SILICA

Adsorption Technology from Design to Turnkey Plant

GAS PURIFICATION

Member of
Berndorf Group

Silica Verfahrenstechnik GmbH:
Innovative Technology with Tradition

For over 80 years Silica has proven its competence in the field of adsorption technology. Based on that experiences in combination with the outstanding expertise of our engineers we are able to deliver our customers innovative adsorption technology for a wide range of applications.

Silica Verfahrenstechnik GmbH:
创新技术与传统的结合

80多年来，Silica已经证明了它在吸附技术领域的能力。以在该领域的丰富经验为基础，结合我们工程师出色的专业技术，我们能够为客户提供适合各种应用的创新吸附技术。

Adsorption Technology from Design to Turnkey Plant

Silica Verfahrenstechnik GmbH designs and constructs complete adsorption plants, tailor-made to fit individual customer requirements. We are your expert for national and international plant construction and offering a complete range of engineering services.

More than eighty years ago the company for the production of Silica Gel and construction of adsorption plants was founded in Berlin. Since the sale of the Silica Gel production plants in 1963, Silica is focused on the engineering and construction of adsorption plants.

During the last 20 years Silica has delivered more than 500 adsorption plants worldwide, with 20 to 30 new plants every year. Since 1993 the Austrian Berndorf AG holds 75 percent of Silica Verfahrenstechnik GmbH. Silica generates an annual turnover of 15 to 20 million Euro with about 50 employees at its location in Berlin-Reinickendorf.

The reliability and quality of Silica plants is appreciated around the world. Decades of experience and technical expertise combined with state-of-the-art technology and timely delivery ensures the successful implementation of customer wishes.

Our plants are used in almost all industrial sectors. Particularly in the fields of petrochemistry, chemical and pharmaceutical industry as well as in the gas and natural gas industry.

We design and construct plants for:

- Drying and purification of air, technical and bio gases
- Process gas purification
- Drying of liquids
- Waste air purification with solvent recovery
- Natural gas conditioning

Furthermore Silica is delivering tank breathers and a wide range of adsorption agents, such as Silica gel, activated alumina, molecular sieves and activated carbon.

Project-specific national and international standards are implemented by qualified and trained employees. Our quality assurance system complies with the requirements of ISO 9001:2015 and SCC*:2011 and is annually verified, thus ensuring the constantly high quality of our deliveries and services.

吸附技术 从设计到即用设备

Silica Verfahrenstechnik GmbH设计并制造整套吸附设备，并实行定制来满足个别客户需求。我们是国内外工业设备制造方面的专家，为您提供整套工程服务。

公司在八十多年前始建于柏林，主营硅胶生产和吸附设备制造。Silica自1963年开始销售硅胶生产设备，并一直侧重于吸附设备的工程设计和制造。

在过去20年间，Silica已向全球供应500多套吸附设备，平均每年供应20至30套新设备。自1993年以来，Austrian Berndorf AG持有Silica Verfahrenstechnik GmbH 75%的股份。Silica的年营业额达1500至2000万欧元，其柏林Reinickendorf工厂的员工约50名。

