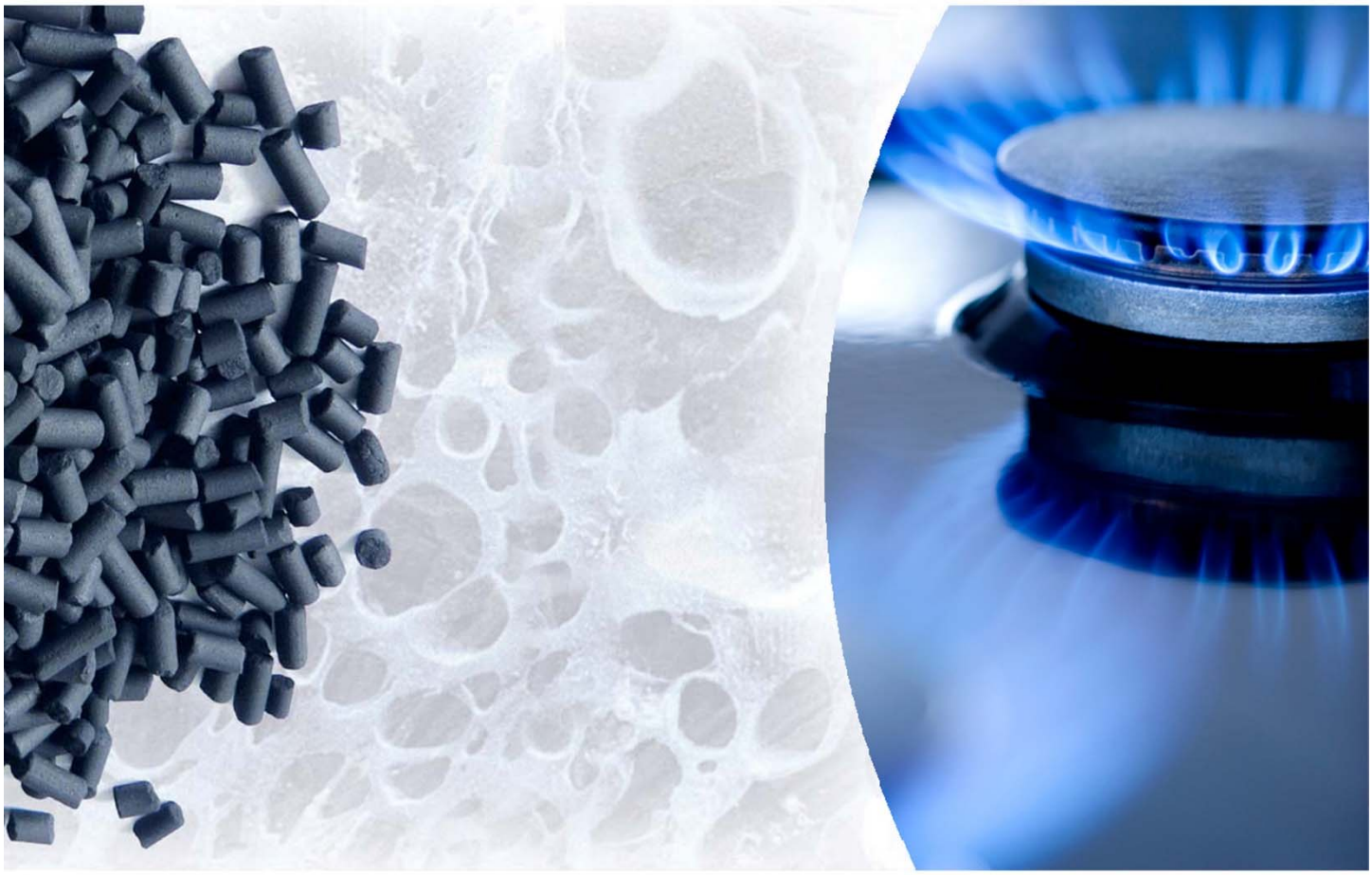
DONAU CARBON



Activated Carbon for Natural Gas Industry

OXORBON® and DESOREX®

Natural Gas

The significance of natural gas as an energy source is increasing rapidly. Yet its discovery and exploitation are far more recent than those of oil as gas projects have begun to develop since the 1960s.

This mixture of gaseous hydrocarbons formed from the natural decomposition of organic matter. Its composition varies widely among different gas fields and the geological time of its formation. Methane is often the major component. Carbon dioxide, nitrogen and hydrogen sulphide are present in amounts more or less important. The proportion of low molecular weight hydrocarbons (having a carbon number less than 5) other than methane is usually between 0 and 20%.

