

Activated Carbon for the Removal of Hydrogen Sulphide

DESOREX®

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.

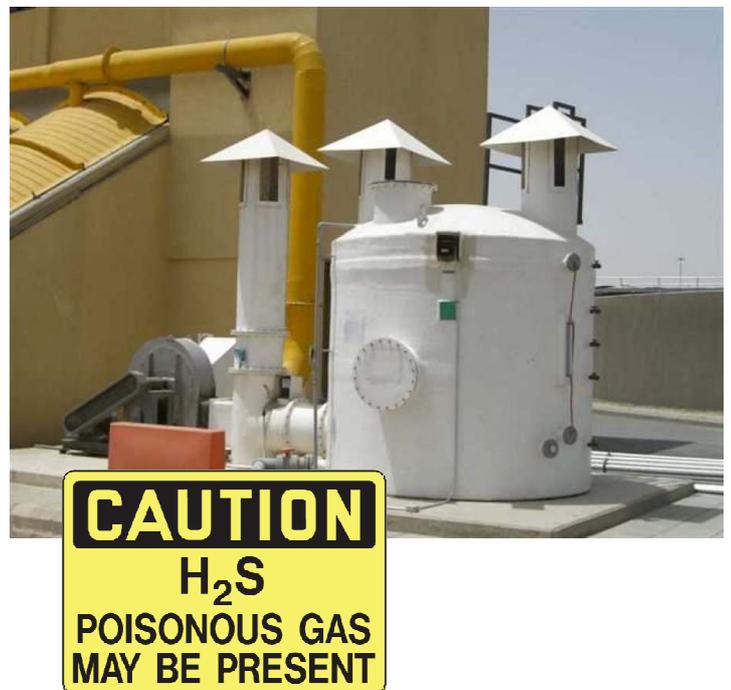
In general three different types of activated carbon can be chosen:

- KI-impregnated activated carbon,
- NaOH-impregnated activated carbon or
- Catalytical activated carbon.

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

Temperature of the gas

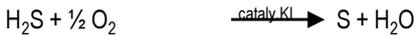
- preferable temperatures of 10 – 70°C
- < 10°C extension of the working layer
=> lower loading of elemental sulfur
- > 70°C causes formation of by-products
=> SO₂ and H₂SO₄ formation
=> corrosion problems in the downstream equipment



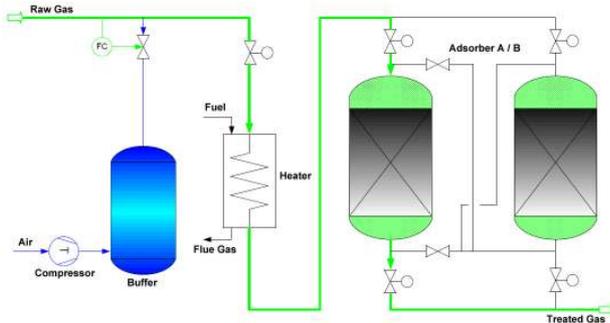
KI impregnated activated carbon

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 60 – 70%.

The conversion of H₂S and mercaptans into elemental sulphur occurs inside the pore structure through catalytic oxidation.



Process-Flowchart



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.

Data Sheet Desorex® K 43 J Cylindrically shaped activated carbon, 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)	950
Diameter of particles (mm)	4
CTC-adsorption (wt.%)	60
Benzene adsorption in air at 20°C (wt.%)	
p/pS*	0.9 > 38
	0.1 > 34

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

Data Sheet Desorex® K 43 Na Cylindrically shaped activated carbon, bituminous coal (NaOH impregnated)

Specifications:

Impregnation (wt.%)	approx. 10
Bulk density (kg/m ³)	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)	950
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 H₂S is a chemisorptive process which is described by the following equation:



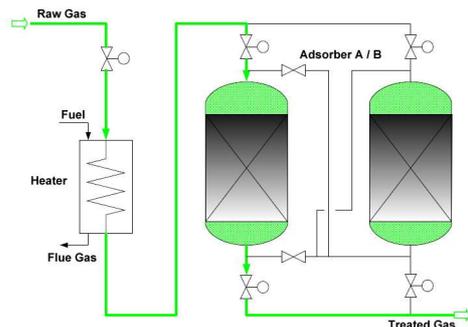
It easily can be seen that the caustic soda is used to neutralise the acidic hydrogen sulphide. The adsorption capacity is limited to the amount of NaOH which also reacts with all other acidic components present in the treated gas. Mercaptanes are converted into their sodium salts according to following equation:



A 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 impregnants can be used.

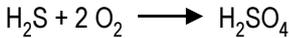
Process-Flowchart



Catalytical activated carbon

The use of catalytic activated carbon (*Desorex® PI 50 K*) requires oxygen in the gas. The humidity of the gas may be higher (max. 90%rh) and the H₂S content is limited to max. 50ppm to run the filter bed without damaging the activated carbon.

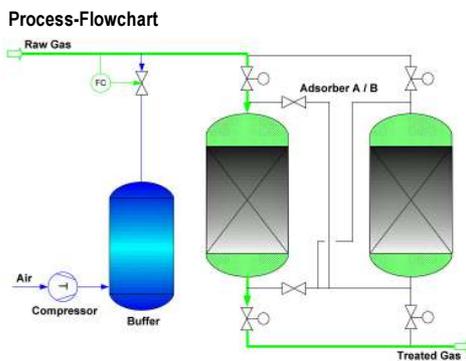
At higher H₂S content the activated carbon also shows a good performance but the oxidation of the H₂S



may be incomplete. In these cases the formation of elementary sulphur may occur which can not be removed from the carbon by washing with water.