Silica工业设备的可靠性和质量享誉全球。数十年的经验和技术专长与先进技术和准时交付相结合，为满足客户各种需求提供了保证。

我们的设备可用于几乎所有的工业部门，特别是在石油化学、化学制药以及气体和天然气行业

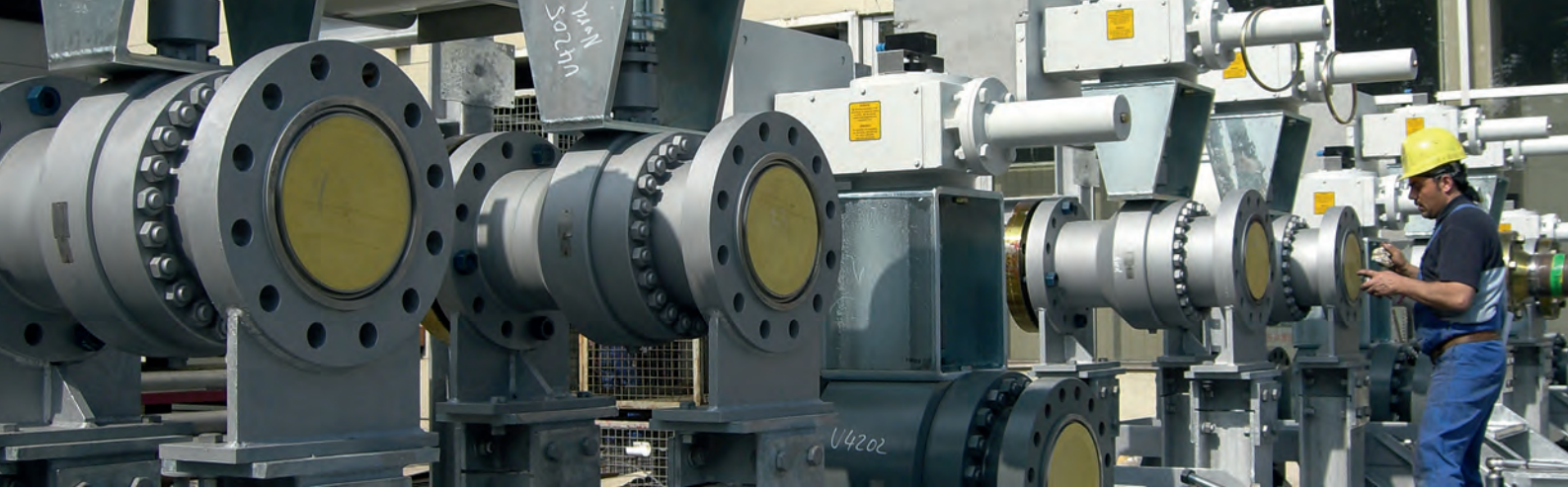
我们设计和制造的设备可用于：

- 干燥和净化空气以及技术和生物气体
- 净化工艺气体
- 干燥液体
- 净化废气和回收溶剂
- 天然气处理

Silica还供应油箱呼吸器和各种吸附剂产品，如硅胶、活性氧化铝、分子筛和活性碳。

具体计划执行所需的国内外各项标准是由我们训练有素的员工实行。我们的质量保证系统符合ISO 9001:2015和SCC*:2011的要求，且每年都经过验证，以此确保我们不断提供高品质的产品和服务。

Process gas purification unit for the adsorptive removal of methanol, carbon dioxide and water; residual contents < 0.1 ppmv
用于吸附去除甲醇、二氧化碳和水的工艺气体净化装置；残留量< 0.1 ppmv



Purification of Gases by Use of Noble Metal Catalysts and by Chemisorption

These purification units can be used for removal of the following components from various gases:

- Oxygen
- Carbon monoxide
- Hydrogen
- Hydrocarbons

Normally the rate of contaminations is less than 2 to 3 Vol.%, but also higher concentrations are allowable but request special measures. The reachable residual content is less than 1 ppmv.

There are two established gas purification processes available:

Catalytic combustion by noble metal catalysts (palladium and platinum):
During this process hydrogen is oxydised to water, carbon monoxide to carbon dioxide, and hydrocarbons to carbon dioxide and water.

Chemisorption by copper contact:
Basis of this process is the oxidation of copper to copper oxide. The oxidized contact is regenerated by reduction with hydrogen or carbon monoxide.

