



Activated Carbon for Biogas Treatment

DESOREX®

Biogas - Sewage Gas

The anaerobic digestion is one of the technologies for generating renewable energy and is an essential part of our energy production in the future.

In contrast to natural gas with a methane concentration between 85% and 98% in addition with an inert gas concentration up to 11%, biogas contains an average methane concentration of only 60% and about 35% CO₂. The content of steam varies in a wide range depending on source, just as the content of hydrogen sulphide.

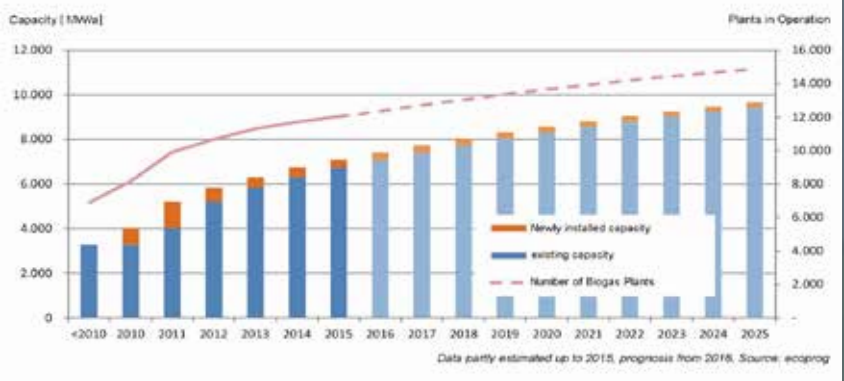
The demands for the purification of natural gas and biogas resemble in many parts but because of the different compositions of the gases there are some special requirements to be heeded for the treatment of biogas.

The hydrogen sulphide must be removed to avoid any corrosion in parts of the plant. The removal also protects catalysts which are used from an impact by sulphur containing compounds and a subsequent deactivation.

Siloxanes are another group of substances being found in biogas only and not in natural gas. The occurrence of siloxanes is often found by recycling of municipal waste, wasted fats and also in sewage treatment plants.



Growth of Biogas-Plants in Germany



Hydrogen Sulphide and Mercaptane Removal

Hydrogen sulphide and mercaptanes can be removed from gas by different types of activated carbon. The selection of the most suitable process and the related activated carbon type is difficult and depends on the chemical composition of the gas as well as on the physical parameters such as humidity and temperature.

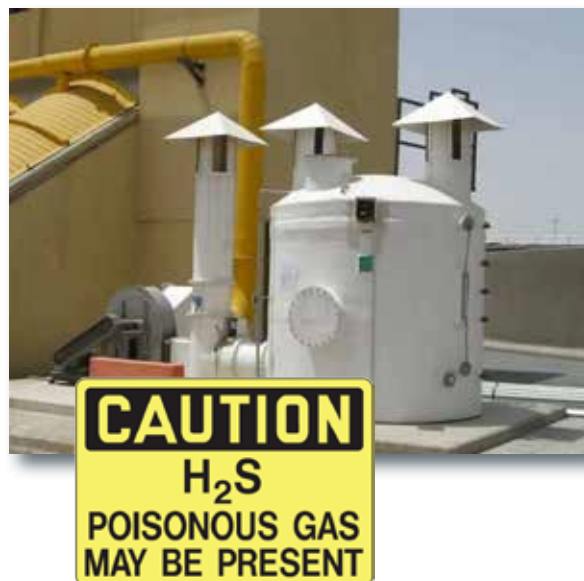
In general four different types of activated carbon can be chosen:

- Potassium iodide impregnated activated carbon,
- Alkaline impregnated activated carbon
- Alkaline earth carbonate impregnated carbon or
- Catalytic activated carbon.

For the selection of the best activated carbon type some hints are given on the following pages.

Temperature of the gas

- preferable temperatures of 10 – 70°C
- < 10°C extension of the working layer
=> lower loading of elemental sulfur
- > 70°C causes formation of by-products
=> SO₂ und H₂SO₄ formation
=> corrosion problems in the downstream equipment



KI impregnated activated carbon

The presence of 2-fold stoichiometric value Oxygen is necessary to realise the transformation from hydrogen sulphide to elemental sulphur.

The precondition for a high loading of elemental sulphur is a sufficient mixture. Heating of the gas is necessary when the relative humidity is more than 70%.

The conversion of H₂S and mercaptans into elemental sulphur occurs inside the pore structure through catalytic oxidation. In this case we recommend the usage of the activated carbon impregnated with potassium iodide, e.g. our **Desorex® K43J**.



