ALPHACHEM®

GAS PHASE FILTRATION

ENVIRONMENTAL FILTRATION SOLUTIONS FOR INDUSTRY

Biogas Purification

www.alphachem.es

Green Keeper

GreenKeeper

WHO WE ARE

Iberia

GREENKEEPER IBERIA is a Spanish company composed by experts in Gas Phase Filtration with large experience in the industry. With its own facilities, develop and commercialize engineered media for air/gas purification for more than 20 years with distributors in all 5 continents.

It is divided into three main sectors:

GREENKEEPER IBERIA
World leader in the ethylene market for fruit preservation.

GREENKEEPER DESSICANTS
Manufacture and marketing of desiccants for transport and storage of products.

ALPHACHEM
Design, manufacture and marketing of filter media and equipment for chemical air filtration, for all markets where pure and odourless air is required.

ALPHACHEM

It is the registered trademark of GreenKeeper Iberia for the range of products for Dry Chemical Gas Filtration. With its own factory in Spain, it designs, manufactures and markets Filter Media and drum scrubber filters. Its most important applications are the protection of control electronics against corrosion generated by corrosive gases generated in the manufacturing process; the elimination of odours in waste water plants; biogas purification; the elimination of polluting gases inside buildings; the preservation of works of art and all those applications where the chemical filtration of air or gases is necessary. In the following catalogue we present products and solutions for biogas purification, that will contribute to the improvement of the relationship between industry and the environment. We hope this information will be of interest to you and looking forward to seeing you soon.

The GreenKeeper Iberia's team.

What is biogas?

Biogas is an environmentally-friendly, renewable energy source. It is produced when organic matter, such as food or animal waste, is broken down by microorganisms in the absence of oxygen, in a process called anaerobic digestion.

Where is biogas produced?

A wide variety of feedstocks can be used to produce biogas including crop residues; animal manure; the organic fraction of Municipal Solid Waste, including industrial waste; and wastewater sludge.

Anaerobic Digestion Process


Livestock Waste


Crops


Waste Water


Food Waste

Anaerobic Digester

Biogas


Boiles


Engines (Turbines)


Upgrading System

Biomethane


Heat Production


Heat & Electricity Cogeneration


Mobility CNG/LNG


Gas grid Injection

Digestate


Horticulture Products


Crop Irrigation

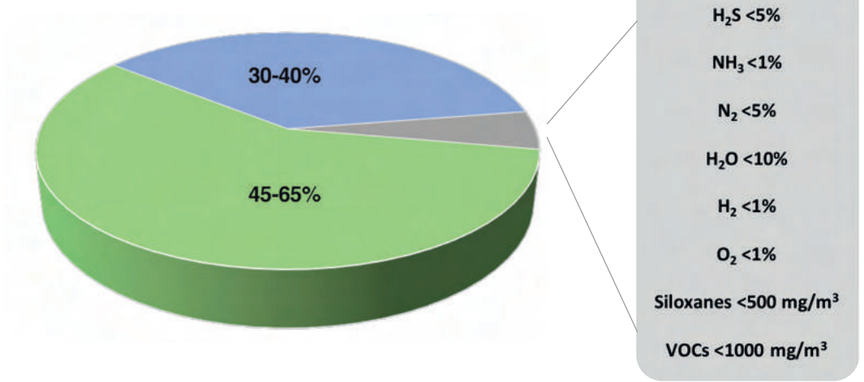

Other Products (e.g., building material)


Animal Bedding

Biogas composition

Biogas consists mainly of methane and carbon dioxide. It can also include small amounts of hydrogen sulphide, hydrogen, nitrogen, siloxanes, VOCs and moisture. The relative quantities of these vary depending on the type of waste involved in the production of the resulting biogas.