For special requirements a combination of both processes can be the most favourable solution of your problem.
Advantages and disadvantages of both processes, exemplified by the removal of oxygen from nitrogen:

Catalytic Combustion	Chemisorption
Advantages: simple unit construction, low investment cost, continuous operation with one reactor	**Advantages:** no additional humidity, hydrogen content of less than 1 ppmv possible
Disadvantages: approx.0.1% hydrogen in the purified nitrogen, increase of humidity corresponding to the double quantity of oxygen	**Disadvantages:** unit considerably more expensive, for a continuous operation two reactors are needed, resulting in high investment and higher operation cost

通过贵金属催化剂和化学吸附作用来净化气体

这些净化装置可用于去除
各种气体中的下列组分：

- 氧气
- 一氧化碳
- 氢
- 烃

污染比率通常小于2至3 Vol.%，同时较高的浓度也是容许的，但须采取特殊措施。可达到的残留量小于1 ppmv。

有两个经证实有效的气体净化工艺可用：

通过贵金属催化剂进行催化燃烧（钯和铂）：
在此工艺中，氢被氧化成水，一氧化碳被氧化成二氧化碳，烃被氧化成二氧化碳和水。

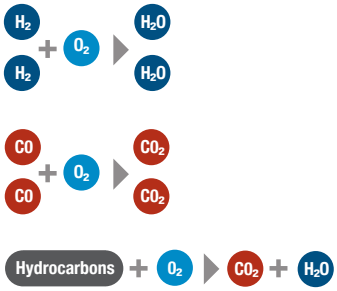
通过铜触点产生化学吸附作用：
该工艺的基础是铜氧化成一氧化铜。被氧化的触点通过氢或一氧化碳还原而再生。

对于特殊要求，结合两种工艺可能是问题的最佳解决方案。
两种工艺的优缺点通过举例说明，例如去除氮气中的氧：

催化燃烧	化学吸附
优点： 装置构建简单，投入成本低，持续运行 采用一台反应器	**优点：** 湿度不会升高，氢含量可小于1 ppmv
缺点： 净化的氮气中含大约0.1%的氢湿度和氧的增加比例为1 : 2	**缺点：** 装置相当昂贵，持续运行需要两台反应器，导致投入和运行成本较高

Catalytic Gas Purification

This process is based on the following reactions:



Upstream the reactor, sufficient oxygen resp. hydrogen, in special cases also carbon monoxide, is supplied to the gas to be purified. The reactor is filled with a palladium or platinum catalyst, where oxygen and hydrogen are oxydised to water resp. carbon monoxide to carbon dioxide.

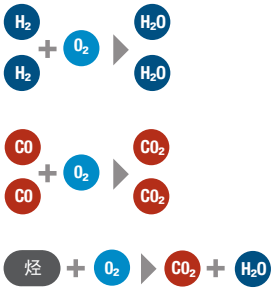
As these reactions are highly exothermic, the gas temperature may increase significantly, depending on the extent of contamination. In the cooler downstream of the reactor the purified gas is re-cooled and possible condensation water drained off.
By a downstream adsorption drying unit, which is also a part of our delivery program, the moisture content can be reduced to less than 1 ppmv.

Characteristic data of this process:

Catalyst:	palladium or platinum
Application:	removal of O_2, H_2, CO and hydrocarbons from gases
Concentration on inlet:	O_2 up to 3%, H_2 up to 6%, higher concentrations, removal of CO and hydrocarbons also possible
Residual contents:	less than 1 ppmv of the component to be removed
Reaction temperature	
for hydrogen:	more than 10 °C
oxygen:	more than 10 °C
carbon monoxide:	more than 120 °C
hydrocarbons:	250 - 500 °C
Reaction gas:	hydrogen, oxygen, carbon monoxide
Consumption of reaction gas:	stoichiometric ratio + 0.1 % surplus
Reaction product:	water, carbon dioxide
Catalyst poisons:	compounds of sulphur, chlorine, arsenic and phosphor, oil, mists of alkali and acid