In view of its marketing and distribution, it will undergo a series of treatments including desulphurization and drying. Indeed, when stored underground - under high pressure and temperature - the presence of sulphur substances will result in the formation of hydrogen sulphide. These corrosive molecules must be removed before the gas leaves the storage facility and is injected into the network.

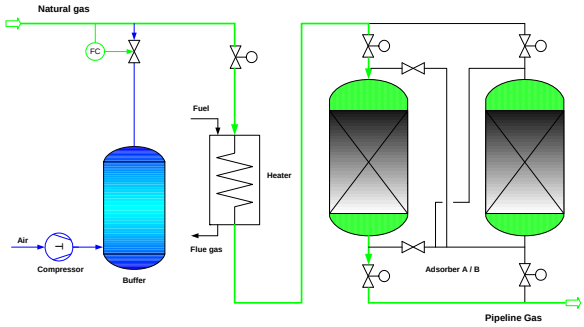
Hydrogen Sulphide and Mercaptan Removal

With the use of impregnated activated carbon the removal of hydrogen sulphide and mercaptans down to a level of < 1ppm by volume can be achieved.
Here, on the activated carbon impregnated with potassium iodide, e.g. Oxorbon® K20J or Oxorbon® K40J, hydrogen sulfide and mercaptans are converted into elementary sulfur or the more adsorbable disulfides. This is generally done by metering in air by means of catalytic conversion.

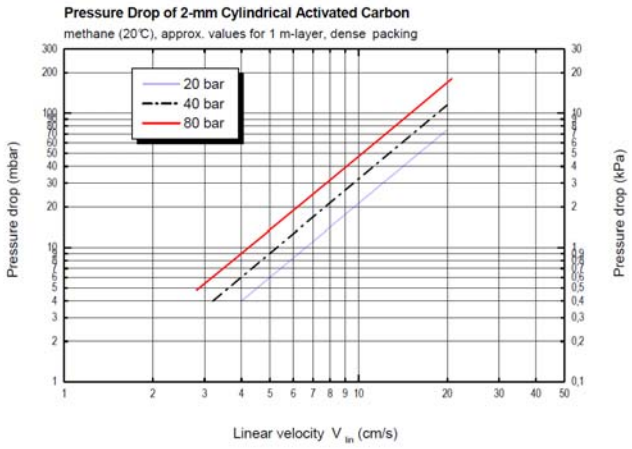
Loadings of much more than 60 wt.% sulphur within the pore structure are possible.

The optimum particle diameter depends on the operational requirements and the filter design. The graphs show the pressure losses for different gas pressures depending on the active carbon diameters 2 mm and 4 mm for our Oxorbon® K20J or Oxorbon® K40J.

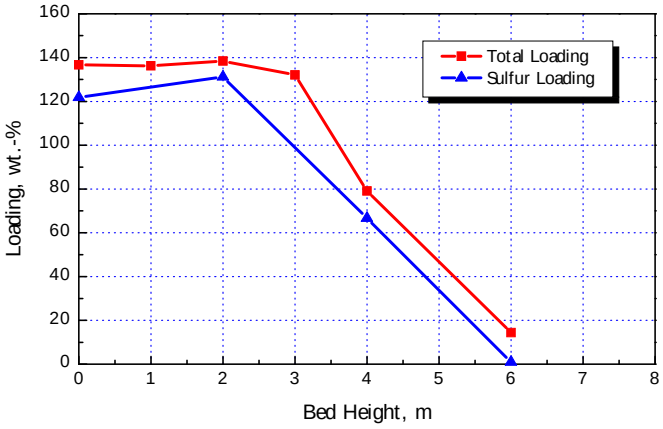
Flow chart of the Oxorbon® Processes

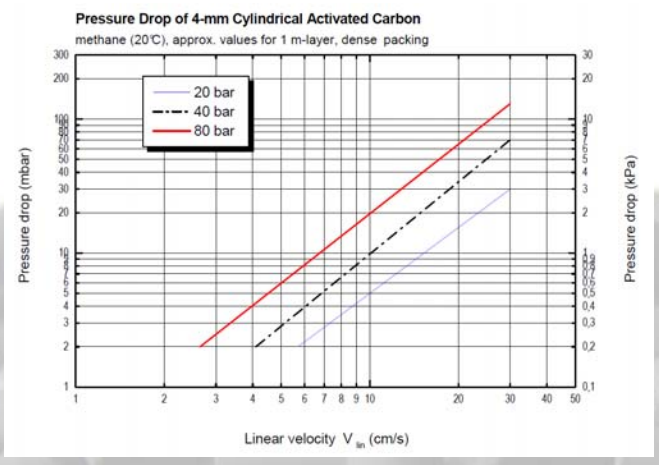


Gas Temperature
- preferable temperature: 10 - 70°C
- < 10°C enlargement of the working layer
  → lower loading by elementary sulphur
- > 70°C formation of by-product
  → formation of SO_2 and H_2SO_4
  → corrosion in downstream parts of the plants



Sulphur Loading in an adsorber in dependence of bed depth





Flow rate: 100.000 Nm³/h
H_2S inlet: approx. 100 mg/Nm³
Pressure: 50 - 110 bar

KI impregnated activated carbon

To accomplish the conversion of hydrogen sulphide to elemental sulfur in our Oxorbon® K 20J or Oxorbon® K 40J , a 2-fold stoichiometric oxygen concentration in the gas is required.
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 60 – 70%.