Within the mentioned limits, a high temperature and high moisture content lead to a better performance of the process.

After washing the carbon can be reused for another adsorption cycle. The capacity of the activated carbon is decreased by an increasing number of loading cycles. As the carbon forms sulphuric acid at the carbon surface, ammonia also can be removed by this activated carbon type. These properties and the high relative humidity of the gas at which the carbon can be used recommend the use of *Desorex® PI 50 K* in odour control plants, where ammonia always occurs.



Data Sheet Desorex® PI 50 K Cylindrically shaped activated carbon, bituminous coal

Typical characteristics:

Bulk density (kg/m ³)	500 ± 30
Moisture content (wt.%) (as packed)	< 5
Iodine adsorption (mg/g)	1000 ± 50
CTC-adsorption (wt.%)	approx. 60
Diameter of particles (mm)	approx. 4
Hardness (wt.%)	> 97
H ₂ S breakthrough capacity (g H ₂ S/cm ³ activated carbon)	> 0.12

Instruction for Activated Carbon Washing to Recover the Adsorption Capacity of Activated Carbon used for H₂S removal

Step 1: Determination of the Conductivity of the Fresh Water (Base Conductivity C_B)

Before starting the activated carbon washing, determine the conductivity of the fresh water. It represents the base conductivity C_B.

Step 2: Beginning of Carbon Washing and Determination of the Initial Conductivity C_I

Washing begins by opening the valve and spraying the water over the activated carbon. As soon as the first gush of water appears at the outlet at the bottom of the adsorber: Immediately measure its conductivity. Repeat twice and calculate the mean value. The mean value represents the initial conductivity C_I of the washing water.

Step 3: Determination of the Criteria for Termination of the Washing (C_T)

Washing shall be ended once the conductivity of the washing water has reached approximately 10% of the initial conductivity. While the water is applied to the carbon, determine this value. To begin with, the base conductivity (C_B) has to be subtracted from the initial conductivity (C_I) as it is enclosed therein.

$$C_I - C_B = C_D$$

Afterwards, determine the terminal conductivity C_T (once this value has been reached in the water, the washing is determined).

$$C_T = (C_D \times 0,1) + C_B$$

C_I = initial conductivity, [mS/cm]

C_B = base conductivity of the fresh water, [mS/cm]

C_D = difference between C_I and C_B, [mS/cm]

C_T = termination point, [mS/cm]

Step 4: Washing

During the ongoing washing, regularly measure the current conductivity of the washing water and compare to the terminal conductivity as calculated in step 3.

Step 5: Termination of the Washing and Re-Start of Adsorption

As soon as the conductivity of the effluent water reaches the value of C_T (step 3):

- Disconnect the water feed and let drain until no more water drips from the carbon.
- Close the water outlet pipe at the bottom of the adsorber and re- start the gas feed.

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 desulfurization and mercury removal.

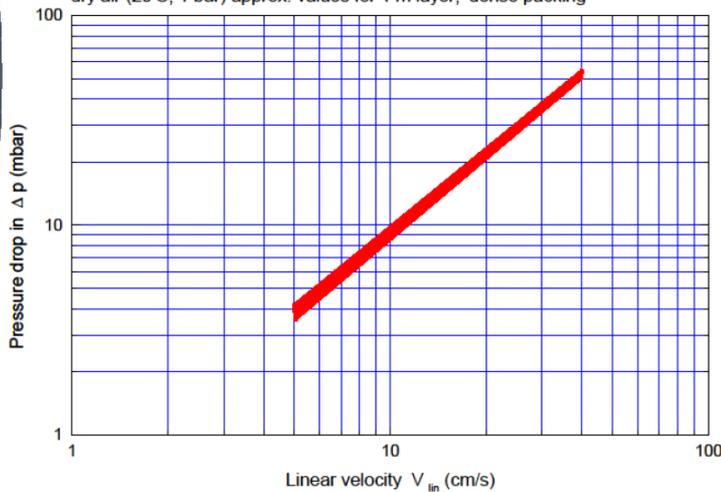
As operators and plant constructors we have developed computer programs which are invaluable in the design and construction of plants and in conducting plant lifetime analyses.



Pressure drop curves

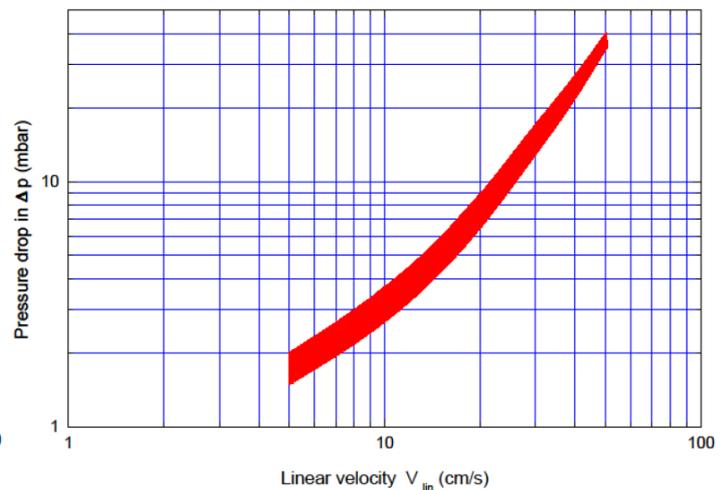
Pressure Drop of 2 mm Cylindrical Activated Carbon

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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