RHEINHÜTTE PUMPEN

An ITT Company

Sulphuric Acid

Horizontal and Vertical Pumps

Special Pumps for Sulphuric Acid and its Production

Sulphuric acid is one of the most important raw materials in the chemical industry and is used as an important auxiliary and disintegration agent in many branches of industry.

In sulphuric acid plants, vertical and horizontal centrifugal pumps convey liquid sulphur as well as dilute and concentrated acids, which can contain sulphur dioxide and sulphur trioxide.
Corrosion-resistant materials with high chemical stability are required here. The materials must convey the media safely even at high temperatures and withstand concentrated sulphuric acid (99 %) up to 240 °C (464 °F).
Rheinhütte Pumpen offers materials adapted to the respective operating conditions, which meet these stringent demands and even provide maximum resistance to the acting „erosion corrosion".

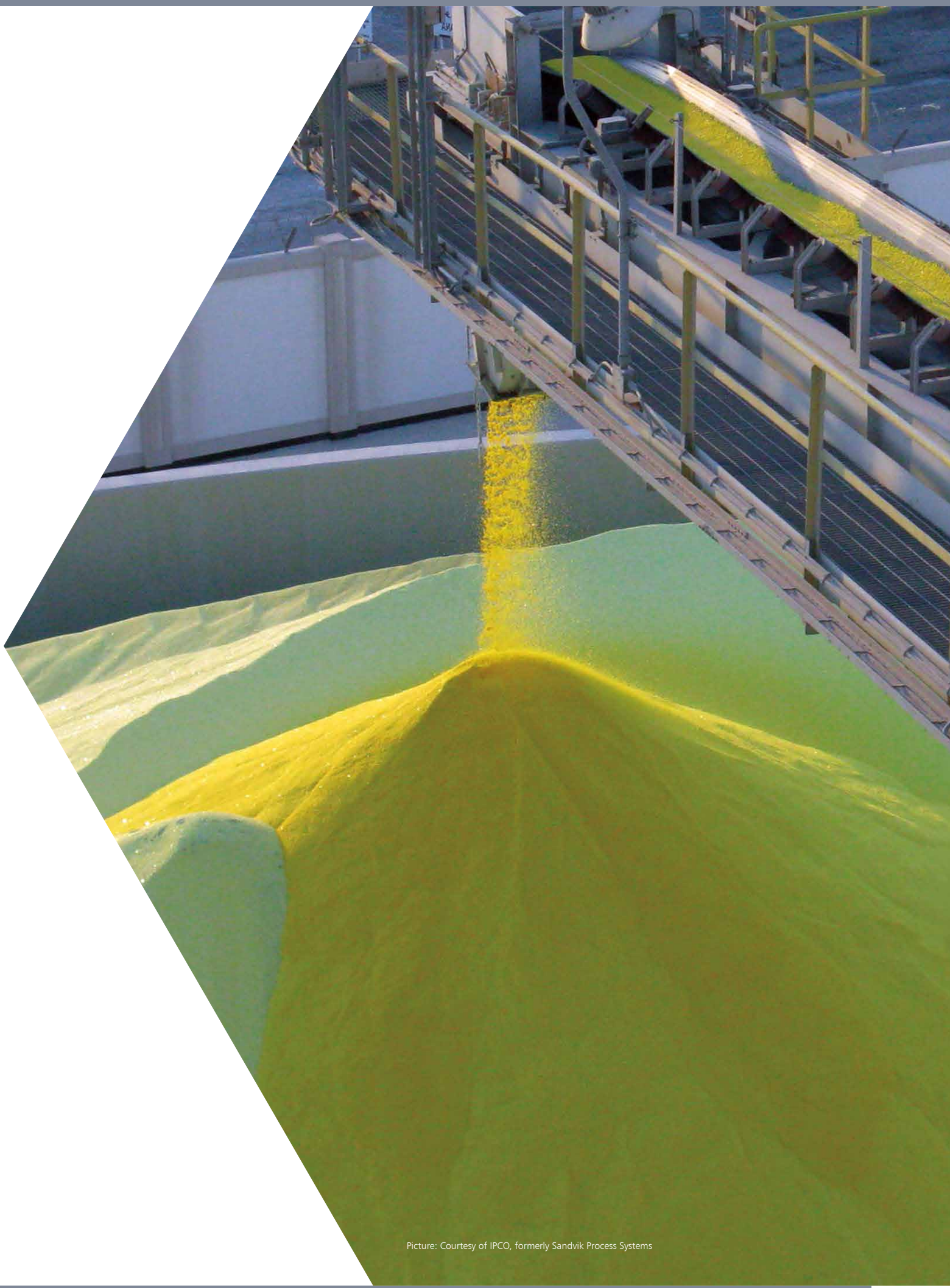
Rheinhütte Pumpen Materials

Rheinhütte is one of the few manufacturers worldwide that can supply pumps for the entire production process of sulphuric acid, from the transport of raw sulphur - often solids-laden - to the reprocessing of dilute acid. The company is able to draw on many years of experience with plastic, metal and ceramic materials that are corrosion and wear-resistant. Metals or plastics are particularly suitable for sulphuric acid applications, as shown by the following examples.
For sulphuric acid applications in which highly concentrated sulphuric acid is to be transported, Rheinhütte often manufactures pumps made of the metallic alloy 1.4136S, a ferritic material with 30 % chromium, 2.5 % molybdenum but without nickel in the alloy. In addition to 1.4136S, one of Rheinhütte's special materials called RHRS, a high alloy ferritic cast steel, is especially suitable for pumping pure hot sulphuric acid. For example, both materials are used in highly concentrated sulphuric acid of up to 180 °C (356 °F) and oleum, and are extremely resistant to corrosion and erosion.

If most common materials fail due to an average acid concentration and high temperatures, Rheinhütte uses SIGUSS. It is the only metallic alloy that remains chemically resistant to all concentrations of H_2SO_4 up to its boiling temperature. Rheinhütte is one of the few pump manufacturers worldwide that produces pumps for sulphuric acid applications out of SIGUSS which contain chromium. The plastic polytetrafluoroethylene (PTFE) has a corrosion resistance comparable to SIGUSS. PTFE reaches its limits when the acid to be pumped is loaded with solids.

Strengths of Rheinhütte Pumpen

- Pumps for all process steps of the sulphuric acid Production.
- Highly resistant special materials for all concentration ranges of sulphuric acid and oleum.
- Plastic pumps for chemical waste water and Scrubber.
- Special seals for liquid sulphur, H_2SO_4 and oleum. In addition to mechanical seals, Rheinhütte Pumpen has sound experience with hydrodynamic sealing (DWH) and heated magnetic drive pumps.
- Customer-specific special designs.
- Customer-specific safety monitoring.



