Based on our extensive experience with corrosion-resistant materials, we are not only competent in the design and manufacture of key process engineering components, but also have the in-house knowledge of processing these highly corrosive products, such as sulfuric acid, nitric acid and hydrochloric acid.

We supply clean, modern and energy-efficient mineral acid processing equipment worldwide without polluting the environment.

In the supply chain of fluoropolymers, we are a trader and also a process/plant supplier. In some cases, the use of PTFE/PFA, for example, is based on the specifications of our customers. Often we do not know which products and chemical processes the customer uses in the equipment and plants we supply. In these cases, we plan and build according to the customer's requirements. However, we also have our own processes, e.g. for the treatment of mineral acids. These process plants are designed, developed, built and commissioned by us. During this process we also specify all materials for the components used.

Examples

- Reconditioning of highly corrosive acids in general
- Denitration and work-up of mixed acids from nitration processes
- Hydrochloric acid recovery
- Hydrochloric acid cleaning
- Purification of pickling acids
- High purity acids (electronic grade): HCl, HNO_3 , $H_2 SO_4$
- Sulfuric acid concentration (pre-concentration, high-concentration)
- Nitric acid concentration, also in electronic grade
- HCl concentration by extractive distillation or two-pressure method.
- Sulfuric acid dilution
- Pre-concentration up to 70 wt.%
- High concentration up to 98% by weight
- Chlorine drying with sulfuric acid incl. reconcentration of sulfuric acid
- Nitric acid concentration via the azeotropic point with sulfuric acid
- Hydrochloric acid concentration via the azeotropic point with sulfuric acid
- Denitration, concentration and treatment of sulfuric acid, e.g. from various nitriding processes
- Bromine recovery and recovery from brines and process wastewater
- Debromination of brines and process streams
- Iodine recovery
- Absorption of HCl, HBr, Cl_2 , Br_2
- Recovery and concentration of HCl and HBr
- Process plants for the processing of highly corrosive halogens such as chlorine, bromine and iodine as well as their salts and acids

Every year, the chemical industry produces large quantities of mineral waste acids that are diluted with water, mixed with other acids or contaminated with other inorganic or organic components. The aim here is to purify and concentrate these waste acids in order to return them to the production cycle. Some of the plants reach industrial scale. For example, a throughput of 150 t/h of sulfuric acid to be concentrated has already been realized.

Generally speaking, we are thus specialized in the treatment of highly corrosive media in the temperature range of up to 200°C, whereby we design and realize the plants.

We are constantly developing our existing processes both theoretically and experimentally in our in-house technical center. An essential factor here is also the development of new process solutions for specific tasks of our customers. As a result, our portfolio for highly corrosion-resistant plant engineering under demanding process conditions (high temperatures, low vacuums) is constantly expanding.

Our internationally built modern and energy-efficient plants also aim to avoid or reduce the disposal of waste materials and to return them to the production cycle. In addition, we supply plants for the purification of exhaust air and wastewater.

Example sulfuric acid:

Sulfuric acid is one of the most widely used chemicals in the world and is used in a wide variety of applications, e.g. in the production of fertilizers, explosives or plastics such as polyurethanes, in the esterification of intermediates, in dyes and in the iron and steel industry. The process used today for the production from sulfur or SO_2 is the so-called "contact process". SO_2 is oxidized on a heterogeneous catalyst - vanadium pentoxide - with oxygen to SO_3 and then absorbed in ~98.5 wt% sulfuric acid, producing oleum, which is then diluted again with water to 98.5 wt%. This process therefore typically produces sulfuric acid at 98.5 wt% or more in the form of oleum.

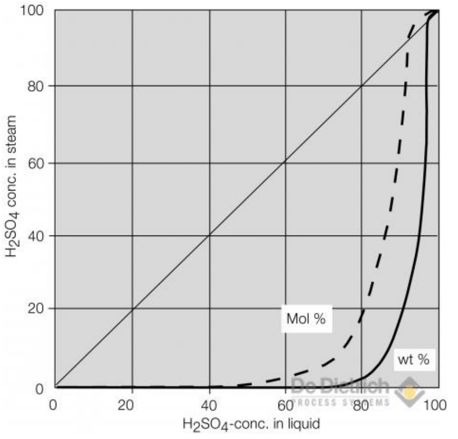
Some of the processes and applications working with sulfuric acid require lower concentrations. As a result, a dilution plant is often still required to produce this weaker acid.

On the other hand, contamination and dilution of concentrated sulfuric acid occurs in many chemical processes, and any number of waste streams of contaminated, spent sulfuric acid are generated. One example is the production of dinitrotoluene, where the waste acid is contaminated with nitric acid and partially nitrated toluene. Another example is the use of concentrated sulfuric acid for drying gases such as chlorine, bromine, hydrogen chloride, or methyl chloride, which produces sulfuric acid with a concentration below 80% by weight.

