



SILICA

Adsorption Technology from Design to Turnkey Plant

WASTE AIR PURIFICATION



**Your Need is our Challenge,
our Experience is your Solution**



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。数十年的经验和专业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、分子筛和活性炭。

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。





Air Purification by Adsorption on Activated Carbon

There is no other physical process to attain lower residual contents than by adsorption. A significant factor in this process are the extremely large surface areas of the adsorbents, caused by their high porosity.

A particularly suitable adsorbent for collecting organic substances is activated carbon. This adsorbent gives preference to the adsorption of non-polar substances such as aromatics, aliphatics, halogenated hydrocarbons, esters, etc. Polar substances such as methanol are poorly adsorbed.

High-quality activated carbons have inner surface areas of 1,200 m²/g and higher. These large surface areas are a result of the enormous number of pores in these materials. This explains the high adsorption capacity with smallest residual contents.

During production of activated carbons their porous structure can be influenced significantly. Appropriate activated carbons will be selected by us depending on their application. The efficiency of activated carbons is represented by adsorption isotherms. At constant temperature and in the absence of moisture, the activated carbons are loaded with specific concentrations of solvents up to the equilibrium state. In practice, only a part of this adsorption capacity can be realized.

通过活性炭吸附净化空气

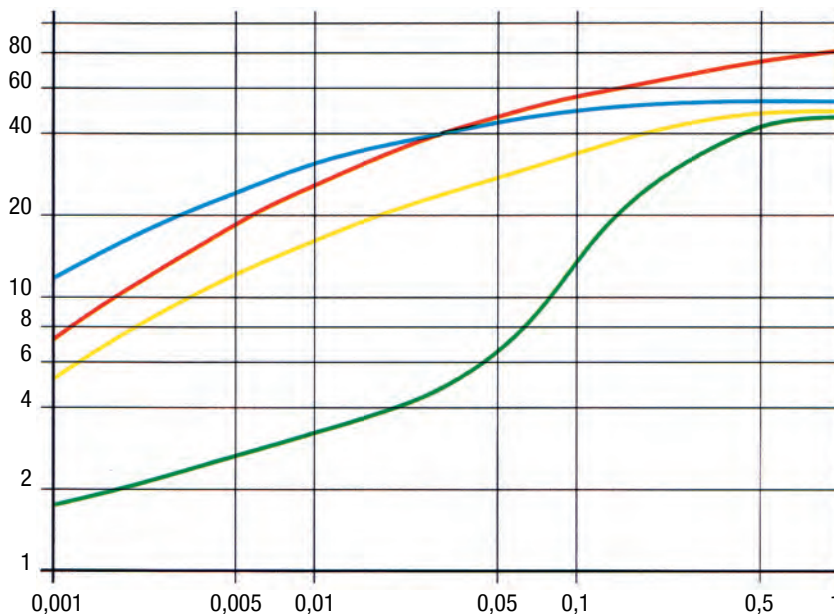
没有其它物理过程可比吸附达到更低的残留量。该工艺中的一个重要特征是，吸附剂因其多孔性而带来极大的表面积。

特别适合收集有机物质的吸附剂是活性炭。该吸附剂优先吸附非极性物质，如芳烃、脂肪烃、卤化烃、酯等。对甲醇这样的极性物质吸附力较差。

高质量的活性炭内表面积可达1,200 m²/g或更大。这么大的表面积是材料中的大量孔隙造成的。这就解释了为何它能实现高吸附容量和最小残留量。

在活性炭生产期间，其多孔结构可能受影响较大。我们将根据其应用条件选择适当的活性炭。

活性炭的效率通过吸附等温线表示。在恒温无湿的条件下，在活性炭中载入特定浓度的溶剂直到平衡状态。实际上，仅一部分吸附容量是可以实现的。



Equilibrium isotherms of an activated carbon

活性炭的平衡等温线

- Dichloromethane | 二氯甲烷
- Benzene | 苯
- Acetone | 丙酮
- Methanol | 甲醇

Relation partial vapour pressure/saturation vapour pressure

相关部分蒸汽压力/饱和蒸汽压力



Processes for Waste Air Purification

To obtain large amounts of solvents from the recovery process, or to ensure low residual concentrations, many factors have to be taken into consideration. The efficiency of adsorption is increased by low temperatures and decreased by high relative humidity. At high concentrations of solvent, the adsorption heat may influence the residual content negatively. Polluting constituents such as plasticizers, high boiling hydrocarbons, phenols or substances that tend to polymerize can reduce the life expectancy of the activated carbon. In addition, the activated carbon has catalytic characteristics so that harmful reaction products may be obtained.

Physical and chemical influences are of the highest importance for the optimal operation of an adsorption plant. A great deal of experience is required to determine the most favourable operating conditions and process steps.