The conversion of H_2S and mercaptans into elemental sulphur occurs inside the pore structure through catalytic oxidation.

$$H_2S + ½\ O_2 \xrightarrow{\text{cataly.KI}} S + H_2O$$

$$2\ CH_3\text{-}CH_2\text{-}SH + ½\ O_2 \xrightarrow{\text{cataly.KI}} CH_3\text{-}CH_2\text{-}S\text{-}S\text{-}CH_2\text{-}CH_3 + H_2O$$

Oxygen demand

- Optimal rate between H_2S / O_2
  => 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 Oxorbon® K20J / K40J Extruded activated carbon based on coal (potassium iodide impregnation)		
Specifications:		
Impregnation (wt. %)	ca. 3	
Bulk density (kg/m³)	440 ± 10%	
Moisture content (wt. %) (as packed)	< 8	
Benzene adsorption (wt. %) in air at 20°C		
p/ps*	0.9	> 55
	0.1	> 45
Typical specifications:		
Total surface area (BET-method) (m^2/g)	1.200	
Diameter of particles (mm)	2 / 4	
CTC adsorption (wt. %)	80	
Comments:		
The above data are based on international accepted test methods like ASTM and methods of Donau Carbon.		
*p/ps = relative saturation (concentration of saturation at 20°C, 320 g/m³)		

Data Sheet Desorex® K 43 Na Extruded activated carbon based on coal (caustic soda impregnated)	
Specifications:	
Impregnation (wt.%)	approx. 10
Bulk density (kg/m³)	580 ± 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

NaOH impregnated activated carbon

The use of activated carbon impregnated with caustic soda does not require an oxygen content of the gas.
The removal of H_2S is a chemisorptive process which is described by the following equation:

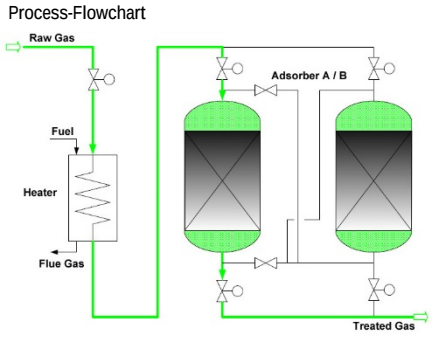
$$H_2S + 2\ NaOH \longrightarrow Na_2S + 2\ H_2O$$

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:

$$R\text{-}SH + NaOH \longrightarrow R\text{-}SNa + H_2O$$

As for the use of KI impregnated activated carbon, the humidity of the gas should not exceed 70%rh.

Instead of NaOH impregnated types also other alkaline impregnates can be used.



Mercury Removal

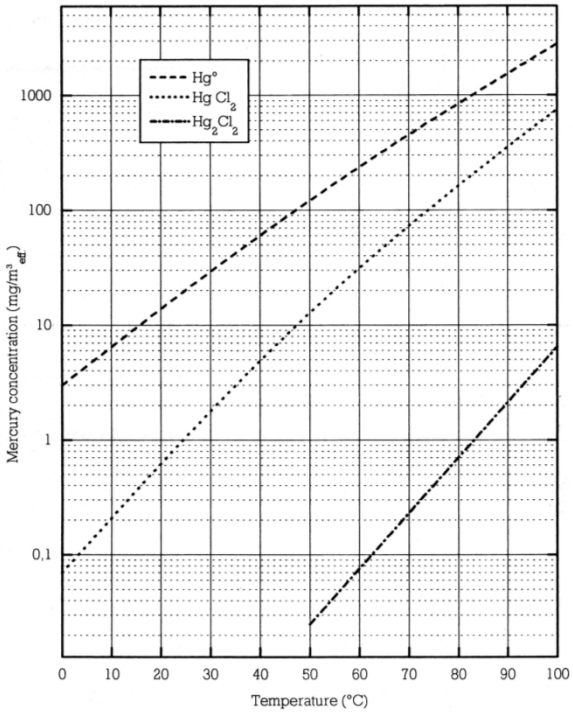
A main point to consider in the production of natural gas is the presence of mercury which readily forms amalgams by destroying the protective oxide layer on metals. This can cause extensive damage to equipment such as aluminium heat exchanger.