Typical Biogas composition ▶



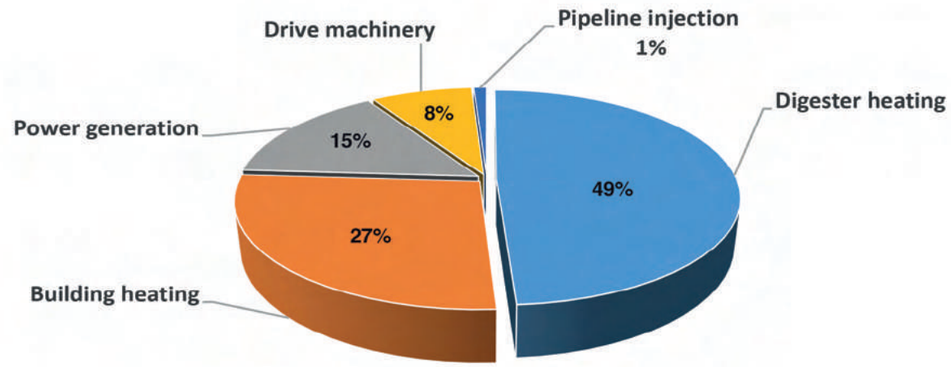
What can biogas be used for?

Biogas is commonly used in combined heat and power (CHP) processes to produce heat and electricity. Depending on the digester type and the climate of the region in which the Anaerobic Digestion facility is located, some or all of the heat produced may be used within the plant to maintain the digester temperature at optimum levels.

Biogas can also be upgraded to biomethane for the production of compressed natural gas (CNG) and liquefied natural gas (LNG), which have similar energy properties as fossil-fuel natural gas and can be used as transportation fuels.

Biogas end use at Waste Water Treatment Plants

Porcentages of biogas utilization technologies in use at WWTPs producing biogas ▼



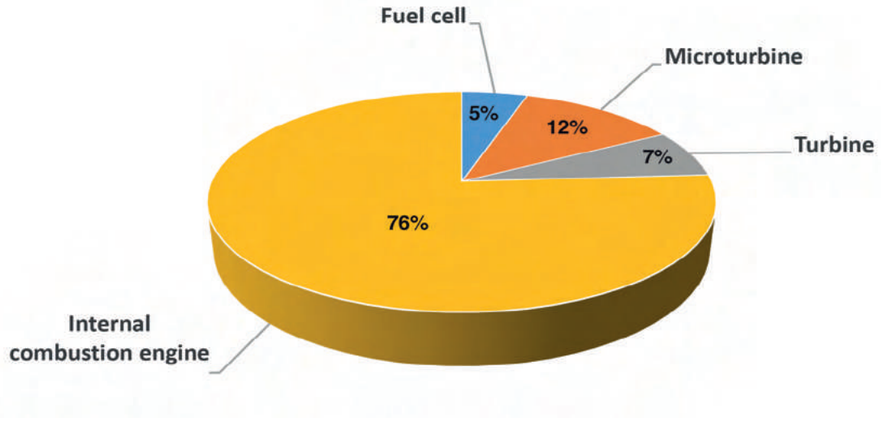
Biogas Applications and H_2S and Siloxanes Operational Limits

Equipment	Typical Application	H_2S Operational Limit (*)
Boiler	Direct combustion for heat production	< 500 ppm_v
Internal Combustion Engine (ICE)	Electricity production (or both heat and electricity if cogeneration engine is used)	< 250 ppm_v
Turbine	Electricity production	< 1000 ppm_v (**)
Fuel Cell	Electricity production	Trace amounts
Gas Pipeline	Electricity production	Trace amounts

(*) Those values may vary depending on manufacturer specifications

(**) Note that upstream biogas compressors typically tolerate 75-100 ppm_v

Porcentages of electricity generation technologies in use at WWTPs producing biogas



Equipment	Siloxanes Operational Limit	Detrimental Effects
Microturbine	< 5 ppm_v (~ 0.03 mg/m^3)	Loss of performance Seizure of turbine wheel
Turbine	< 90 ppm_v (~ 0.1 mg/m^3)	Accumulation of silica on the turbine nozzles
Internal Combustion Engines	< 2800 ppm_v (~ 17 mg/m^3)	Higher maintenance costs
Catalysts	Not reported	Catalyst inactivation
Fuel Cells	< 100 ppm_v (~ 0.1 mg/m^3)	Higher maintenance costs

Biogas Two Major Targets

1. CHP Motors (Cogeneration Motors). Effects of Corrosive Gases in CHP Engines

H_2S can lead to equipment corrosion, increased maintenance and associated maintenance costs, and a shorter equipment lifespan.