Single-Stage Adsorption

The basic plant comprises one vessel (adsorber) with highly effective activated carbon. Solvent loaded waste air flows through the bed of activated carbon for purification, and exits the adsorber into the atmosphere (adsorption).

Subsequent to the adsorption process, the solvents have to be removed from the adsorber (desorption). Since the adsorption process must be interrupted during desorption, the operation of the plant will be discontinuous with only one adsorber. At least two adsorbers are necessary for continuous operation. By adding additional adsorbers, the working capacity of the plant can be increased. In this case it will also be necessary to appropriately increase the capacity of both the blower and condensation system.

To initiate the desorption process, steam is led into the adsorber in the reverse direction to the adsorption. The steam drives the solvents out of the activated carbon. This mixture of steam and solvents (desorbate) is then led into a condenser to be condensed and cooled. If the solvents are water insoluble, the solvents can, to a large extent, be separated from the water in a separator. Depending upon their solubility, small amounts of solvent will still be present in the waste water. Subsequent purification of the water, e.g., by using an air-stripping process, will remove most of the remaining solvent so that only slight traces remain in the water. The strip-air containing solvent is then led back to the inlet side of the plant and mixed with the waste air.

废气净化工艺

为了从回收工艺获得大量的溶剂，或为确保低残留浓度，必须考虑许多因素。吸附效率会随温度的降低而上升，以及随相对湿度的增加而下降。在高浓度的溶剂中，吸附热可能使残留量升高。污染成分（如塑化剂、高沸点的烃类、酚类或易聚物质）可降低活性炭的预期寿命。另外，活性炭具有催化特性，可能产生有害的反应产物。

对吸附设备的最佳运行中以物理和化学影响最为重要。要确定最有利的工作条件和工艺步骤，需要大量的经验。

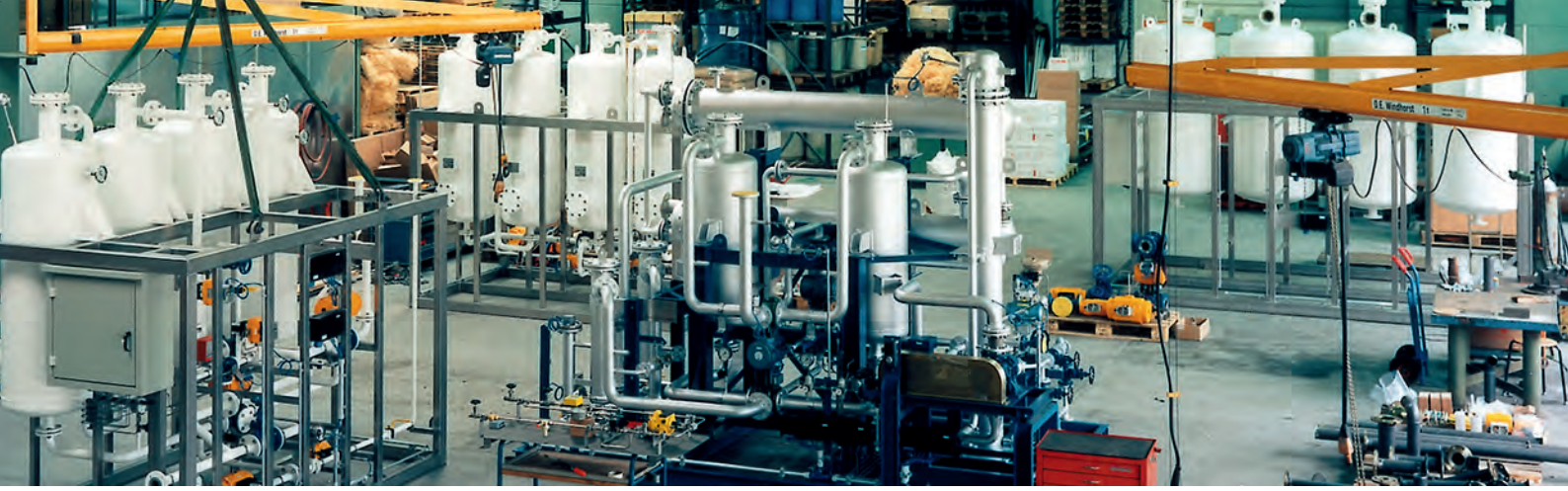
单级吸附

基本设备包括一个有高效活性炭容器（吸附器）。加载溶剂的废气流经活性炭床净化后，自吸附器退出进入大气（吸附）。

吸附过程之后，必须从吸附器去除溶剂（解吸）。由于在解吸期间，吸附工艺必须中断，在只有一台吸附器的情况下，设备的运行不能持续。要持续运行至少需要两台吸附器。增设另外的吸附器可以提升设备的工作能力。在这种情况下，还有必要适当增加鼓风机和冷凝系统的容量。