The reprocessing of this spent sulfuric acid is either a prerequisite for the profitable operation of these processes or brings significant cost savings in raw materials and wastewater disposal. We build clean, modern plants around the world to produce acid for reuse without polluting the environment.

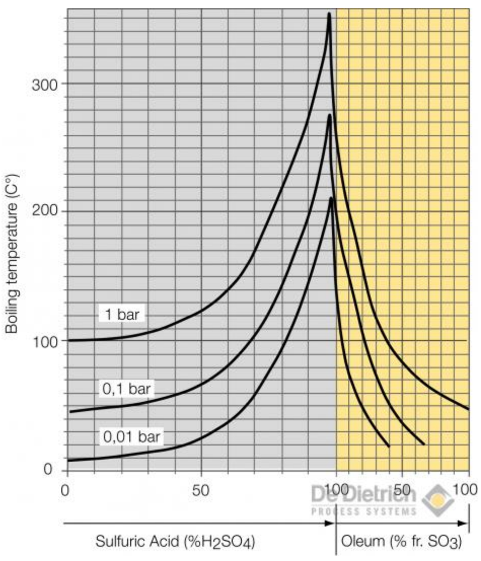
For all of the above processes, it is important to know the behavior of the binary mixture of sulfuric acid and water. The vapor-liquid equilibrium of sulfuric acid/water is shown below. It can be seen that up to a sulfuric acid concentration of 70 wt% in the liquid phase, there is almost no sulfuric acid in the vapor phase. Above a concentration of 85 wt%, the vapor pressure of the sulfuric acid increases significantly. At a concentration just above 98.5 wt.%, a maximum azeotrope forms at ambient pressure. Higher sulfuric acid concentrations can only be achieved by adding sulfur trioxide or oleum.

Vapor/liquid equilibrium diagram of sulfuric acid/water



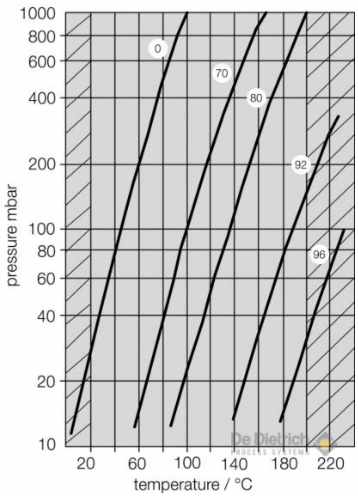
The following diagram shows that the boiling temperature at ambient pressure is quite high, e.g. 338 °C at the azeotropic point. Sulfuric acid at such a high boiling temperature is very corrosive and therefore damages almost any material. At these temperatures, even steam or oil are no longer useful as heating media from an economic point of view. The tried-and-tested method for reconcentrating sulfuric acid is therefore the so-called pot or cylinder concentrator, in which the acid is either boiled with a burner in a pot made of silicon iron or fed together with fuel gases into cylinders lined with bricks. These high-temperature applications generate exhaust gases from combustion products and often also considerable amounts of sulfuric acid mist, which cause environmental pollution.

Boiling temperature for three different pressures over the entire concentration range



To avoid these environmental and corrosion problems, we have developed a process for concentrating sulfuric acid under vacuum. This allows sulfuric acid to be concentrated to 98 wt% at below 210 °C and also allows the use of steam as the heating medium and steel/enamel, borosilicate glass 3.3, tantalum and PTFE as materials. The lower limit of the operating pressure (vacuum) in the boiler is determined by the temperature of the cooling medium, since evaporated water must condense at this low temperature.

Vapor pressure as a function of temperature for different sulfuric acid concentrations



Sulfuric acid recovery unit (borosilicate glass 3.3, examples for PTFE gaskets)

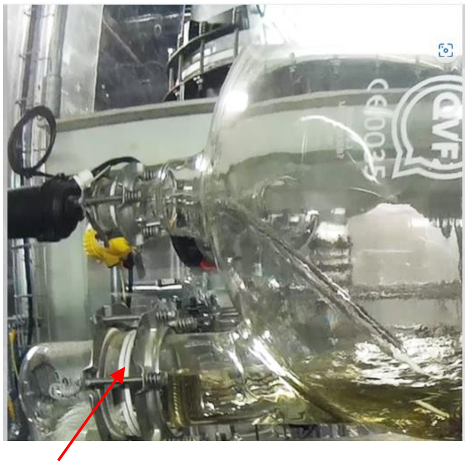
Borosilicate glass 3.3 has a chemical resistance to almost all products and thus more comprehensive than that of other known materials. It is highly resistant to water, salt solutions, organic substances, halogens such as chlorine and bromine, and many acids. In contrast, hydrofluoric acid, concentrated phosphoric acid and strong alkalis at elevated temperatures cause noticeable erosion of the glass surface. The very diverse use of our material worldwide is based in particular on its chemical and thermal properties, as well as on a large number of other advantages that distinguish borosilicate glass 3.3 from other construction materials (see EN1595). These include special properties such as:

- smooth, non-porous surface
- catalytic indifference
- physiological harmlessness
- Odorless and tasteless
- Incombustibility
- Transparency
- Recyclability

The fluoropolymers we use (PTFE/PVDF/FEP/PFA/FKM/FFKM/ETFE/GFK/ePTFE/TFM's) cannot be replaced by any other material in our field of application. Nevertheless, all materials would be affected by the currently planned ban. We have about 2500 different articles that consist of or contain fluoropolymers. These include, for example, gaskets for our piping, columns and apparatus made of borosilicate glass 3.3 and steel/enamel, stirrers for stirring apparatus and mixer-settler apparatus, column internals, components for shell-and-tube heat exchangers, components for horizontal evaporators, O-rings, screw fittings, steel/PTFE piping.

By using PTFE, we have a universally applicable plastic that matches our universally applicable borosilicate glass 3.3.

Example horizontal evaporator sulfuric acid:
(high temperature and conc. sulfuric acid - only PTFE can be used here)



Gasket PTFE

Example shell and tube heat exchanger

Installed PTFE parts in a heat exchanger:

- Deflection segments (baffle)
- Tube sheet
- Pipe fittings for fixing/fastening the pipes in the tube sheet
- Gasketing rings
- Sleeves for spacer bars
- Gaskets

vertical design in a plant for the production of concentrated hydrochloric acid

Example use of O-rings:

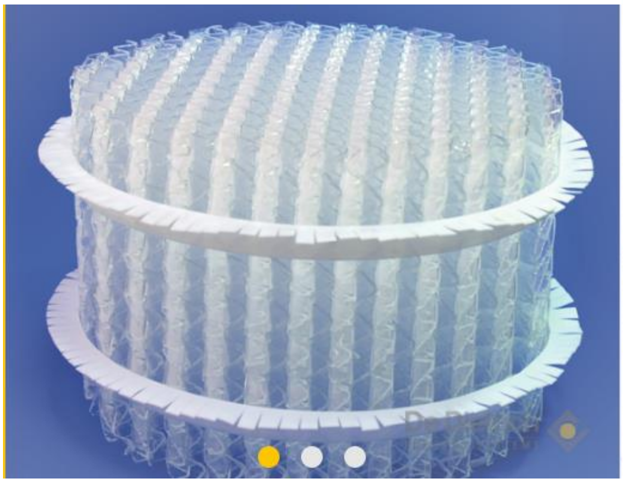
The picture is different for O-rings. PTFE is not the dominant material here. We mainly use O-rings with the materials FFKM, FKM, FEP coated, PFA, but also PTFE. Here again it is the resistance problem but also the temperature problem. Wherever possible, we use NBR or EPDM. Here, the application limit is at a temperature of 120°C or 130°C, respectively. With fluoropolymers it goes up to 260°C. In the case of O-rings, the problem is compounded by the fact that not all of them are FDA-compliant. Cord strength and cord hardness also affect applicability. O-rings are installed in valves, heat exchangers, piping, etc.

Example use of glass packs:

Thermal separation processes are frequently used in the preparation and purification of chemicals. Processes involving two liquids or a liquid and a gas are the most common. The processes primarily used include extraction, absorption, desorption or stripping, distillation or rectification. These separation processes require a mass transfer between two phases. In the above example of rectification, the mass transfer occurs between the liquid phase and the gas phase. To keep the equipment used for this process as compact as possible, as much mass transfer area as possible must be created in a limited space. Our DURAPACK® glass packing ensures high flow rates with low pressure drop and, at the same time, large mass transfer areas for efficient separation.

To intensify mass transfer in absorption, desorption, rectification and extraction columns, DURAPACK® ordered packings made of borosilicate glass 3.3 are the best choice for corrosive media. Applications therefore include corrosive chemicals such as sulfuric acid, nitric acid, other mineral acids such as HCl, and also halides such as chlorine, bromine and iodine. In short, it is used wherever metallic materials but also plastics fail.