Picture: Courtesy of IPCO, formerly Sandvik Process Systems

Product Range

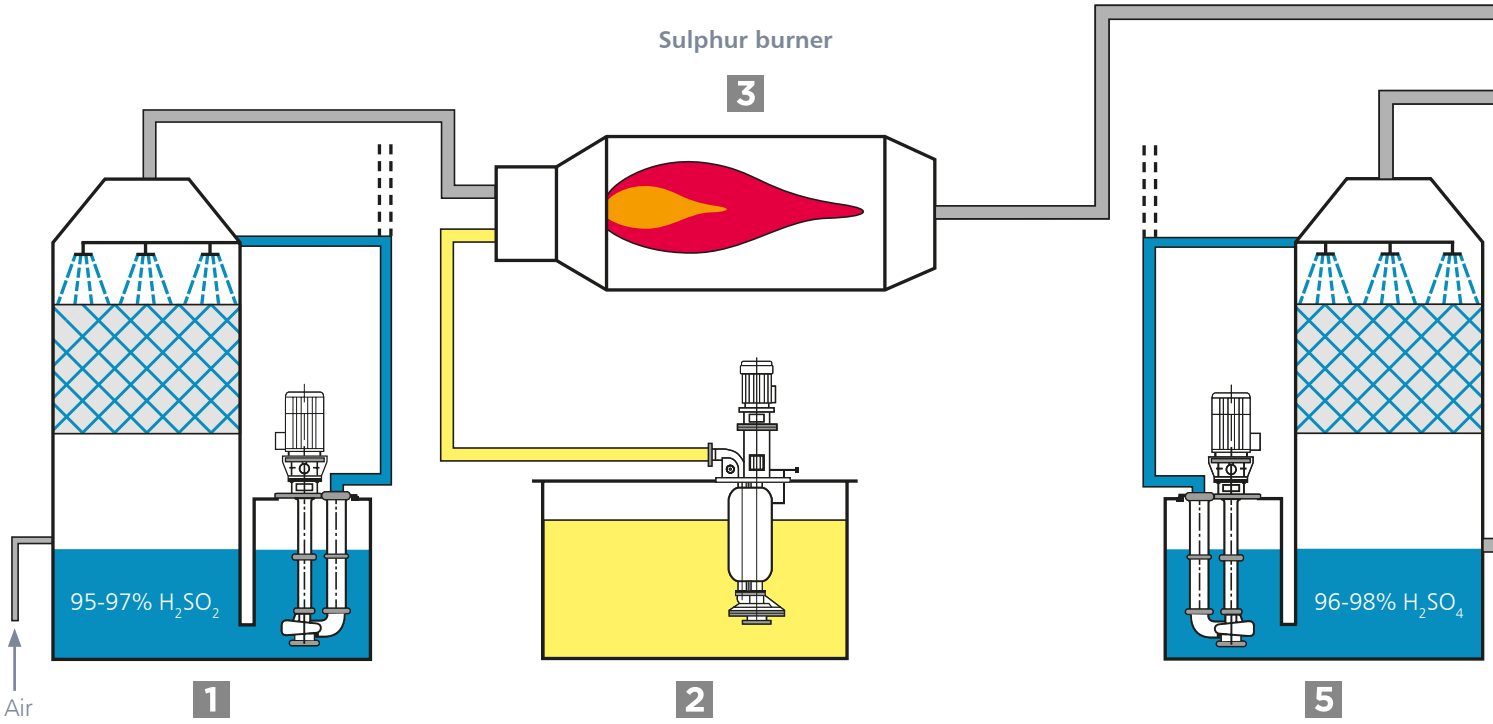
A wide variety of designs for sulphuric acid

The product family of Rheinhütte Pumpen offers specific solutions for all industrial processes of sulphuric acid and its production. Diversity and flexibility characterise Rheinhütte pumps, especially in the pump design. Taking into account the special requirements of the pumped media and the individual customer wishes, the appropriate Rheinhütte pump is designed, the right material is selected and the optimum sealing system is chosen. In this way we have been a successful partner in sulphuric acid processes for more than 60 years.