为开始解吸过程，蒸汽被反向（相对于吸附）导入吸附器，并将溶剂驱出活性炭。蒸汽和溶剂的混合物（解吸物）被导入冷凝器以待冷凝冷却。如果溶剂不是水溶性的，在很大程度上可在分离器中从水中分离。基于其溶解度，少量的溶剂将仍存在于废水中。水的后续净化（例如，通过使用气提工艺）将去除大部分的残留溶剂，这样，只有微量残留于水中。含有溶剂的气体接着被导回至设备的入口侧，并与废气混合。





In most cases, the solvents flowing out of the separator can be re-used immediately. The solvents may still contain traces of water. In so far as this water prevents any reuse of the solvents, it can be dried with adsorbents such as Silica Gel or molecular sieves. If the solvent is water soluble, it is not possible to use simple separation techniques. Other methods involving processes such as distillation or rectification will have to be employed.

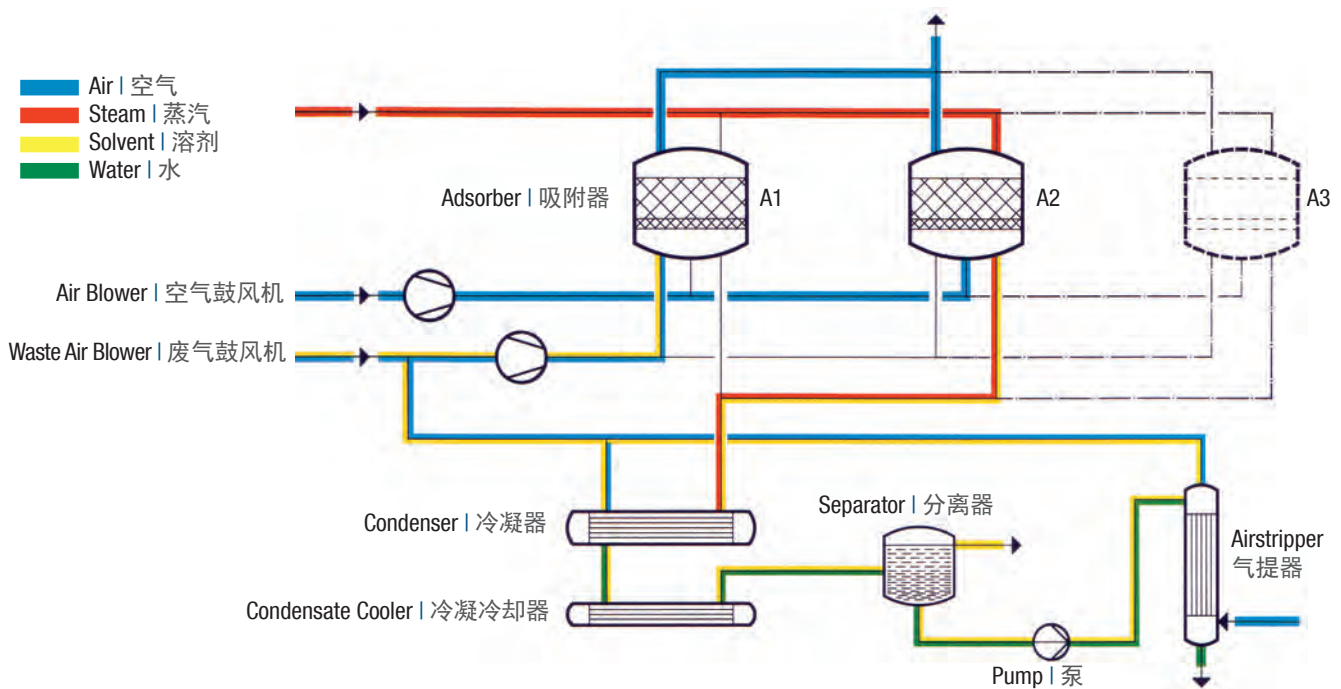
After steaming, small quantities of solvent still remain in the activated carbon as well as in the steam that flows into the condenser. A brief purging cycle will prevent the solvent from harming the environment. In order to purge, fresh air is led via the adsorber into the condenser. The non-condensable purge gas ends up at the inlet side of the plant and is mixed with the waste air.

After steaming, it is important that the activated carbon will be dried and cooled as soon as possible so that the adsorber can be put back to service. In many cases, these steps are carried out immediately after the desorption process by using solvent loaded air. In order to improve drying, a heat-storing material is placed beneath the bed of activated carbon. During the steaming cycle, this material will also be heated, thereby helping to reduce the consumption of cooling water. For low boiling solvents and/or high solvent concentrations, an additional drying cycle is necessary. A separate blower drives fresh air through the adsorber for drying and cooling. In order to accelerate drying, the fresh air can be heated before it enters the adsorber.