催化气体净化

该工艺基于下列反应：

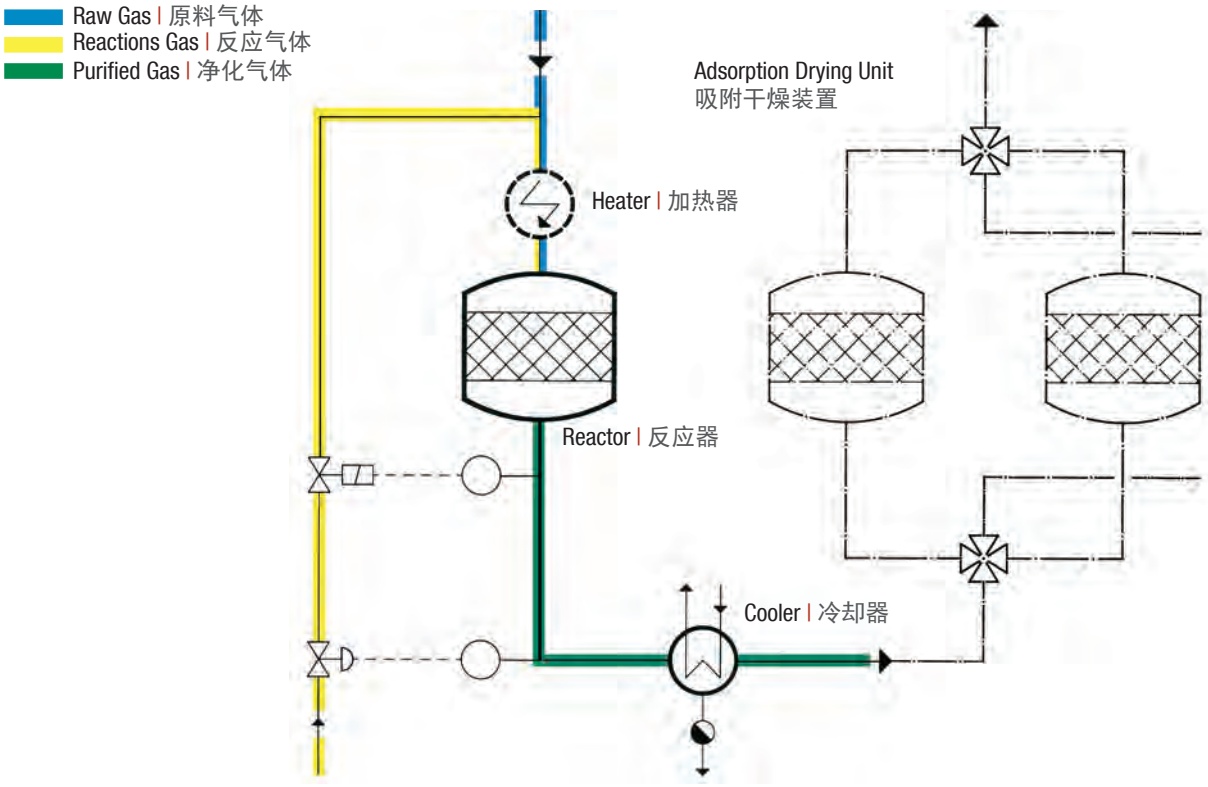


将反应器置于上游，并供应足够的氧气、氢气，在特殊情况下还有一氧化碳，给待净化的气体。该反应器填充有钯或铂催化剂，在这里，氧和氢被氧化成水，而一氧化碳被氧化成二氧化碳。

由于这些都是强放热反应，气体温度可能会显著增加，具体取决于污染程度而定。在反应器下游的冷却器中，净化气体被再次冷却，并可能排出凝结水。
通过下游吸附干燥装置（也是我们供应项目的一部分），水分含量可降至1 ppmv以下。

本工艺的特性数据：

催化剂：	钯或铂
应用：	去除气体中的O_2、H_2、CO和烃
入口处浓度：	O_2最高3%，H_2最高6%，浓度可能更高，还可去除CO和烃
残留量：	1 ppmv以下的待去除组分
反应温度，氢：	10° C以上
氧：	10° C以上
一氧化碳：	120° C以上
烃：	250 – 500° C
反应气体：	氢、氧、一氧化碳
反应气体的消耗：	化学计量比 + 0.1%的剩余量
反应产物：	水、二氧化碳
催化剂毒物：	硫化合物、氯、砷和磷、油、碱酸雾