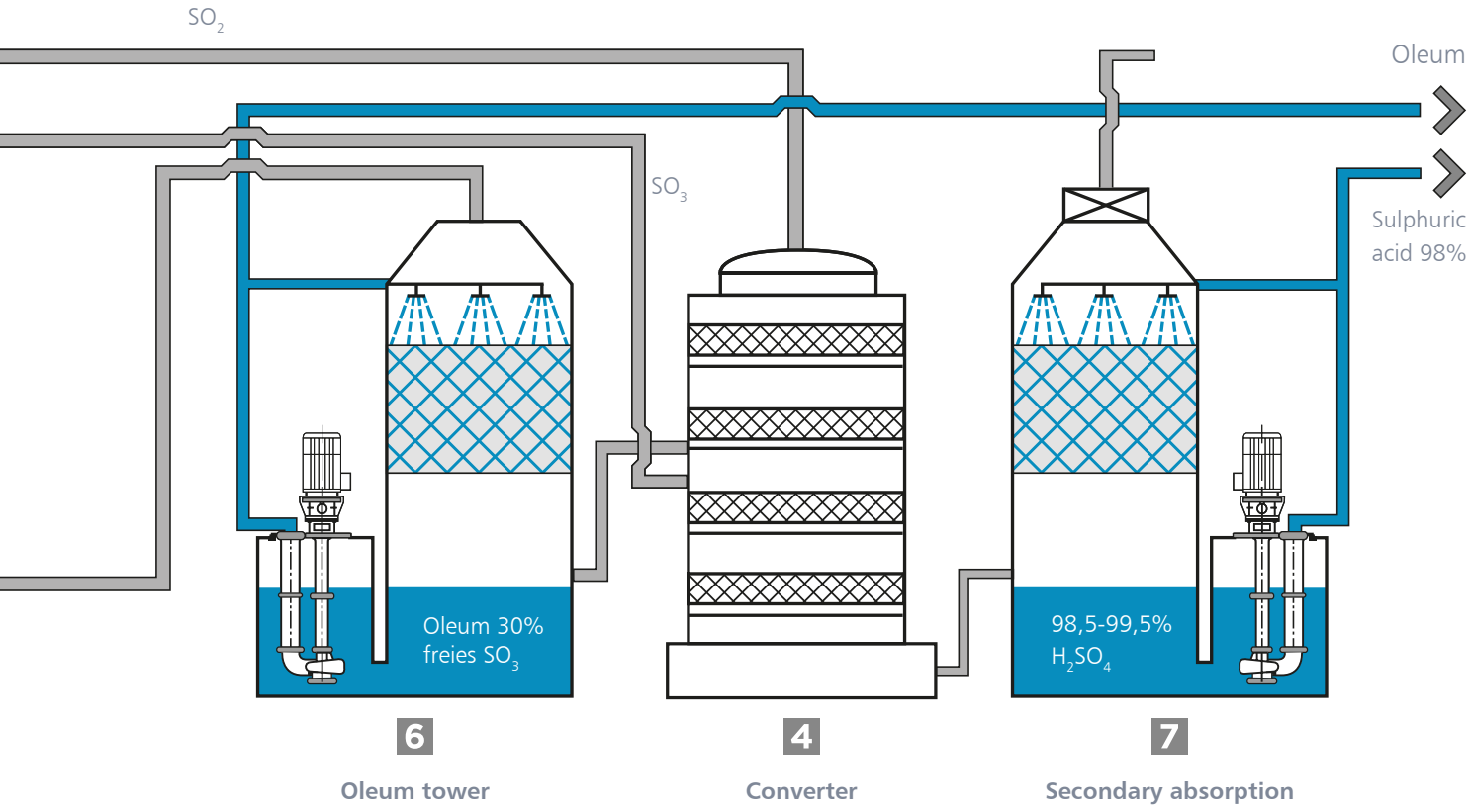
	RCE	RN	RNSi	RMKN	GVRN	RCEV
Assembly type	Horizontal	Horizontal	Horizontal	Horizontal	Vertical	Vertical
Q_{max}	1.200 m³/h 5,280 us. gpm	2.700 m³/h 11,890 us. gpm	1.500 m³/h 6,604 us. gpm	500 m³/h 2,200 us. gpm	4.000 m³/h 17,610 us. gpm	900 m³/h 3,960 us. gpm
H_{max}	180 m 590 ft	150 m 490 ft	100 m 328 ft	150 m 490 ft	85 m 279 ft	85 m 279 ft
Medium temperature max.	+450 °C +842 °F	+300 °C +572 °F	+300 °C +572 °F	+250 °C + 482 °F	+250 °C + 482 °F	+200 °C +392 °F
Submersible depth max.	–	–	–	–	3,4 m 11,2 ft	2 m 6,5 ft
Impeller design	closed, open	closed, open	closed	closed, open	closed	closed, open
Shaft seal type	mechanical seal, hydrodynamic shaft seals	mechanical seal, hydrodynamic shaft seals	mechanical seal, hydrodynamic shaft seals	magnetic coupling	mechanical seal, stuffing box packing	lip ring seal, stuffing box packing
Materials	wear-resistant alloys, cast steel, various stainless steels, nickel-based alloys	Cast steel, various stainless steels, nickel-based alloys	SIGUSS	Cast steel, various stainless steels, nickel-based alloys	high-alloy cast steel	wear-resistant alloys, cast steel, various stainless steels, nickelbased alloys