Donau Carbon has developed a special impregnation technique for its Desorex® activated carbon whereby the sulphur is evenly distributed throughout the macro pores. The technique minimizes the sulphur requirement. Impregnation levels of between 5 and 15 weight % are available depending on the special requirements of the customer.

Characteristics Desorex® HGD Types Extruded activated carbon based on coal (sulphur impregnated)	
Specifications:	
Impregnation (wt. %)	min. 10
Bulk density (kg/m³)	560 ± 30
Moisture content (wt. %) (as packed)	< 5
pH-value	approx. 3
Diameter of particles (mm)	2, 4
Granulation (mm)	2.0 – 4.0
Typical specifications:	
Total surface area (BET-method) (m^2/g)	1.000
Iodine adsorption (mg/g)	950
CTC adsorption (wt. %)	> 60
Comments:	
The above data are based on international accepted Test methods like ASTM and methods of Donau Carbon. Copies are available upon request.	

Mercury can be removed from gas flows in areas of high concentration using one of several different washing processes. For fine purification, however, adsorptive processes employing special adsorbent are generally preferred.
In the majority of cases mercury exists in metallic form; but can also be present combined with other elements such as chlorine.

Concentration of saturation in mg/m³



	Hg	$HgCl_2$	Hg_2Cl_2
20°C	13	1.1	0.0001
30°C	30	3.2	0.002
50°C	130	25	0.05

Analytic

-Continuous measurement
- → Atomic Absorption Spectrometry (AAS)
- → Concentrations within the range of about > 1 µg/m³
- → Vaporous mercury compounds have been reduced to metallic form in a prior phase

-Discontinuous measurement
- → ISO 6978: Natural Gas – Determination of mercury
- → Method A (up to 0.5 µg Hg/m³)
  Wet chemical pulping, measuring with AAS
- → Method B (1 – 1000 ng Hg/m³)
  Accumulation at Ag and Au, measuring with AAS
- → Today's measuring instruments are able to measure both

Operating Conditions

- velocity: 0.05-0.4 m/sec.
- Relative humidity: < 70%
- Residence time: > 6 sec.

Gas Temperature

- preferable temperature: 10 - 80°C
- < 10°C extension of the working layer
  → lower mercury loading
- > 80°C added by-product formation
  → sulphur lost

SO_2-Concentration

- < 20 mg/Nm³
  → at higher concentration formation of sulphuric acid

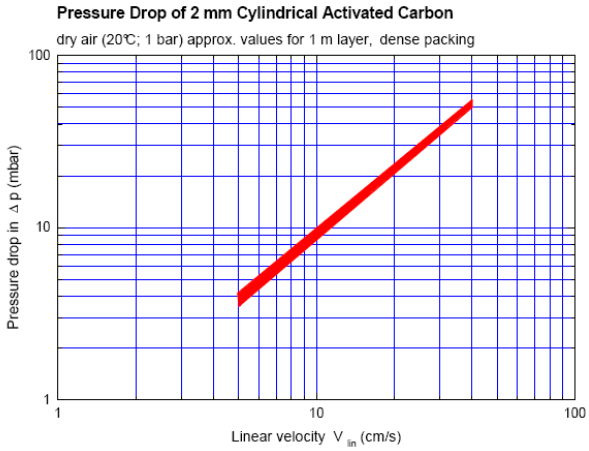
General Infomation

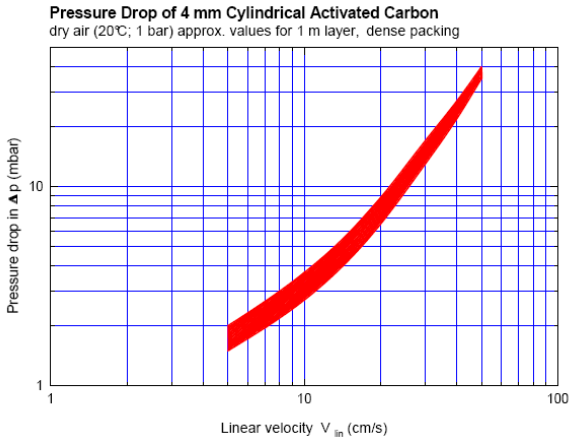
Laboratory / application technology consulting

In our own laboratories we prove and evaluate new and used activated carbons utilizing our own analytical methods as well as National and International Test Procedures.

Our technical applications are based on decades-long experience in the field of natural gas desulphurization and mercury removal.
As operators and plant constructors we have developed computer programs which are invaluable in the design and construction of plants and in conducting plant lifetime analyses.

TÜVRheinland® CERT ISO 9001





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