designed indirect chillers.

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Ammonia R-717

It has been in industrial applications since the 1930s, in fact its high evaporation heat allows high efficiencies.

However, ammonia is a toxic gas, flammable in certain concentrations, and incompatible with copper and its alloys.

For these characteristics, direct expansion technology is normally avoided, preferring secondary fluid (glycol water) systems.

In several systems, two refrigerant circuits can be used in cascade, the primary one operating with ammonia or other refrigerant gas, and a second carbon dioxide cycle.



The correct storage of perishable products requires observance of the cold chain all the way from production to sale

In the world of temperature-controlled transportation, conventional refrigeration systems, which operate with fluorinated refrigerant gases with a high environmental impact, are widely used. SIAD provides innovative *green* technology solutions that offer high performance and low power consumption, ensuring that the required operating temperatures are always maintained.

COOOL[®] FreeToGo Refrigerated road transport

COOOL[®] FreeToGo is the refrigeration system that, by harnessing the refrigeration power of CO_2 R-744, enables the maintenance of the cold chain inside a temperature-controlled vehicle.

Unlike the vehicles in use today, the system is independent, quiet and high-performance. The natural refrigerant gas, once its refrigeration power is are released, is directed outside of the vehicle.

The user recharges it easily, autonomously and automatically.

COOOL[®] FreeToGo is designed to operate on both fresh and frozen products, depending on customer needs.

It is the ideal solution for the delivery world, but it is perfectly suited to all refrigerated road transport needs.



REFRIGERATED ROAD TRANSPORT





COOOL[®] RollBox Refrigerated transport in roll containers

COOOL[®] RollBox is the SIAD refrigerated transport technology that provides cold chain preservation and maximum flexibility in travel by refrigerated isothermal containers.

The quick coupling allows liquid CO_2 to be injected directly into the drawer, generating carbonic snow. The amount is selected from the control panel to immediately achieve the required refrigeration.

The system, fixed inside the isothermal roll container, behaves as if it were a eutectic plate, however, offering more power and consistency in the emission of refrigeration and ensuring temperature control and longer storage of goods.

COOOL[®] RollBox enables simplification in cold logistics.

The engineering of the drawer ensures that the correct amount of cold is transmitted to the transport compartment.

REFRIGERATED TRANSPORT IN ROLL CONTAINERS





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The use of solid carbon dioxide is a valid alternative to mechanical refrigeration systems.

SIAD supplies both dry ice pellets, available in multiple packages and suitable for all needs, and dry ice makers, which produce carbon dioxide snow and distribute it directly onto the products to be refrigerated.

These solutions maintain the correct storage temperature and ensure continuity of the cold chain.



ESA is at the forefront in the development of sustainable combustion systems using hydrogen or other "carbon neutral" fuels

ESA provides solutions for pure hydrogen combustion, NG/H₂ mixtures, as well as for any gaseous or liquid synthetic fuel (biomethane, biodiesel, ethanol, ammonia, etc...) using air or oxygen as oxidizers.

Fuels

- ✓ Hydrogen and Hydromethane
- ✓ Liquid bio fuels
- Syngas and Biogas
- ✓ Process gas



H₂ ready is our hallmark certifying that a product is suitable for hydrogen use, and has been designed with sustainability and energy conservation in mind.





With SIAD, supplies suit your production process. Reliability, timeliness and security, wherever and whenever you want!

Small- or large-scale uses? Full service or no-frills? Our gases, cryogenic or compressed, are supplied in a wide range of containers:

- Cylinders and cylinder packs available in various capacities
- Containers for cryogenic gases in liquid phase available in various capacities
- Flexigas, minibulk for more flexible supplies.





CYLINDERS

CYLINDER PACKS

FURTHER READING

DISPOSAL OF ACETYLENE CYLINDERS

Thanks to Tecnoservizi Ambientali, SIAD can offer their Customers a disposal service for acetylene cylinders. At the end of service, the Customer receives from Tecnoservizi Ambientali the final certificate of disposal.