GVSO	**RSU**	**RVKu**	**RKuV**	**FNPM**	**RCNKu⁺**
Vertical	Horizontal	Vertical	Vertical	Horizontal	Horizontal
4.000 m³/h 17,610 us. gpm	3.400 m³/h 4.403 us. gpm	3.400 m³/h us. gpm	120 m³/h 528 us. gpm	350 m³/h 1,540 us. gpm	400 m³/h 1,760 us. gpm
180 m 591 ft	6 m 20 ft	70 m 230 ft	60 m 197 ft	100 m 328 ft	110 m 361 ft
+600 °C +1112 °F	+150 °C +302 °F	+90 °C +194 °F	+100 °C +212 °F	+190 °C +374 °F	+130 °C +266 °F
17,5 m 57 ft	–	+3 m 9,8 ft	+1,8 m 5,9 ft	–	–
closed	Propeller, helical impeller	closed	open	closed	closed, free flow impeller
mechanical seal, stuffing box packing, magnetic coupling (GVSOM)	mechanical seal, stuffing box packing	lip ring seal, Labyrinth seal	lip ring seal, Labyrinth seal	magnetic coupling	mechanical seal
Cast steel, various stainless steels	SIGUSS	Polyolefins and fluoropolymers	Polyolefins and fluoropolymers	Fluoropolymers	Polyolefins and fluoropolymers