Raw Gas | 原料气体
Reactions Gas | 反应气体
Purified Gas | 净化气体
Adsorption Drying Unit
吸附干燥装置
Heater | 加热器
Reactor | 反应器
Cooler | 冷却器

Gas Purification by Chemisorption

The chemisorption process is used for removal of oxygen from gases. The oxygen contained in the process gas is absorbed by the copper contact according to following formula:

When the contact is saturated, it is regenerated by supply of hydrogen, rarely by carbon monoxide:

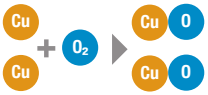
To attain a capacity as high as possible of the copper contact, this process takes place at a temperature of approx. 200 °C. A continuous operation is only guaranteed when two reactors are installed. One reactor purifies the gas, while the other one is being regenerated.

First the gas is heated up to the necessary operating temperature, mostly using the heat stored in the purified gas. When passing through the reactor the oxygen contained in the gas reacts with the copper contact; the gas exits the unit oxygen-free.

The regeneration of the charged reactors mostly takes place in a closed cycle with process gas to which a defined quantity of hydrogen is added. When passing through the copper contact, it is reduced by hydrogen. The water originating from this reaction is condensed at the cooling in the cycle cooler and drained off via a separator. To keep the energy consumption for regeneration as low as possible, a heat recovery should be integrated in the regeneration cycle. At this mode of process only hydrogen is used as regeneration gas, specifically twice as much as the oxygen contained in the process gas.

通过化学吸附净化气体

该化学吸附工艺用于从气体中清除氧。工艺气体中所含的氧按下列方程式被铜触点吸收：



当触点饱和时，通过氢再生，而很少通过一氧化碳：

为了获得尽可能高的铜触点容量，该工艺在200° C左右的温度下进行。当安装两台反应器时才能保证持续运行。一台反应器净化气体时，另一台同时再生。

首先，气体加热到必需的工作温度，大多采用净化气体中的热量。气体中所含氧气在通过反应器时与铜触点发生反应；气体退出装置时不含氧。

填充反应器的再生大多发生在闭环中，在工艺气体中添加规定量的氢。工艺气体在通过铜触点时被氢还原。这一反应所产生的水在循环冷却器的作用下冷凝，并通过分离器排出。为了使再生能耗尽可能低，再生循环中应安装热回收装置。在该工艺模式中，只有氢被用作再生气体，用量是工艺气体中所含氧的两倍。