在大多数情况下，流出分离器的溶剂可直接再次使用。溶剂可能仍含有少量的水。此时，由于这部分水使任何溶剂无法再次使用，可利用吸附剂（如硅胶或分子筛）对其进行干燥。如果溶剂是水溶性的，则不能采用简单的分离技术。必须采用涉及蒸馏或提纯等工艺的其它方法。

汽蒸后，少量的溶剂仍残留在活性炭以及流入冷凝器的蒸汽中。短时的吹扫周期将防止溶剂危害环境。为了吹扫，新鲜空气通过吸附器导入冷凝器。非冷凝吹扫气体最终到达设备入口侧与废气混合。

汽蒸后，尽可能快地干燥和冷却活性炭以便吸附器返回工作状态很重要。在许多情况下，在通过使用加载溶剂的空气中的解吸过程后，立即执行这些步骤。为了加速干燥，储热材料置于活性炭床下。汽蒸期间，该材料也将加热，因此有助于减少冷却水的消耗。对于低沸点溶剂和/或高浓度溶剂，需要附加干燥循环。一个单独的鼓风机驱使新鲜空气通过吸附器进行干燥和冷却。为了加速干燥，新鲜空气在进入吸附器之前可进行加热。





Two-Stage Adsorption

We have developed a two-stage process, the Silicarbon Process, that offers significant advantages in many cases.

This process makes use of two adsorbers that are operating alternately in series. The four-way reverse valves ensure safe change-over. During operation, the air passages of the valves are always open so that any blocking of the flow is impossible. Solvent loaded air first passes into one of the adsorbers. Purified air is released into the atmosphere only during the time when the second adsorber is being steamed. During this phase of the process, the online adsorber is only slightly charged with solvent which means that it will be completely adsorbed. In general, the time required for steaming an adsorber takes up at most 50% of the time provided for adsorption.

After the adsorber has been steamed, the outlet valve is switched over. The steamed adsorber is then dried with solvent free air taken from the outlet of the other operated adsorber. A feature of this process is that the steamed adsorber is always dried with solvent-free air. An advantage of this two-stage process is that the adsorber can be loaded beyond the breakthrough capacity since the second already steamed adsorber can accept any excess solvent.

Condensation and processing of the desorbate are carried out in the same way as described for the single-stage plant.