Sulfur residues in biogas form sediment in the engine oil which often turns into a premature change, while siloxanes, settles as SiO_2 in the cylinder head damaging valve seats.

Summarizing, most ICE manufacturers limit H_2S in the fuel to 100 ppm_v and only guarantee proper functioning if proof can be provided that H_2S limit has been observed.

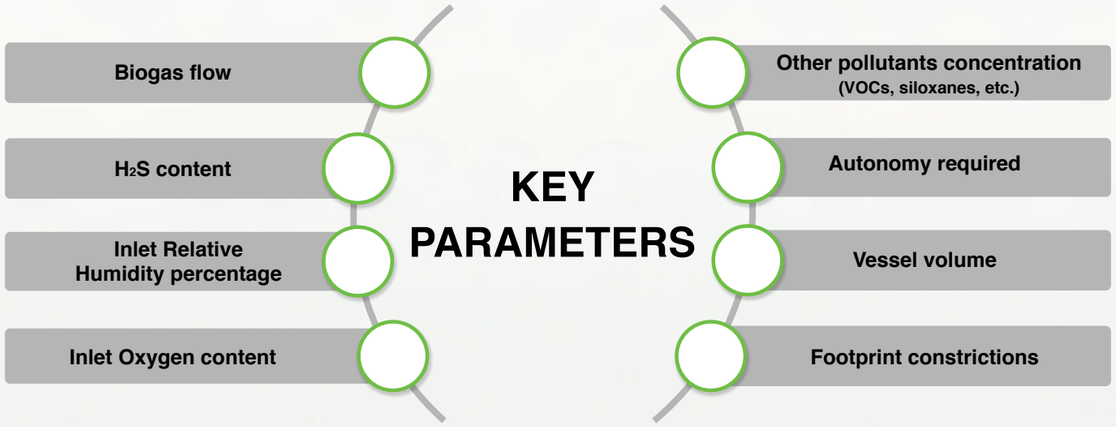
2. Biogas Upgrading

Within the last years, market situation has evolved and biogas is not just a source of energy for self-consumption, but also a source of income. Removal of CO_2 will be required if the biogas needs to be upgraded to natural gas standards or vehicle fuel use, since it dilutes the energy content of the biogas. Thus, in order to comply gas network requirements (over 97-98% pure CH_4 in most of the countries), biofilters or scrubbers that cannot reach 99% efficiency levels, will always be followed by dry media polishing systems.