The DURAPACK® mass transfer packing made of borosilicate glass 3.3 combines advantages of high performance with the possibility of being able to treat even very aggressive and/or high-purity media. The individual corrugated glass plates are homogeneously
fused together and form flow channels inclined at 45° to each other. The specific surface area is 300 m /m^{23} , the free cross-section 82%. In the nominal diameter range DN100 to DN450, the packing elements are in one piece; for larger diameters, they are divided into segments. Glass packing has many advantages over plastic packing and plastic packing elements.
But even DURAPACK® cannot do without fluoropolymers. Up to nominal size DN300, two edge deflectors are used per element, above that one each. One-piece packings are supported by glass or steel/PTFE support rings.
The edge deflector is made of PTFE, the heat shrink tubing required for fastening is made of FEP, and the edge protector for larger nominal sizes is made of PTFE.
The DURAPACK® is also an alternative to plastic fillers. However, it is also not free of fluoropolymers. Plastic fillers, which we also use, are often made of PTFE, PFA and PVDF.



Glaskolonne DN 600 mit DURAPACK® Packungsbett

Other equipment with PTFE/PFA use

In the highly corrosion-resistant plant engineering we operate, further equipment with PTFE, PFA, PVDF, ETFE components is also used. The reason for the use of PTFE is in principle always the same: universal usability, very often only PTFE/PFA resistant and applicable, no use of very many different materials for better and safer maintenance and compliance with various legal regulations in the operation of chemical production plants (TA-Luft, FDA, ...).

Examples include:

- Valves: Body borosilicate glass 3.3, bellows PTFE (on/off valves, control valves)
- Safety valves: body borosilicate glass 3.3, valve bellows PTFE
- Ball valves: seat rings made of PTFE, ball PFA coated
- Flap: PFA lined
- Ball check valve: seat, ball and catch plate made of PTFE
- Non-return valve: valve incl. gasket made of PTFE
- Strainer: Filter/support filter made of PTFE, filter stocking made of ETFE
- Bellows: metal flanges, PTFE bellows
- Rupture discs: Graphite with PTFE coating
- Stirrer: Stirrer shaft and stirrer head steel/PTFE
- Mixer Settler: double PTFE weir
- Column internals: PTFE hold-downs, glass support grid with PTFE components, PTFE support ring, PTFE guide funnels, ETFE demisters, PTFE spouts for spout distributors, PTFE inlet tubes, PTFE gaskets/gasketing bands, PTFE bells for bell-bottom columns, PTFE/PFA/PVDF packing or structured packing, PTFE nuts, PTFE washers.
- PTFE Vortex Crusher
- Steel/PTFE lined piping
- PTFE/PFA lined fittings
- PTFE/PFA lined pumps
- PVDF pumps
- TempCoat® - Coating for screws, nuts, springs in high corrosive atmosphere
- and much more.

Our main materials are borosilicate glass 3.3 and steel/enamel. But the assembly of the individual components into a functional system cannot be done without fluoroplastics, especially PTFE, PFA and PVDF.

Compliance with ATEX directive, reduction of explosion potential

Another great advantage of PTFE besides the normal version and the version of modified PTFE is the possibility of producing dissipative PTFE. If the installation site is in an explosive atmosphere or if explosive mixtures arise in the plant in the product space, the ATEX directive must be complied with. For this purpose, gaskets, valve bellows, pipeline bellows, stirrers, etc. are manufactured from conductive PTFE. These can then be grounded via grounding connections. There is an elaborate concept for glass plant engineering for this purpose.

Conclusion:

Without PTFE, there will be no more apparatus and plant engineering made of borosilicate glass 3.3 or steel/enamel. PTFE is the only material that can be used for gaskets and internals at high temperatures (up to 200°C for us) and with high chemical resistance. Also important with PTFE is the lower diffusion compared to the other plastics. This is very important for the emission values in the plants.

Our product range meets the requirements of TA-Luft, FDA, Pressure Equipment Directive, ATEX and Machinery Directive. The TA-Luft is particularly critical here when other plastics are used. With PTFE gaskets, diffusion is lower than with other plastics. With other gaskets, we can no longer meet the requirements of TA-Luft. This would mean that they could no longer be used in chemical and pharmaceutical applications.

We see the possibility to reduce the variety of different fluoropolymers. In addition, it would be possible to replace part of the steel/PTFE piping with borosilicate glass 3.3 or steel/enamel piping. This would leave only the gaskets and bellows made of PTFE and PFA, but not the complete piping.

Steel/enamel stirrers are also available as an alternative to steel/PTFE stirrers. A complete substitution is not possible. The steel/PTFE stirrers are significantly lighter. With enamel stirrers there are difficulties in making small dimensions and the significantly higher weight cannot be used with every stirrer. The glass spout on the hood must still be able to hold both together.

PTFE cannot damage the surface of the materials used for our equipment (borosilicate glass 3.3 and steel/enamel). This would not be the case for similar corrosion-resistant metallic materials. Damage to the surface of the equipment can ultimately lead to equipment failure or leakage and must therefore be avoided.