Special Pumps for all H_2SO_4 Process Steps



Position	Fluid	Tempera-ture	Type of pump, ver-tical	Type of pump, hori-zontale	Materials
1	**Air dryer acid** (95 – 97 % H_2SO_4)	60 to 80 °C (140 zo 176 °F)	GVSO, GVRN	RN B, RMKN FNPM	▪ Austenit (1.4408), Super-Duplex (1.4517), 1.4136S, RHSX ▪ PTFE
2	**Liquid sulphur** (with or without solids)	130 to 150 °C (266 to 302 °F)	GVSO AH RCEV H	RCE, DWH, RMKN H	▪ Stahlguss (1.0619), Austenit (1.4408)
5	**Primary absorption Acid** (96 – 98 % H_2SO_4)	80 to 240 °C (176 to 464 °F)	GVSO, GVRN	RN, RMKN	▪ Austenit (1.4408), Super-Duplex (1.4517), 1.4136S, RHSX, RHRS
6	**Oleum**, 30 % free SO_3	60 to 80 °C (140 zo 176 °F)	GVSO, GVRN	RN, RMKN FNPM	▪ Austenit (1.4408), Super-Duplex (1.4517), 1.4136S ▪ PTFE
7	**Secondary absorption** (98,5 – 99,5 % H_2SO_4)	80 to 240 °C (176 to 464 °F)	GVSO, GVRN	RN, RMKN	▪ Austenit (1.4408), Super-Duplex (1.4517), 1.4136S, RHSX, RHRS
	Washing acid, 15–75%ige H_2SO_4 + SO_2 saturated / containing Cl^-- o. F^-	60 to 80 °C (140 zo 176 °F)	RVKu Y RKuV Y	RCNKu CS FNPM	▪ PVDF, PTFE
	TiO_2 production / Acid evaporation / **Pickling** with $FeSO_4$ crystals	30 to 200 °C (86 to 392 °F)		RNSi, RSU	▪ SIGUSS
	Acid evaporation	30 to 200 °C (86 to 392 °F)		RSU	▪ SIGUSS



The GVSO and RCEV series are used in heated versions, especially for conveying liquid sulphur.
Impurities and solids in the liquid sulphur are another challenge, but they are no problem for the GVSO. The RCEV is used for media with a high solids content. While plastic pumps are unsuitable for highly concentrated sulphuric acid and at high temperatures, they are often used in the lower concentrated range, for example for pumping washing acid, a mixture of 15% to 75% sulphuric acid and sulphur dioxide. The GVRN pump is used for all sulphuric acids of higher concentration, from gas dryer acid to pure highly concentrated sulphuric acid. The GVRN 450/500 vertical centrifugal pump is capable of pumping up to 3,000 cubic metres of sulphuric acid per hour. Rheinhütte's RMKN, a magnetic drive pump made of metal, is also suitable for pumping hot and aggressive sulphuric acid, although horizontal pumps are rather the exception during the sulphuric acid production process.

For low to medium concentrations, Rheinhütte plastic pumps made of PP, PE or PVDF up to PTFE/PFA are often suitable. As horizontal chemical standard pump with single-acting stationary or double-acting mechanical seal type RCNKu or as innovative magnetic drive pump type FNPM with up to 45 kW drive power, plastics are versatile. In combination with the vertical tank and sump pumps RVKu and RKuV, Rheinhütte offers a wide range of pump solutions in the plastics sector.

Many Years of Experience H_2SO_4 Processes

Chemical Industry

Pumping sulphuric acid in various concentrations and temperatures is a core competence of ITT Rheinhütte Pumpen GmbH. Pumps specially developed for this application, such as the vertical GVRN and the horizontal RNSi, guarantee safe pumping of the aggressive medium.
The GVRN pump type is an ideal operating equipment in all sulphuric acid applications in chemical process engineering, petrochemical and ore processing.