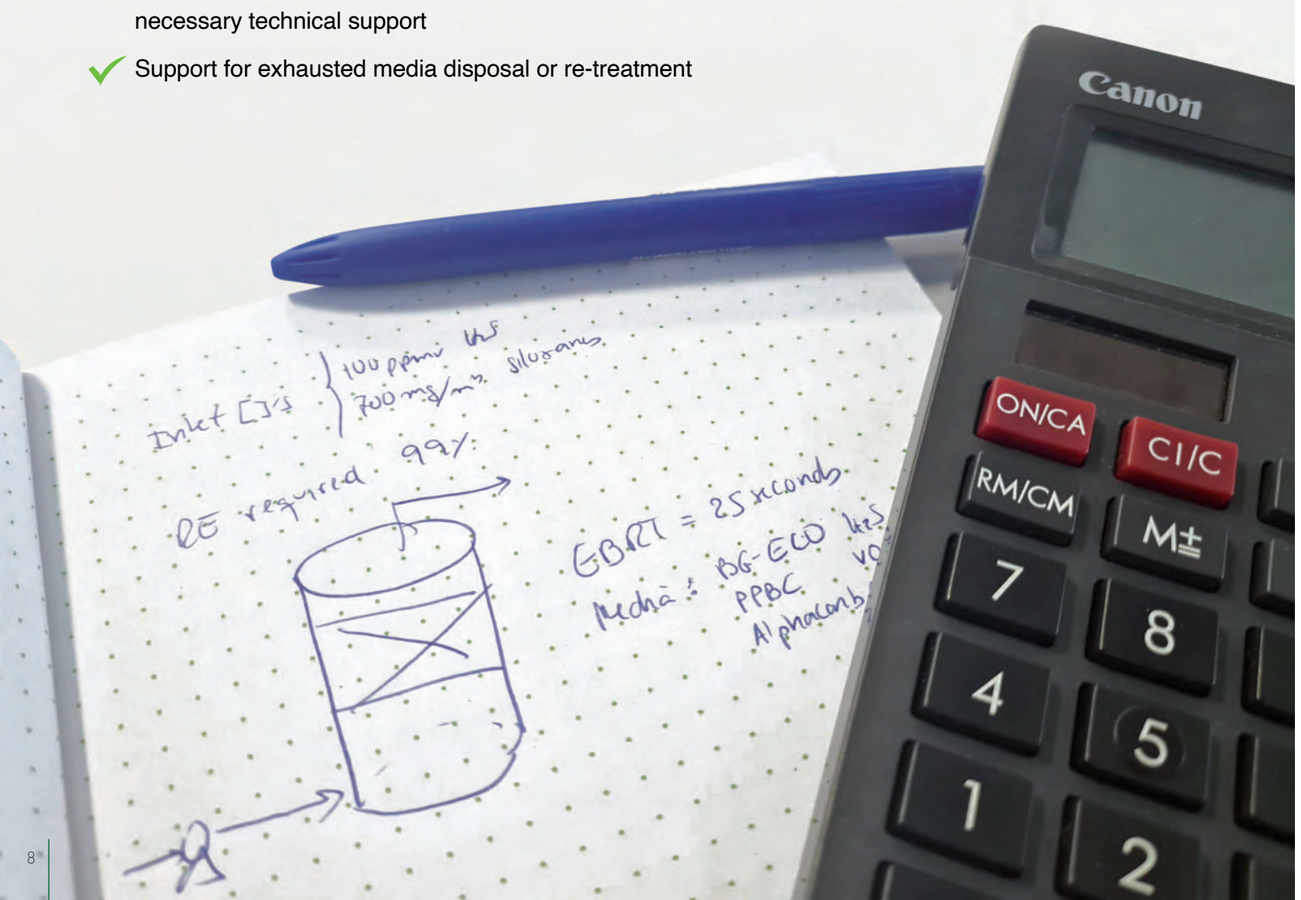
Biomethane generation

Alphachem Solutions for Biogas Purification

Based on our technical experience, Alphachem by Greenkeeper offers different solutions for each scenario depending on the following key parameters:



- Customized calculation of media life expectancy
- Design and dimensioning of the required filtration equipment
- After sales service including remaining life assays and offering the necessary technical support
- Support for exhausted media disposal or re-treatment



H_2S elimination (major corrosion source)

Alphachem by Greenkeeper has three different solutions for biogas desulfurization. Depending on each scenario our technical team will recommend the most adequate solution.

Alphachem 15

- H_2S elimination capacities up to 35% weight/weight
- extruded activated carbon based adsorbent with KOH and KI
- catalytic reaction that prevents H_2S desorption
- high performance treating acidic gases, nitrogen oxides, sulphur dioxide and mercaptans

Alphacarb BGS

- H_2S elimination capacities up to 70% weight/weight
- engineered media impregnated with a special formulation that provides an enhanced adsorption capacity for the H_2S abatement
- also recommended for the elimination of mercaptans, organic sulphides and other malodorous compounds

Alphacarb BGS-H

- H_2S elimination capacities up to 50% weight/weight
- specially designed to overcome the harshest conditions
- exceptional mechanical properties make ideal alternative to scenarios where high moisture content appears and when meters of bed depth are required

engineered media

Advantages of Alphacarb BGS and Alphacarb BGS-H front common solutions:

- ✓ Alphacarb BGS can achieve elimination capacity values as high as 70% w/w at optimal conditions, while Alphacarb BGS-H can achieve values up to 50% w/w
- ✓ Both media have an improved adsorption kinetics resulting in a small Mass Transfer Zone (MTZ) which implies the utilization of all media potential
- ✓ Both media contain a mixture of active compounds that ensures that the end oxidation H_2S product is Sulphur. Depending on the country regulations, the exhausted media can be employed as a co-composting product as a structural agent
- ✓ Highest performance achieved when ratio H_2S-O_2 is close to 1:2
- ✓ Price stability since most of the raw materials are European and it is not directly linked to carbon market price
- ✓ Non-flammable, which makes both media handling safer front high carbon content alternatives

Mass Transfer Zone

Drum Scrubbers Filters Design and Construction

Alphachem by Greenkeeper designs unique units for each customer in order to achieve a proper biogas purification. It is crucial to design specific treatment units for each scenario taking into account key operational parameters such as flow rates or pollutants concentrations, among others.

Our units can be manufactured with different materials such as conductive polypropylene, reinforced fiber glass or stainless steel and can be loaded with 1, 2 or 3 different types of filter media in series to achieve the highest biogas purification level covering the widest spectrum of pollutants possible. Our biogas desulfurization units are designed specifically for each scenario looking for the highest performance at an adequate residence time.

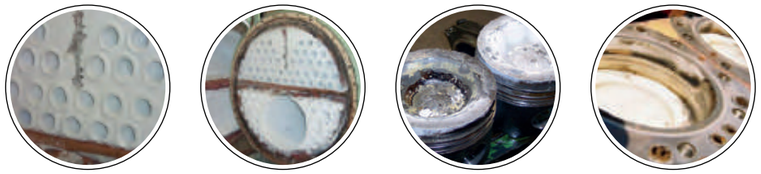
customized design

Siloxanes elimination

Siloxanes abatement in Biogas

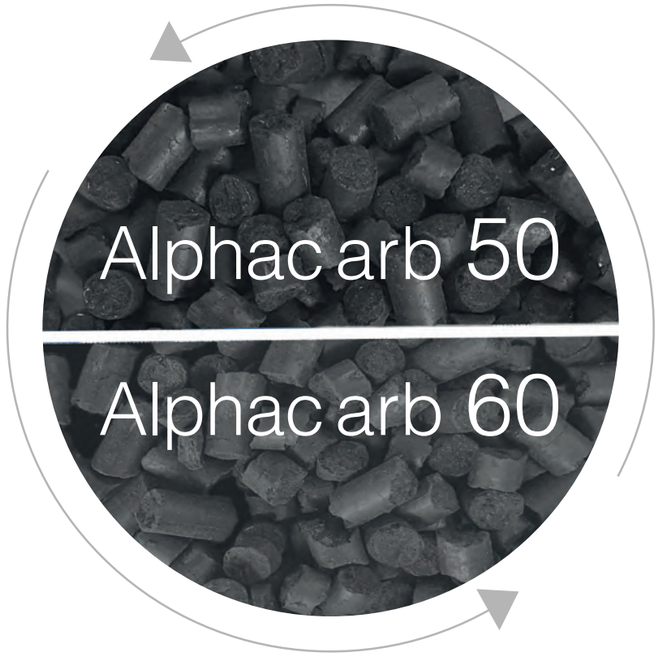
1 **Source:** mainly found in Landfills.

2 **Negative Effects:** siloxanes are deposited as Silicon dioxide (SiO_2) in the cylinder head damaging the valve seat and causing erosion of the metallic parts of the equipment.



3 **Maintenance:** SiO_2 accumulates in the oil used for engine lubrication and refrigeration, damaging it and shortening its lifespan. Overall implies an increase in the maintenance costs.

A siloxanes speciation will help to choose the most suitable blend to reach the highest purification level.



VOCs elimination

A wide spectrum of VOCs can be found in Biogas. The highest performance might be achieved depending on several parameters:

1 Quality Carbon (usually defined as CTC or Iodine Number)

2 VOCs speciation

3 Presence of other pollutants in the biogas

4 Operational conditions (mainly relative humidity and temperature)

ALPHACHEM GAS PHASE FILTRATION by Greenkeeper

GreenKeeper Iberia, S.L.