Oxygen demand

- Optimal rate between H₂S / O₂
=> A factor of 1.7 times the stoichiometric value
- If the air flow interrupted irreversible damage to the carbon bed occurs
- This damage cannot be reversed by the injection of more air.

Characteristics Desorex® K 43 J Extruded activated carbon based on bituminous coal (potassium iodide impregnated)	
Specifications:	
Impregnation (wt.%)	approx. 2
Bulk density (kg/m ³)	480 ± 30
Moisture content (wt.%) (as packed)	< 10
Product data before impregnation:	
Total surface area (m ² /g) (BET-method)	1000
Diameter of particles (mm)	4
CTC-adsorption (wt.%)	60
Benzene adsorption in air at 20°C (wt.%)	
p/p _S *	0.9 > 38
	0.1 > 34
Comments:	
*p/p _S = relative saturation (concentration of saturation at 20°C, 320 g/m ³)	

Characteristics Desorex® G 50 Extruded activated carbon based on bituminous coal (alkaline impregnated)	
Specifications:	
Impregnation (wt.%)	approx. 5
Bulk density (kg/m ³)	570 ± 30
Moisture content (wt.%) (as packed)	< 15
Diameter of particles (mm)	4
Product data before impregnation:	
Total surface area (m ² /g) (BET-method)	1000
CTC-adsorption (wt.%)	> 60
Hardness (wt.%)	95

Alkaline impregnated activated carbon

The use of alkaline impregnated activated carbon can also be carried out at very high and very low relative gas humidity in the gas to be purified without any major performance degradation.

The removal of H₂S is a chemisorptive process which is described by the following equation with caustic soda:



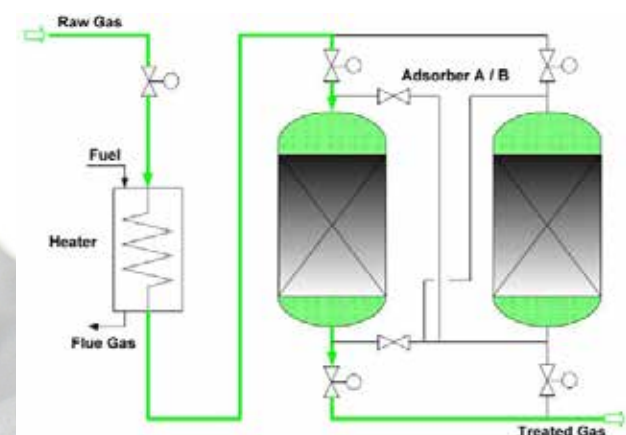
It easily can be seen that the caustic soda is used to neutralise the acidic hydrogen sulphide. The adsorption capacity is limited to the amount of NaOH which also reacts with all other acidic components present in the treated gas.

Mercaptanes are converted into their sodium salts according to following equation:



In addition, alkaline-impregnated activated carbon, e.g. our **Desorex® G50** is less sensitive to lower oxygen concentrations in the gas to be purified compared to other impregnated active carbon types.

Process-Flowchart



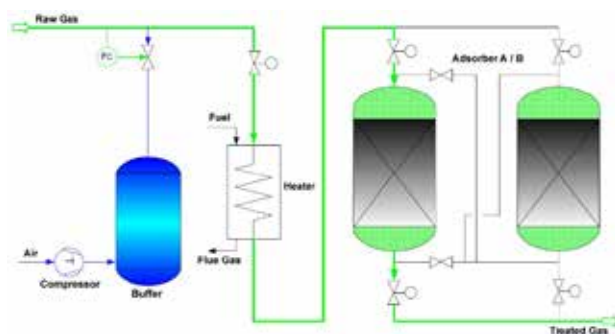
Alkaline earth carbonate impregnated activated carbon

Especially in biogas plants with a significantly higher gas humidity of > 50%, the use of active carbons impregnated with alkaline earth carbonates, e.g. our **Desorex® K 43 BG**, is an excellent solution.

This product represents a very good alternative for biogas plants without pre-drying, in which the potassium iodide impregnated activated carbon can not be used.

The conversion of the hydrogen sulfide is similar to the alkali impregnated activated carbon.

