

Heraeus



Gas Purification Catalysts

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Introduction

Since Wilhelm Carl Heraeus founded our company in 1851, precious metals have been reclaimed and processed into technological products. During the 1970's heterogeneous catalysts were added to the product portfolio.

Today the product programme extends from the standard chemical and exhaust gas catalysts to specially developed catalysts to meet customers' requirements. Thanks to continuing innovation, new technologies are constantly being developed at Heraeus and put into industrial application. Heraeus has thereby established itself as an important partner for companies in almost every branch of industry and research. The competitive factors for the future are worldwide presence, maximum flexibility and above all the maximum possible orientation to meet the needs of individual customers.

Heraeus offers catalysts for the purification of technical gases, for air purification, industrial exhausts and various other applications. In order to meet present

and future emission limits and to take care of clean air, our slogan "Pure Air Everywhere" is to be understood as a commitment to nature and to our customers.

Our product spectrum ranges from the standard K-types to customer-specific solutions. We regard it as our job to select catalysts with well defined amounts of precious metals or base metals and the best possible support material to give optimum technical and economical solutions. Different types of support can be offered such as Al_2O_3 , SiO_2 , TiO_2 , ZrO_2 , cordierite, metallic and various shapes, e.g. spheres, pellets, extrudates or monoliths. High activity and mechanical stability are absolutely essential together with a long operating life and good resistance to catalyst poisons.



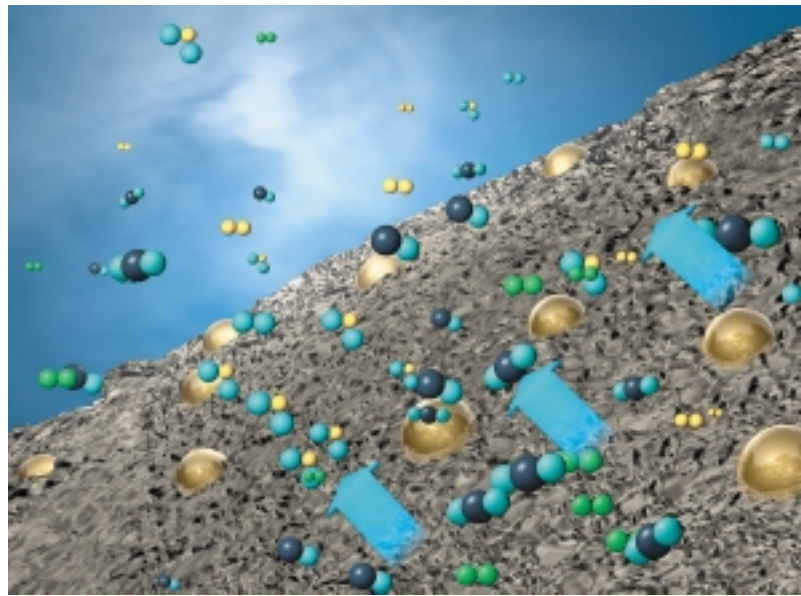
Ultra-pure Gases



For various technical processes and applications pure and ultra-pure gases are needed, such as air, N₂, O₂, H₂, He, Ar, etc. To achieve the required qualities, a variety of impurities such as CO, H₂, hydrocarbons and others have to be removed.

Synthetic air, for instance, is a type of industrial gas which is required for countless technical processes in different concentrations and purities. Using Heraeus catalysts in a final purification step ensures a product with extremely low concentrations of undesired constituents. Special catalysts can also be used to treat air and remove traces of CO and hydrogen. In the electronics industry ultra-pure gases, free from CO and hydrogen, are required to produce advanced semiconductors.

Furthermore, oxygen even in traces has to be eliminated from technical gases such as nitrogen, hydrogen and noble gases. In a catalytic reaction with hydrogen

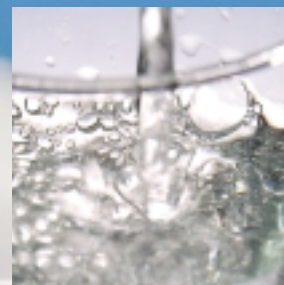


– in traces or as the main component – the oxygen is converted into water vapour, which can be easily removed by adsorption dryers if necessary. In the purified gas residual concentrations of oxygen can be achieved down to the ppb range. This kind of reaction can take place at temperatures far below 100°C or even at room temperature.