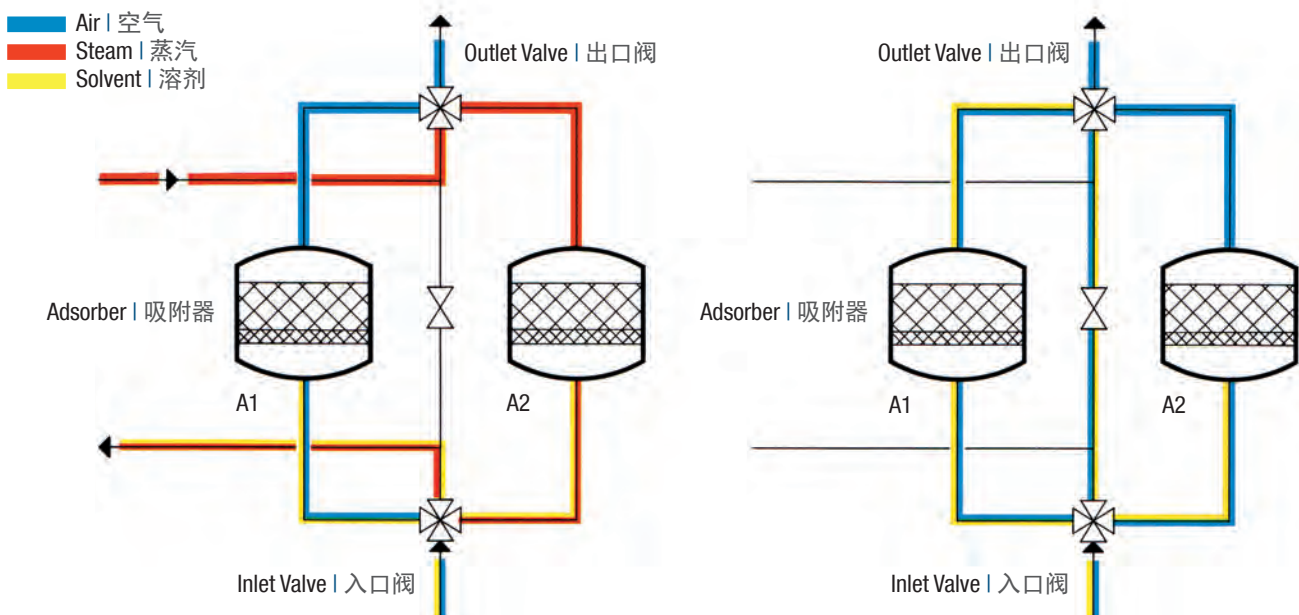
双级吸附

我们已研发出在许多情况中表现出显著优点的双级工艺—Silicarbon工艺。

该工艺利用两台串联且交替运行的吸附器。四通反向阀确保安全切换。在运行期间，阀门的气道始终打开，这样就不可能出现任何的气流阻塞。加载溶剂的空气首先进入其中一个吸附器。净化空气只有在第二台吸附器的汽蒸时段才释放到大气中。在此工艺阶段，串联吸附器只是被注入少量溶剂，这就意味着溶剂将被完全吸附。一般来说，汽蒸吸附器所需的时间最多占用50%的规定吸附时间。

在汽蒸吸附器后，切换出口阀。然后利用从另一台工作吸附器的出口取得的不含溶剂的空气来干燥已汽蒸的吸附器。该工艺的特点是，总是利用不含溶剂的空气干燥被汽蒸的吸附器。该双级工艺的优点是，吸附器可超越其穿透容量进行加载，因为第二台已汽蒸的吸附器可以接纳过量溶剂。

冷凝和解吸物的处理使用相同方式，见单级设备相关说明。



Implementation of Plants and Operating Cost

The choice of appropriate materials and components to ensure the safe, reliable operation of a plant is of particular importance. Some solvents tend to hydrolyse to acetic acid, while others tend to hydrolyse to chlorine or hydrochloric acid. In order to avoid interrupting the production, corrosion-resistant materials have to be installed on endangered parts of the equipment. In addition to stainless steels, glass, and graphite, depending on requirements, other materials that can be used include ceramic and PTFE-linings as well as enamelled vessels. Availability and service life of the plants are important factors, particularly when considering that, in accordance with environmental laws, only production plants equipped with appropriate and efficient cleaning devices for waste air will be granted authorization to operate.

Plants that are continuously in service are generally operated automatically. Preference is usually given to the installation of freely programmable electronic control systems in the facility. To monitor the exhaust air as well as to switch over the adsorbers, the plants are fitted with concentration measuring equipment. As a result, the online adsorber can be loaded up to the breakthrough point, and power consumption can be reduced to the necessary minimum.

In order to use the condensation energy resulting from the regeneration process, the additional installation of a heat recovery system is recommended.

The possibilities of using this heat are:

- Installation of a heat exchanger, located upstream the condensation system, producing hot water up to 80 °C for heating purposes, process heat and for absorption refrigeration units
- If high pressure steam is available, low pressure steam for desorption can be produced by means of a steam generation system using the condensation heat.

In the past, plants were only installed to economically recover solvents. Today, however, purification plants for waste air are operated primarily to protect the environment. The adsorption process, which often enables solvents to be recycled, is frequently the most economical solution.

In addition to depreciation allowances and interest payments, it is particularly necessary to know the expenses for utilities if a cost comparison with other methods is to be made. Necessary utilities are steam, electric power and cooling water. The required amounts of these items depend on the inlet concentration of solvents and the degree of purity of the exhaust air. Personnel costs for maintenance and repairs are low.

For average solvent concentrations of 5 to 10 g per m³ of waste air, the following utilities are required to recover 1,000 kg of solvent:

Steam: 2.5 to 4 t
Power: 130 to 260 kWh
Cooling water: 100 to 150 m³

设备执行和运行成本

为了确保安全和设备的可靠运行，选择适当的材料和组分特别重要。有些溶剂易于水解成乙酸，而其它溶剂易于水解成氯或盐酸。为了避免中断生产，设备的危险部件上必须安装耐腐蚀材料。除了不锈钢、玻璃和石墨，根据要求，可使用的其它材料包括陶瓷和PTFE衬里以及搪瓷容器。设备的可用性和使用寿命很重要，特别是考虑到，根据环保法，只有配备适当有效的废气清洁装置的生产设备才可以运行。

持续运行设备一般是自动操作的。通常优先考虑在设备中安装可自由编程的电子控制系统。为了监测排气以及切换吸附器，设备配有浓度测量仪器。因此，安装的吸附器可加载到穿透点，能耗降低到最低限度。

为了利用再生过程所产生的冷凝能量，建议另外安装一个热回收系统。

使用这部分热量可以：

- 安装热交换器，将其置于冷凝系统上游，从而产生高达80 °C的热水，用于加热、工艺用热和吸附制冷装置。
- 如果有高压蒸汽，则可以通过使用冷凝热的蒸气生成系统产生用于吸附的低压蒸气。