This service is offered both to operators in the sector and private individuals.

FURTHER READING

GET GROUP

ESA chairs the GET hydrogen group of ANIMA Confindustria, which works to promote hydrogen in industry by removing any technical and legislative obstacles.

- Declarations of conformity and certificates of analysis
- Issued upon request, referring to standard or custom parameters depending on the various quality, certification or process requirements.
- Certificates of analysis and declarations of conformity follow the product and the Customer anywhere, and are available 24/7 on the SIAD Online reserved area.



CRYOGENIC CONTAINERS



FLEXIGAS





Discover the new SIAD Online Customer Area!

The advantages of SIAD online:

- ✓ Order in complete autonomy
- ✓ Cylinder stock reports
- ✓ Cylinder rental fee (MDB) explanations
- ✓ Account statements
- ✓ Find all the commercial and technical information you need.

REGISTER FOR FREE and you will immediately have access to a space dedicated to your needs, that will allow you to use our services at **any time, easily** and in complete **autonomy**



siadonline.com





EASE OF USE Simple and intuitive to use

AUTONOMY You can use it at any time and in real time



SIAD MOBILE: YOUR ORDERS ALWAYS ON YOUR SMARTPHONE!

With the *SIAD Mobile App* you no longer need to be in the office to order gas: you can access the innovative SIAD app at any time of the day, ordering completely independently from your cell phone. You can create a new order or replicate a previous one, and thanks to the tracking system you will know exactly the status of the order and the expected delivery date.

In addition, thanks to barcode scanning, the order can be placed even by those unfamiliar with gas names!



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The SIAD Group

Technical gases

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GPS: N 42 39:10 - E 22 27:43 **CZECH REPUBLIC** SIAD Czech spol. s r.o. Prague Office Park II - K Hájúm 2606/2b C2-155 00 PPAGUE 5 Tel. +420 235097520 - Fax +420 235097525 www.siad.cz - siad@siad.cz GPS: N 50 03.21 - E 14 19.32 FRANCE SIAD France SAS Parc d'activité de Signes, espace Arusha Avenue de Berlin F-83870 SIGNES Tel. +33 (0) 498181463 www.siad.com - siad_france@siad.eu GPS: N 43 25.68 - E 5 80.05 GERMANY W. Eichstetter GmbH Ziffling 1 D-93497 Willmering bei CHAM Tel. +49 (0)9971 858010 - Fax +49 (0)9971 8580110 www.eichstetter-gase.de - info@eichstetter-gase.de GPS: N 49 23.78 - E 12 67.81

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www.siad.hu - siad@siad.hu GPS: N 48 07.25 - E 20 48.07 POLAND

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RUSSIA LLC SIAD Rus

C SIAD Hus Bolshaya Dmitrovka street 12/1 - build 1, 3 floor RU-107031 MOSCOW Tel./Fax +7 (495) 7213026 www.siad.ru eww.siad.ru GPS: N 55 45.41 - E 37 36.53

GF95: N 50 40.41 + C 57 90.00 SIAD Slovakia spol, s r.o. Rožňavská č. 17 SK-831 04 BRATISLAVA Tel. +421 (2) 44460347 - Fax +421 (2) 44460348 www.slad.sk - siad@siad.sk GF95: N 48 10.29 - E 17 09.47

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ESA Manufacturing Pvt. Ltd. Plot No. J - 244, MIDC, Bhosari IN-411 026 PUNE Tel. +91 9822601452 www.esapyronics.com - esaindia@esapyronics.com GPS: N 18 38.41 - E 73 49.38 Tecno Project Industriale S.r.I. Via Enrico Fermi, 40 I-24035 CURNO Tel. +39 035 4551891 - Fax +39 035 4551895

Engineering

www.tecnoproject.com - info@tecnoproject.com GPS: N 45 41.11 - E 9 37.19

Technical gases

Healthcare

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