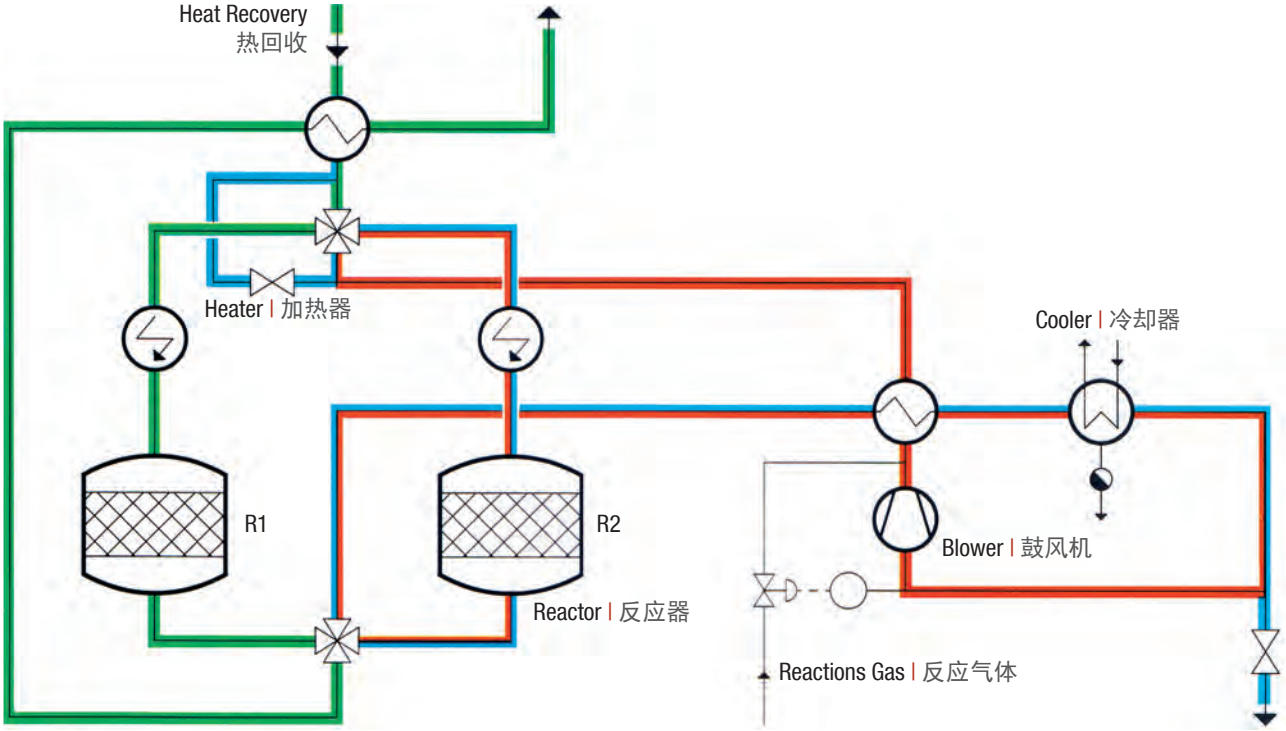
Characteristic data of the process:

Catalyst:	copper
Application:	removal of O_2 from gases
Concentration on inlet:	up to approx. 1 Vol. %, higher contents are possible
Residual content:	O_2, H_2 less than 1 ppmv
Operating temperature:	150 - 250 °C
Regeneration gas:	hydrogen or carbon monoxide
Reaction product:	copper oxide, thus process gas not contaminated with other gases
Contact poisons:	sulphur compounds, salts, oil

本工艺的特性数据：

催化剂：	铜
应用：	去除气体中的O_2
入口处浓度：	最大约1 Vol. %，更高的含量亦有可能
残留量：	O_2，H_2小于1 ppmv
工作温度：	150 – 250° C
再生气体：	氢或一氧化碳
反应产物：	氧化铜，因此，工艺气体不沾染其它气体
触点毒物：	硫化合物、盐、油

Loading Gas | 加载气体
Regeneration | 再生
Purging | 吹扫



Gas Purification by Adsorption and by Impregnated Activated Carbons

Heat regenerated units with molecular sieves:
Due to their defined equal pore structure molecular sieves are specially suited for the selective separation of gas compounds. The molecular sieves used are those with pores of 0.3 nm (3 Å), 0.4 nm (4 Å), 0.5 nm (5 Å) and 1 nm (10Å). For instance hydrogen sulphide, ammonia, carbon dioxide, hydrocarbons etc. with an inlet concentration of less than 2 Vol. % can be reduced to residual contents of less than 1 ppmv.

The molecular sieves can either be regenerated with the aid of external gas, for instance nitrogen, in an open system or with gas in a closed cycle, purging with foreign gas. The advantage of the latter process is that the consumption of regeneration gas is minimized, however, the investment costs for the unit are higher.

Filters with impregnated activated carbons:
By using impregnated activated carbons, for instance hydrogen sulphide, mercury and other contaminations can be removed from gases. For economical reasons, this is mostly based on a concentration of up to approx. 0.1 %. The attainable residual content is less than 0.1 ppmv.

Dependent on the inlet concentration the life time of the carbon is between one month and several years. In many cases a regeneration of the activated carbon would be possible, but is not applied for economical reasons.

Type of Plant

We can draw upon decades of experience in the design and manufacture of purification units, enabling us to find optimal solutions for your specific problems with respect to your choice of processes and materials.