过去，设备的安装只是为了经济有效地回收溶剂。然而现在，废气净化设备的运行主要是为保护环境。吸附工艺通常可回收溶剂，所以经常是最经济的解决方案。

如果要与其它方法进行成本比较的话，除了折旧免税额和支付利息，尤其需要了解公用事业费用。所需公用事业项目是蒸汽、电力和冷却水。这些项目的需求量取决于入口溶剂浓度以及排气净化程度。维护维修人工费用低。

对于平均溶剂浓度为5至10 g/m³的废气，回收1,000 kg的溶剂需要下列公用项目：

蒸汽： 2.5至4 t
电力： 130至260 kWh
冷却水： 100至150 m³





Use of Adsorption Plants

For more than 80 years adsorption plants with activated carbon are used for different production processes that need organic solvents for dissolution and dilution purposes. On the one hand the solvents were recovered for environmental protection, but on the other hand there were especially great economical advantages. Depending on the kind and concentration of solvents, activated carbon units paid off after only few months. Often, profitability was already given at concentrations of 2 - 3 g/m³. Organic solvents are used in all industry sectors. Essential amounts of solvents are evaporated in the manufacture of gaskets, adhesive tapes, brake linings, foils, rubber goods, explosives, as well as in rotogravure printing shops, and in processes involving degreasing and cleaning, in chemical and pharmaceutical processes, in breathing processes in apparatuses, in storage tanks, as well as in distilleries and extraction plants.

More responsibility for the environment, odour nuisance, and especially stronger law restrictions have led to the need for the purification of waste air streams which are contaminated with organic and especially halogenated hydrocarbons. These waste air purification units have the function to remove many different constituents and to purify the waste air to such an extent that the values fall below those prescribed by law. This is especially applicable to carcinogenic constituents. Such units are needed in factories using various solvents, in chemical and pharmaceutical works, in lacquer and varnish factories, for cleaning of floor- and groundwater and for garbage dumps.

Our many years of experience enable us to advise you regarding the optimization of the whole process. For instance, it should always be tried to reduce the air streams through better encapsulation, more favourable pipe routings or increase of solvent concentration, in order to save electrical energy at suction, heat, steam and cooling water for regeneration. If water soluble solvents are used, the adsorption unit delivers a watery desorbate containing about 60 to 80% water. For reuse of the solvent the desorbate must be freed of the water. If a reuse of the solvents is impossible only a concentration will be performed in order to reduce the cost for disposal.

For rotogravure printing presses we offer the complete suction system. By distributing the air stream over all printing presses in conjunction with a particular concentration control the whole waste air stream of the machines can be reduced by 35%.

Not all organic substances are well adsorbed by the activated carbon so that it can be useful to provide an absorption plant (washer) upstream to the activated carbon unit.

Since we are active in the domain of waste air purification for more than 80 years and have essentially influenced the development in this line, we are also well acquainted with the adjacent problems. We are not only able to deliver activated carbon units, but also any necessary installations like steam generators, steam saving systems, absorption units, distillation units, stripping columns, cooling towers, suction systems, chimneys etc., up to a turnkey unit.

吸附设备的使用

80多年来，活性炭吸附设备用于各种需要有机溶剂进行溶解和稀释的生产工艺。一方面，回收溶剂是出于环境保护，另一方面是因为其有特别大的经济效益。根据溶剂的种类和浓度，活性炭装置只要几个月就可以收回成本。一般来说浓度达到2 - 3 g/m³时即可获利。有机溶剂用于各行各业。下列各项会产生必要量的溶剂挥发：垫片、胶带、刹车片、金属箔片、橡胶制品和炸药的制造中、轮转凹版印刷车间、涉及脱脂和清洁的工艺、化学和制造工艺、器械的瞬时工艺、储罐以及蒸馏室和萃取设备中。

对环境的更多责任、令人不悦的异味，以及，特别是更严格的法律限制下，都引领了净化废气的需要（有机物特别是卤化烃的污染）。这些废气净化装置具有去除各种成分并净化废气至法律规定值以下的的能力，特别适用于致癌成分。在使用各种溶剂的工厂、化学和制药工程、漆及清漆工厂、地表和地下水清洁及垃圾场作业中都需要这样的装置。

多年的经验使我们能够为您提供有关整个流程优化的建议。例如，总是尝试通过更好的封装，更有利的管道路线或增加溶剂浓度来减少气流，以节约抽吸装置用电、热量、蒸汽以及再生用冷却水。如果使用水溶性溶剂，吸附装置会产出水一样的解吸物，其中所含水分达60至80%。为了溶剂的重复利用，该解吸物必须分离水分。如果溶剂的重复利用不现实，则只进行浓缩以减少处置成本。