➤ *Further information can be found in the brochures „GVRN" and „RN, RNSi".*

Surface Treatment

Rheinhütte Pumpen offers pumps for all processes in the steel and stainless steel industry. Due to their good wear and corrosion resistance, mainly plastic pumps like the horizontal series RCNKu⁺ and FNPM as well as the vertical series RVKu are in use. For acids containing solids in combination with high temperatures, SIGUSS has proven to be a reliable alternative material.

➤ *Further information can be found in the brochure „Steel and Stainless Steel Industry".*

Titanium Dioxide Production

Due to the critical temperatures and the sometimes heavy solid matter load, high demands are placed on the pumps used. For this reason, the pump types RSU and RNSi made of the material SIGUSS are preferably used at the most important positions.
This material is a universal material for sulphuric acid applications due to its excellent resistance and good wear properties.

In gas purification and in the treatment of HCl and $FeCl_2$, plastic pumps of the type CPDR, RCNKu and RVKu made of PP, PE 1000 or PVDF have proven to be very successful.

Fertilizer Production

The vertical pump types RCEV and GVSO as well as the horizontal pumps RN, RCE and RMKN allow a flexible use in different fertilizer plants.
The vertically installed pump type RCEV allows dry-running safe operation due to its specially designed hydraulics and the omission of a slide bearing. The RCEV is used when there are abrasive solids in the medium or when pumping concentrated ammonium nitrate solutions and melts.
The vertical submersible pump GVSO safely pumps difficult media such as highly concentrated alkalis, ammonium nitrate solutions and melts. Especially when space is limited, the GSVO can be used due to its special vertical and partly multi-stage hydraulics and its small installation dimensions.
The type RN and type RCE series can handle difficult pumping media and conditions and can be configured to suit the specific application. In particular, the robust RCE type chemical pump can be adapted to suit specific requirements with a wide range of options.

➤ *Further information can be found in the brochure „Fertilizer Production".*

Metal Materials

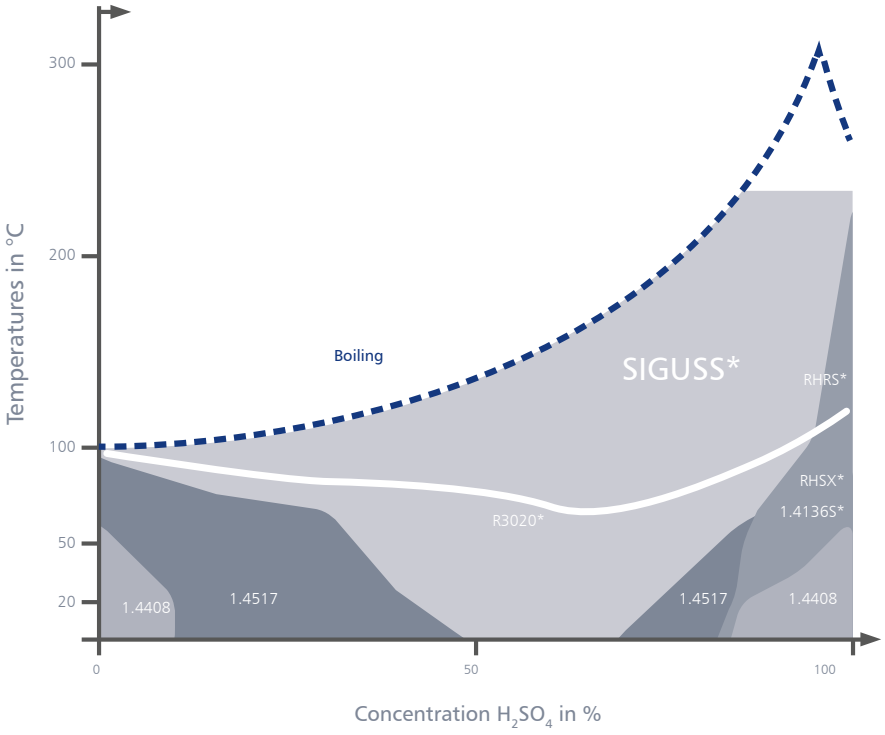
As an expert in corrosion and wear-resistant materials, Rheinhütte Pumpen offers you high-quality metallic materials developed in-house that meet the special requirements of sulphuric acid processes.