Our methods of construction and production conform to European and German standards and regulations. However, customer standards and the various international standards such as ASME, BS and others can be followed as well.

Catalytic purification units are often provided with a controlled feeding of the necessary reaction gas flow – in most cases hydrogen, i.e. the concentration of the reaction gas is measured at the purification unit outlet and constantly kept to a minimum via a closed loop control system. This ensures that, if the operating conditions fluctuate markedly, only the absolutely necessary quantity of reaction gas is consumed. For the concentration measurement—also in the ppm-range—only long-time established instruments of notable manufacturers are used, setting a high value on simple handling and maintenance.

For the unit control—especially in combination with a drying unit—programmable electronic sequence controllers are preferred. These are projected and programmed in-house.

In addition to purification our delivery range also comprises any necessary pre-filters, demisters, pre-heaters, after-coolers, etc. Thus we are in a position to offer a complete unit, for which we can also provide the later maintenance.

通过吸附和浸渍活性炭净化气体

使用分子筛的热再生装置：
由于其一样的孔洞结构，分子筛特别适合气体化合物的选择性分离。所用分子筛的孔隙尺寸分别为0.3 nm（3 Å）、0.4 nm（4 Å）、0.5 nm（5 Å）或1 nm（10 Å）。例如，入口浓度小于2 Vol. %的硫化氢、氨、二氧化碳、碳氢化合物等可还原到不足1 ppmv的残留量。

分子筛可借助外部气体（如氮）在开放系统中再生，或在闭环中利用气体吹扫杂质气体再生。后一工艺的优点是再生气体的消耗最小，但装置的投入成本较高。

使用浸渍活性炭过滤器：
使用浸渍活性碳（例如硫化氢）可去除气体中的汞和其他污染物。出于成本考虑，主要基于最高约0.1 %的浓度。最终的残留量小于0.1 ppmv。

碳的寿命在一个月至数年，具体取决于入口浓度。大多数情况下，活性碳可以再生，但出于成本考虑并未再生。

设备类型

我们利用数十年的净化装置设计和制造经验，针对您在工艺和材料选择方面的具体问题提供最佳解决方案。
我们的制造和生产方法符合欧洲和德国标准和法规。但也遵循客户标准和ASME，BS等各种国际标准。

催化净化装置通常具备所需反应气流 - （大多情况下是氢）的控制供给系统，也就是说，反应气体的浓度在净化装置出口处测得，且通过闭环控制系统始终保持在最小值。这就确保了工作条件明显波动时只有绝对必要量的反应气体消耗。对于浓度测量 - 也在 ppm-范围内 - 只使用知名制造商长期以来经证实有效的仪器，且重视简单的操作和维护。