Process-Flowchart



Characteristics Desorex® K 43 BG Extruded activated carbon based on bituminous coal (alkaline earth carbonate impregnated)

Specifications:

Impregnation (wt.%)	approx. 5
Bulk density (kg/m ³)	570 ± 10%
Moisture content (wt.%) (as packed)	< 20

Product data before impregnation:

Total surface area (m ² /g) (BET-method)	1000
Diameter of particles (mm)	4
CTC-adsorption (wt.%)	> 60
Hardness (wt.%)	95

Characteristics Desorex® G 70

Extruded activated carbon based on bituminous coal
(Special activation)

Specifications:

Bulk density (kg/m ³)	510 ± 30
Moisture content (wt.%) (as packed)	< 15
Benzene adsorption in air at 20°C (wt.%)	
p/p _s *	0.9 > 41
	0.1 > 36

Comments:

*p/p_s = relative saturation (concentration of saturation at 20°C, 320 g/m³)

Product data before impregnation:

Total surface area (m ² /g) (BET-method)	1050
Diameter of particles (mm)	4
CTC-adsorption (wt.%)	> 65
Hardness (wt.%)	95

Catalytic activated carbon

A superior adsorption capacity is absolutely necessary for very small activated carbon filter units, so that the adsorption time between the change intervals is as long as possible. Very high loading capacities over all other impregnated activated carbon types very long periods of operation can be realized.

The activated carbons produced by a special activation with pronounced catalytic properties, e.g. our **Desorex® G 70**, shows superior hydrogen sulfide removal at higher gas humidity of > 60% compared to other activated carbon grades.

Due to its positive characteristics, the use of this product quality in addition to the very long operating life, high service intervals and reduced disposal costs offers.



Removal of organosilicon Compounds

Besides the silicones, siloxanes also belong to organosilicon compounds. Siloxanes are synthetic components and do not appear in nature.

The input of these kind of impurities into biogas plants results from the processing of waste water which contains siloxanes deliberated from cosmetics and detergents. Municipal waste and fats which are used as coferments also contain siloxanes.

As a result siloxanes do not occur in plants which are exclusively run with biomass originating from agricultural production.

When burning siloxanes there are accruing fine-crystalline SiO_2 . It is deposited at cylinders and valves of the combusting engines of the thermal power station which leads to damage by enhanced abrasion.



Silica deposits at a cylinder and valve of a thermal power station run with biogas

Characteristics Desorex® K47 Extruded activated carbon based on bituminous coal

Specifications:

Bulk density (kg/m^3)	500 ± 30
Moisture content (wt. %) (as packed)	< 8
Benzene adsorption (wt. %) in air at 20°C	
p/ps*	0.9 > 31
	0.1 > 26
	0.01 > 21
	0.001 > 13

Typical specifications :

Total surface area (m^2/g) (BET-Method)	900
Diameter of particles (mm)	ca. 4
CTC adsorption (wt. %)	> 50

Comments:

The above data are based on test methods of Donau Carbon. Copies are available upon request.

*p/ps = relative saturation (concentration of saturation at 20°C , $320 \text{ g}/\text{m}^3$)

A pilot plant from Donau Carbon was used to perform a test for the adsorption of siloxanes which showed that siloxanes easily can be removed from biogas by activated carbon.

The removal by activated carbon – a relatively cheap action – avoids the damage caused by siloxanes and leads to a longer life cycle of the combustion engines, which otherwise can only be achieved by more frequent replacement of the SiO_2 contaminated lubricants.

General Information

Laboratories / Applications Engineering Support

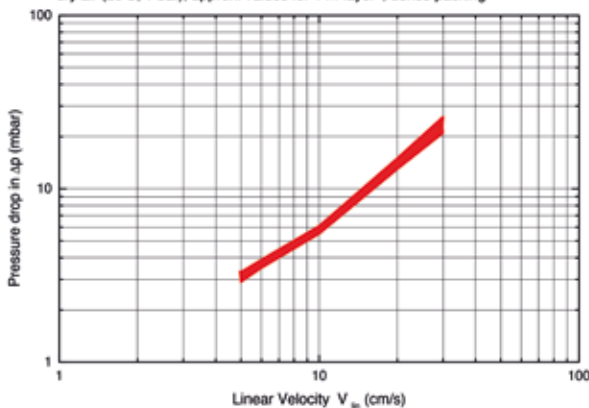
The controlling and evaluation of new and used activated carbon will be done in our own laboratories in compliance as well with own methods as also with national and international standard test processes.

Furthermore, our application engineering have decades of experience on the sectors of hydrogen sulphide removal.