对于轮转凹版印刷机，我们提供完整的抽吸系统。在所有印刷机之间分布气流，再结合特定浓度控制，机器的整体废气流可降低35%。

并非所有的有机物质都可被活性炭充分吸附，所以，在活性炭装置的上游安置吸附设备（洗涤器）会有所帮助。

我们从事废气净化已超过80年之久，从根本上影响了这个行业的发展，我们还很熟悉相关问题。我们不仅能够供应活性炭装置，而且可以提供所需装置，如蒸汽发生器、节约蒸汽系统、吸附装置、蒸馏装置、脱附塔、冷却塔、抽吸系统、烟道等，一直到成套。



Special Processes for Air Purification and Solvent Recovery

For special applications, combinations of processes have been developed which are partly protected by patent. These are used, for instance, when:

- the concentration of solvents in the waste air is very low
- very low boiling organic substances have to be removed
- water-soluble solvents have to be recovered almost free of water.

Adsorption—Vacuum Regeneration

Adsorption takes place at normal pressures. In the regeneration (desorption) phase, the adsorbent is heated and placed under a vacuum. The vapours of drawn off solvents are condensed, and the inert gas components are fed back to the inlet side of the adsorption plant. The advantage of this process is that the recovered solvents are almost entirely free of water. Since high regeneration temperatures and condensate are avoided in the adsorption plant, there is only little risk of corrosion. This process is particularly suitable for recovering temperature-sensitive and water-soluble solvents.

Compression—Condensation—Pressure Swing Adsorption

The solvent loaded waste air is compressed to a pressure of more than 5 bar. Subsequently, solvents are condensed out by cooling and then removed from the plant via a separator. Solvents remaining in the waste air after being cooled are retained in a pressure swing adsorption plant. In general, these plants comprise two adsorbers of which one is used for adsorption, while the other is simultaneously being regenerated with a small, cleaned, and expanded partial flow of air. This solvent loaded flow is led back to the suction side of the compressor. With this process, all of the solvents in the waste air can be condensed out in the cooler located downstream of the compressor. When compared with conventional techniques, this process has the advantage of having lower investment and operating costs as well as requiring less space for the installation. The process is particularly well suited for non-explosive solvents such as halogenated hydrocarbons. Since a warming up is not necessary for regeneration and high compression temperatures are avoided, a corrosion caused by separation of chlorine is not to be expected.

适用于空气净化和溶剂回收的特殊工艺

针对特殊应用，我们开发了工艺组合，且部分受专利保护。它们用于：

- 废气中的溶剂浓度非常低时
- 必须去除极低沸点的有机物质时
- 必须回收水溶性溶剂，且要求几乎不含水时。

吸附 - 真空再生

吸附在常压下进行。在再生（解吸）阶段，吸附剂加热且置于真空中。从溶剂分离出的蒸气得到冷凝，且惰性气体成分返回到吸附设备的入口侧。

这一工艺的优点是，回收溶剂几乎完全不含水。由于再生温度，吸附设备中没有冷凝物，腐蚀的风险很小。该工艺特别适合回收热敏性和水溶性溶剂。

压缩 - 冷凝 - 变压吸附

加载溶剂的废气被压缩到5巴以上。接着，溶剂通过冷却冷凝下来，然后通过分离器从设备中去除。残留在废气中的溶剂经冷却后保留在变压吸附设备中。

一般来说，这些设备包括两台吸附器，其中一台用于吸附，另一台利用少量清洁且膨胀的部分气流进行再生。这一加载溶剂的气流被导回至压缩机的吸入侧。利用此工艺，废气中的所有溶剂可在位于压缩机下游的冷却器中冷凝。

与传统技术相比，该工艺的优势在于投入和运行成本较低，且安装所需空间较小。该工艺特别适用于非爆炸性溶剂，如卤化烃。由于再生不需要预热，且避免了高压温度，不会出现因氯分离而引起的腐蚀。



Drying—Adsorption

Waste air is initially dried in an adsorption plant by using molecular sieves that are selected in a manner that a co-adsorption of solvents in the pores is avoided.

Following this step, the dried waste air is cooled. In the downstream adsorption plant, only solvent is adsorbed and recovered in a water-free condition. The dried, clean air is used to regenerate the molecular sieves.

This process is particularly well suited for water-soluble solvents whose reprocessing in distillation plants is difficult and expensive.

Drying—Condensation—Adsorption

Waste air is initially dried in an adsorption plant by using molecular sieves that are selected in a manner that a co-adsorption of solvents in the pores is avoided. The dried waste air is then chilled down far below the freezing point without risk. During this step, part of the solvent can be condensed. The solvent remaining in the waste air is then removed at low temperature in a downstream adsorption plant.

By using heat exchangers, this process can be operated very economically. This process is used particularly for high solvent concentrations and low waste air streams.