对于装置控制 - 特别是结合干燥装置时 - 优选可编程电子序列控制器。这些控制器可内部设计和编程。

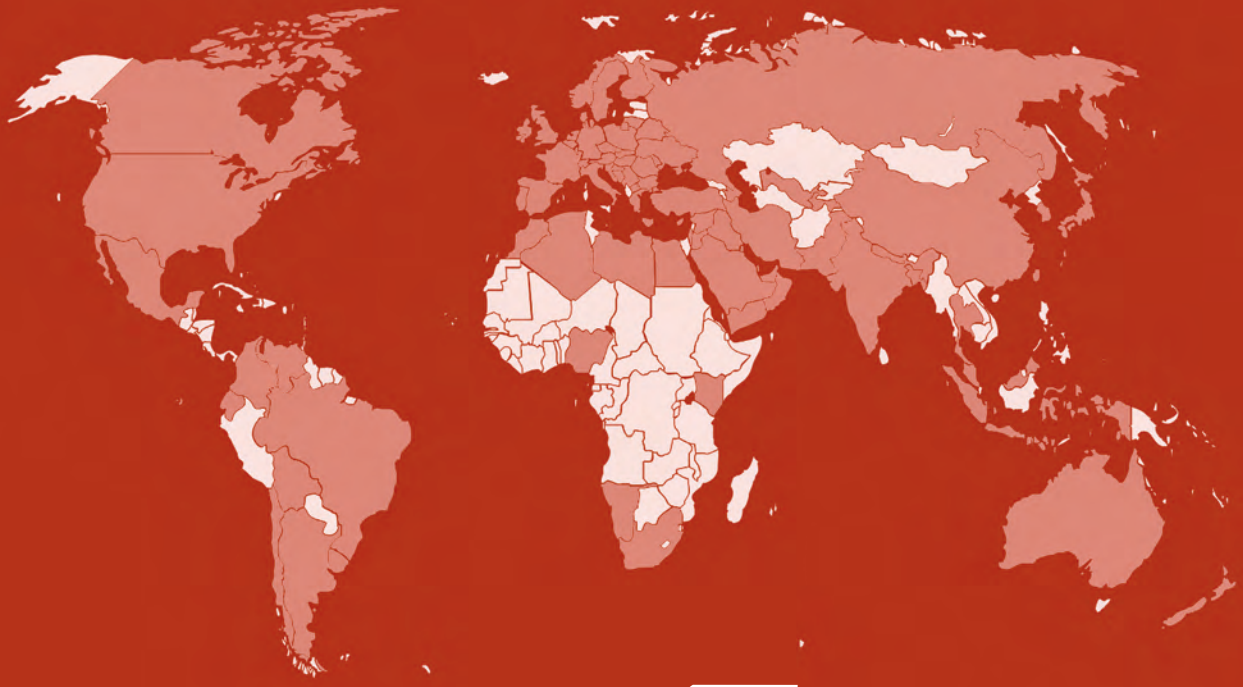
除了净化，我们的产品系列还包括预过滤器、去雾器、预加热器、后冷却器等所需器件。因此我们能够提供一整套的装置以及后期维护服务。

Silica Adsorption Technology all over the World

In the last two decades Silica delivered more than 500 adsorption plants in over 80 countries worldwide. More than 300 satisfied customers appreciate our expertise and experience as well as the quality and reliability of our plants.

Silica吸附技术遍布世界各地

在过去二十年中，Silica生产的500多套吸附设备遍布全球80多个国家。赢得300多位客户的满意，以及对我们专业技术和经验，及我们设备质量和可靠性的称赞。



SILICA

Silica Verfahrenstechnik GmbH

Our premises of 7,000 m² in the north of Berlin comprise all the necessary departments needed for the design and construction of special plants, such as calculation and projects department, assembly and installation, as well as our commissioning and service department.

我们位于柏林北部的经营场所占地7,000 m²，包含专用设备设计和制造所需的所有部门，如计算和工程部门、装配和安装部门以及试运转和服务部门。

SILICA

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Arriving by Car from North
Coming on autobahn A111 from direction Hamburg leave the autobahn at exit Holzhauser Straße, turn left and pass beneath the autobahn bridge. Turn right into the Wittestraße at the next junction about 100m away. Silica is located on the left side after about 100m.

Arriving by Car from South
Follow the autobahn to Berlin-Center (Airport Tegel). At junction no.1 Dreieck Funkturm follow autobahn A100 to Hamburg. Change to A111 to Hamburg at junction no.4 Charlottenburg. Leave the autobahn at exit Holzhauser Straße and turn right. Turn right again into the Wittestraße at the next junction. Silica is located on the left side.

Arriving by Car from Airport Schönefeld (SXF)
Take autobahn A113 to Berlin Center. Follow the course of autobahn A100 to Hamburg (Airport Tegel). At junction no.4 Charlottenburg follow autobahn A111 to Hamburg. Leave the autobahn at exit Holzhauser Straße and turn right. Turn right again into the Wittestraße at the next junction. Silica is located on the left side.

Arriving from Airport Tegel (TXL)
Airport Tegel is located very close to Silica. Take a taxi to Wittestraße. Silica can be reached in about 10 minutes.