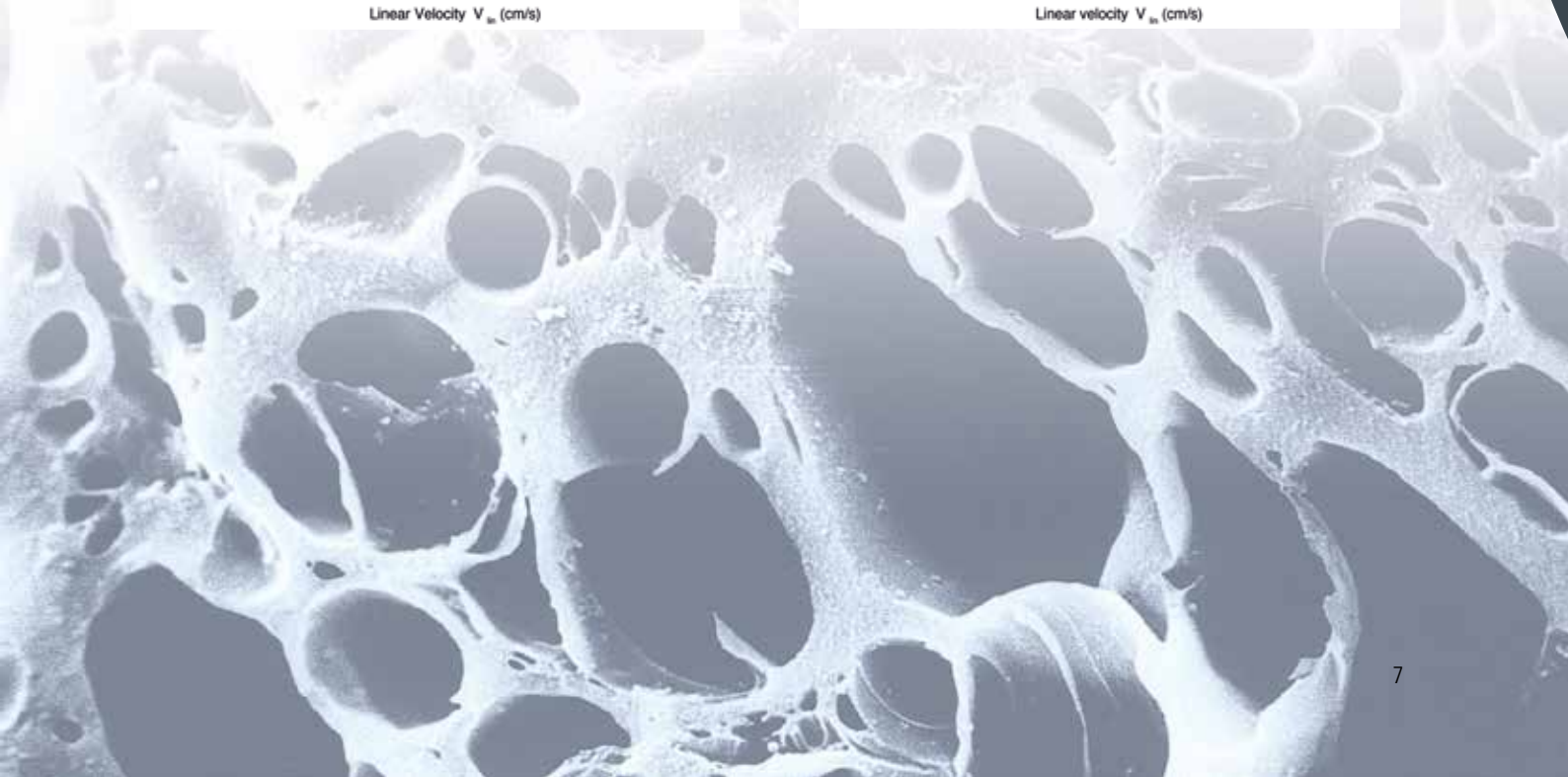
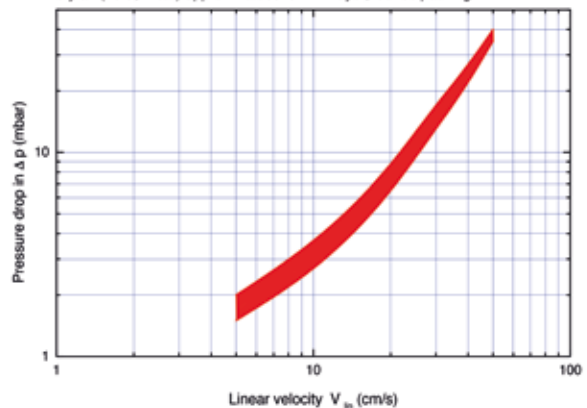
We provide special calculations for operators and plant builders to support e.g. with the determination of the service life of activated carbon in filters.



Pressure Drop of 3-mm Cylindrical Activated Carbon
dry air (20°C; 1 bar), approx. values for 1 m-layer, dense packing



Pressure Drop of 4 mm Cylindrical Activated Carbon
dry air (20°C; 1 bar) approx. values for 1 m layer, dense packing



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