Gas	Impurities	Catalyst	Product
Air, O ₂	H ₂	Pd	H ₂ O
	CO	Pd, Pt	CO ₂
	CH ₄	Pd	H ₂ O, CO ₂
	organic compounds	Pt	H ₂ O, CO ₂
N ₂ noble gases Ar, He	O ₂ / H ₂	Pd	H ₂ O
	CO	Pd, Pt	CO ₂
	hydrocarbons organic compounds	Pt, Pd	H ₂ O, CO ₂
H ₂	O ₂	Pd	H ₂ O
	CO	Ru	CH ₄

* = To classify the products, see table at page 5.

Gas Purification Catalysts



Carbon Dioxide Purification

B*

The food industry in particular, but also other industrial applications, have large requirements for highly purified CO₂. In order to achieve CO₂ in high-purity quality, the raw gases from natural wells or chemical plants can be treated with catalysts to oxidize the undesirable constituents.

Depending on the source of the CO₂, there are many different impurities, such as CO, H₂, hydrocarbons and

highly toxic aromatic compounds, which have to be reduced to a few ppm in most cases or, for example benzene, which even has to be reduced to the ppb range.

Heraeus catalysts allow the precise removal of these impurities from carbon dioxide streams. This technology ensures the provision of high quality carbon dioxide not only for food applications but also for all industries where highly purified carbon dioxide is required.

Gas	Impurities	Catalyst	Product
CO ₂	CO, H ₂ , hydrocarbons, aromatics and other organic compounds	Pd, Pt	CO ₂ , H ₂ O

Inert Gas Purification

C*

Inert gases (e.g. nitrogen) are used in the thermal treatment of raw materials for plastics, such as the Solid State Polycondensation (SSP) process for polyester resins. The impurities accumulating in the inert gas stream are organic compounds such as aldehydes, glycols and oligomers. To purify the recycled inert gas, these compounds can be removed by catalytic oxidation. Heraeus special catalysts are designed to implement the purification process even with a very small

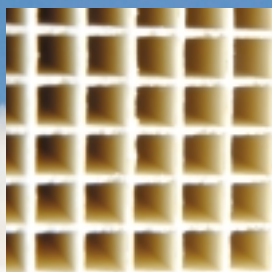
(stoichiometric) oxygen excess. The purified gas can be directly recycled to the SSP reactor after a prior drying treatment.

Heraeus catalysts can be applied not only to the purification of inert gas coming from an SSP reactor, but also to inert gas containing any organic impurities, provided that they can be oxidized to CO₂ and water under process conditions.

Gas	Impurities	Catalyst	Product
N ₂	O ₂	Pd	H ₂ O
CO ₂	organic compounds (e.g. ethylen glycol, acetaldehyde, oligomers)	Pd, Pt	CO ₂ , H ₂ O



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VOC abatement

Although there are many methods available for the abatement of emissions of volatile organic compounds (VOC) and CO, the most practical and effective technique for their destruction is incineration or oxidation. In this way, the VOC and CO are oxidized at elevated temperatures to harmless products such as CO₂ and H₂O. The advantage of catalytic oxidation is the lower temperature which is required in comparison to thermal incineration. Catalytic oxidation is thus a proven and cost-effective technology to control VOC emissions generated by various industrial processes (e. g. chemical production, printing and painting facilities, food processing, electronics, soil and groundwater cleanup systems). Because of the lower temperatures, the combustion units can be constructed with simpler structural materials resulting in a longer operating life of the plant components and lower maintenance costs.

D*

For these applications we offer catalysts comprising precious metals or base metals as active compounds on a high-surface carrier.

In the case of large gas streams and where low pressure drop is required the use of monolithic catalysts shows technical advantages compared to shaped materials.

Further applications for these catalyst types are:

- Off-gas purification in TPA plants
- Removal of halogenated organic compounds
- Ozone decomposition



Catalyst classification (ABCD)