干燥 - 吸附

使用分子筛使废气在吸附设备中初步干燥，分子筛的选择依据：避免孔隙中溶剂共吸附。

此后，干燥的废气得到冷却。在下游吸附设备中，只吸附溶剂且回收后不含水。干燥的清洁空气用于再生分子筛。

该工艺特别适合于在蒸馏设备中回收难度大且成本高的水溶性溶剂。

干燥 - 冷凝 - 吸附

使用分子筛使废气在吸附设备中初步干燥，分子筛的选择依据：避免孔隙中溶剂共吸附。

然后，干燥的废气被冷却到远低于冰点的温度。在此期间，部分溶剂可能会冷凝。之后，以低温去除残留在废气中的溶剂在下游吸附设备中。使用热交换器，可非常经济高效地实现该工艺。

该工艺特别适用于溶剂浓度高而废气流小的情况。





Legal Reasons for Air Purification

In the Federal Republic of Germany, the legal foundations for keeping air clean are based on the Federal Emission-Control Law (Bundes-Immissionsschutzgesetz BImSchG), the ordinance concerning plants requiring authorization to operate (Verordnung über genehmigungsbedürftige Anlagen BImSchV), and the Anti-Pollution instructions (Technische Anleitung zur Reinhaltung der Luft TA-Luft).

The minimal requirements for limiting the emission of plants needing authorization to operate are set forth in TA-Luft. The allowable emissions of organic substances are subdivided into three categories, depending upon their noxious properties. For substances categorized as carcinogenic, the TA-Luft stipulates appropriately lower levels of emission. Depending upon the area influenced by the pollutants, even lower levels of emission than those prescribed in TA-Luft can be imposed on plants that require authorization to operate. For EU Member States the VOC-directive is binding since several years. Many other countries are following the German regulations on emission control. If different laws govern the emission of noxious substances in a country where a plant is being considered, this information should be provided when making inquiries.

In addition to the provisions designed to protect the quality of air, the laws, regulations, and government requirements governing pollution control of water have to be observed (Wasserhaushaltsgesetz WHG etc.).

净化的法律因素

在德意志联邦共和国，保持空气清洁的法律依据是“联邦排放控制法”（Bundes-Immissionsschutzgesetz BImSchG）、“需授权运行设备相关条例”（Verordnung über genehmigungsbedürftige Anlagen BImSchV）和“污染防治指令”（Technische Anleitung zur Reinhaltung der Luft TA-Luft）。

对限制需授权运行设备的排放最低要求列于TA-Luft中。有机物质的允许排放量分为三类，具体取决于其毒性。对于列为致癌类的物质，TA-Luft适当规定了较低的排放水平。根据污染物的影响区域，即使低于TA-Luft中规定的排放水平也可能列入需授权运行的设备中。对于欧盟成员国，VOC-指令的约束力已生效数年。许多其它国家现在也遵守有关排放控制的德国法规。如果正在考虑安装设备的所在国家实行不同的法律控制有毒物质的排放量，请在进行咨询时提供此信息。

除了旨在保持空气质量的规定，还必须遵守用于水污染防治的相关法律、法规和政府要求（Wasserhaushaltsgesetz WHG）。



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，以及对我们的专业技术和经验，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

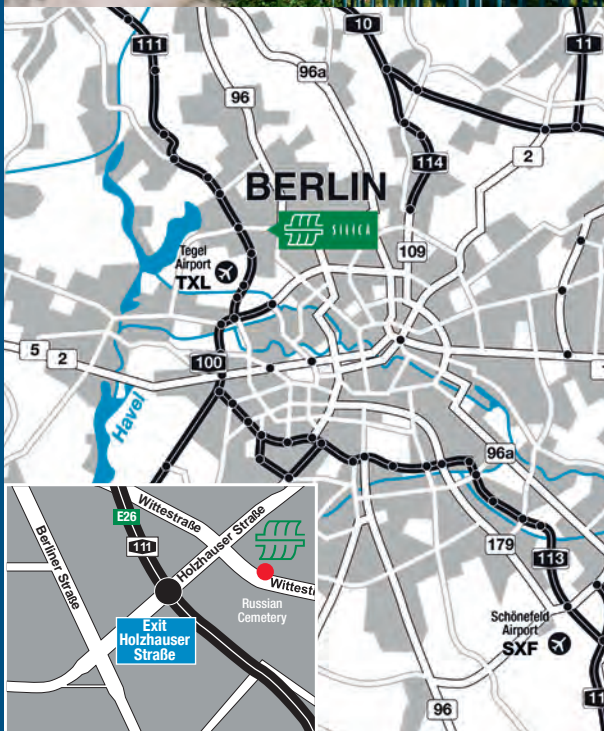
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Arriving by Car from North

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.