Type	Content %	Composition	Shape	Recommended catalyst for application:
K-0137	0.1-0.5	Pt/Al ₂ O ₃	Spheres	D
K-0140	0.1-0.5	Pt/Al ₂ O ₃	Pellets	A/B
K-0162	0.1-0.5	Pt/Al ₂ O ₃	Spheres	D
K-0171	0.1-0.5	Pt/Al ₂ O ₃	Spheres	D
K-0240	0.1-0.5	Pd/Al ₂ O ₃	Pellets	A/B
K-0242	0.1-0.5	Pd/Al ₂ O ₃	Spheres	D
K-0247	0.1-0.5	Pd/Al ₂ O ₃	Spheres	A/D
K-0264	0.1-0.5	Pd/Al ₂ O ₃	Spheres	A/B
K-0288	0.2/0.1	Pd-Pt/Al ₂ O ₃	Spheres	A
K-0299	0.1-0.5	Pd/Al ₂ O ₃	Spheres	A/B
K-02120	0.15/0.15	Pd-Pt/Al ₂ O ₃	Spheres	A/B/C
K-02130	0.15/0.15	Pd-Pt/Al ₂ O ₃	Spheres	D
K-02131	0.15/0.15	Pd-Pt/Al ₂ O ₃	Spheres	C/D
K-02132	0.5	Pd/Al ₂ O ₃	Spheres	A/D
K-02133	0.3-1.0	Pd/Al ₂ O ₃	Spheres	A
K-02134	0.15/0.15	Pd-Pt/Al ₂ O ₃	Spheres	B/C/D
K-02135	0.1-0.5	Pd/Al ₂ O ₃	Spheres	A/D
K-02136	0.5	Pd/Al ₂ O ₃	Spheres	A
K-02137	0.5/5.0	Pd-Ag/ TiO ₂	Extrudates	A
K-0801	5.0-20.0	base metals	Spheres	D
Herapur 90	various	Pt, Pd, base metals	Monolithes	D

Gas Purification Catalysts

Activity tests

As a basis for an individual conception and development of customer specific catalysts our different test facilities are used. Various reaction conditions can be chosen

to simulate the respective industrial applications in order to recommend the most suitable catalyst.

A survey of our different activity test is listed in the following scheme:

Test Facility	CO/H ₂ removal	O ₂ removal	HC conversion	Gas purification
Parameter				
Temperature [°C]	up to 250	up to 180	up to 650	up to 750
Pressure [bar]	up to 6	1	up to 5	up to 15
Feed	air	N ₂ , H ₂	air	air, N ₂ , CO ₂
Space velocity [1/h]	up to 20,000	up to 30,000	up to 20,000	up to 30,000

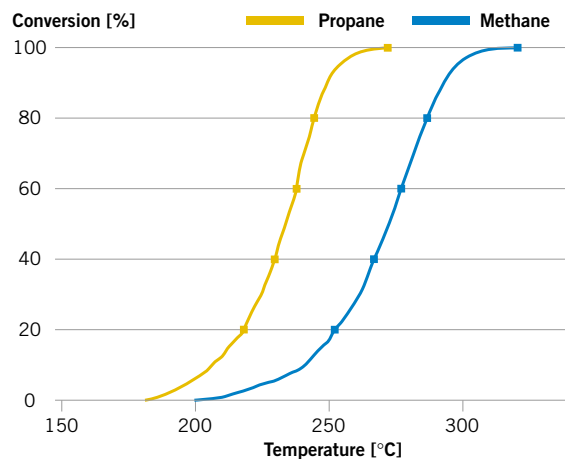


One kind of our standard tests is to measure the conversion of gaseous hydrocarbons in subject to the temperature in the catalyst bed.

The representative figure given below shows the results of the oxidation of 500 ppm methane and 500 ppm ethane with a standard Heraeus catalyst:



Conversion of gaseous hydrocarbons





Product analysis

With each catalyst shipment an inspection certificate is supplied for orders or data sheets for samples.

Following analyses are available to characterize the catalyst

Method:

AAS/CP/wet chemistry

BET/CO adsorption

Density

Hg porosimetry

REM/EDX/XPS

RDA

RFA

Laser granulometry

DTA/TG

Crush strength and attrition

Target Property:

Qualitative and quantitative analysis of a sample

Specific surface area/precious metal surface area

Bulk density

Pore volume and distribution of pore diameters

Microscopic inspection and determination of the composition of the surface

X-Ray investigations for phase analysis

Composition of a sample

Particle size distribution

Thermal behaviour of a sample

Mechanical properties

Catalyst handling, storage and safety

The catalysts are supplied in reduced state, so no activation procedure is needed before use. Since every technical catalyst needs some in-process conditioning, it is possible that it will take some time to achieve the full efficiency depending on the process and process conditions.

We recommend storing the product in its original packing in the closed drums under dry conditions and protecting the material from volatile substances.

Each shipment of catalyst is accompanied by a current MSDS (Material Safety Data Sheet)

Standard packaging

Heraeus catalysts are packed in 220l steel drums with one PE internal liner. The max. net weight per drum depending on the bulk density of the catalyst is 140 kg.

Other drums and packing units are possible on request.



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