The effects of the intensive type of corrosion of sulphuric acid can very quickly lead to the complete destruction of the pump if a material is used that is not sufficiently resistant or if the operating point of the pump is far from the optimum.
Its service life is also greatly influenced by the operating method. In the case of heavily throttled gate or globe valves, higher acid flow velocities are generated, which results in a rapid increase in corrosion. This attack (erosion corrosion) can be counteracted by choosing a suitable material.

With regard to the practical application of corrosion and wear-resistant materials for sulphuric acid pumps, Rheinhütte Pumpen has many years of experience.
Good contacts with plant manufacturers and the results of our own research allow Rheinhütte Pumpen to match the available range of materials to the constantly changing requirements in the best possible way.
For further applications in the field of conveying media similar to sulphuric acid, Rheinhütte Pumpen has additional, process-specific materials and extensive process expertise.

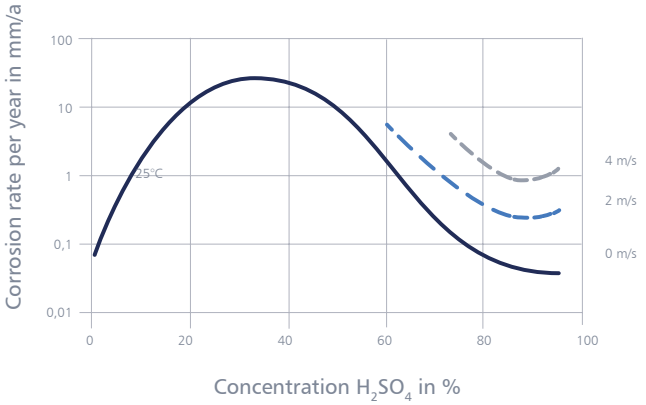
Stainless steel alloys are particularly suitable for highly concentrated sulphuric acid, because they form a passive oxide layer as an anti-corrosive coating. In pump manufacturing, SIGUSS is the only metallic material that is suitable across all concentrations and temperatures.

ISO Corrosion Diagram for Metallic Material in H_2SO_4



* Rheinhütte Pumpen materials

Influence of the Flow Velocity of H_2SO_4 on the Corrosion Rate for the Material 19/11 Chrome-Nickel Steel



The corrosion rate of metallic materials in sulphuric acid depends on the concentration, temperature and flow velocity. Additives such as salts, gases or solids greatly influence the attack strength of the acid.
The adjacent figure shows the extent to which the concentration and flow rate of sulphuric acid change the erosion rate of an austenitic chrome-nickel steel.

Material	Designation DIN [ASTM]	Properties and use
1.4517	G-X 5 CrNilMoCu 25 6 3 3 ~ [A 743 CD 4 MCuN]	Super duplex steel proves its worth in sulphuric acid, especially with low or very high concentrations.
1.4136S	G-X 50 CrMo 29 2	Corrosion and erosion-resistant, high alloy, ferritic cast steel. Typical applications are highly concentrated sulphuric acid up to 225 °C (437 °F), oleum and fertiliser production.
1.4408	G-X 6 CrNiMo 18 10 316 (316 Nb) [A 743 CF-8 M]	Austenitic chromium nickel molybdenum steels with good general corrosion resistance.
RHRS	30% Cr-Ferrit	Special ferritic, chromium-rich material with high erosion and corrosion resistance, specifically for use in highly concentrated sulphuric acid up to 225 °C (437 °F).
RHSX	G-X 6 NiCr Si Cu 20-18-5	Austenitic stainless steel with a particularly large percentage of silicon. This special, high-alloy material with high erosion corrosion resistance is suitable for pumps in the dryer, intermediate absorber and end absorber area of sulphuric acid production up to temperatures of 150 °C (302 °F).
R3020	G-X 3 NiCrMoCu 30 25 4 Alloy 20 < R3020 < Alloy 28	Full austenitic special stainless steel with a high content of molybdenum and copper. High resistance to pitting, stress corrosion cracking and intergranular corrosion. Suitable for all concentrations of sulphuric acid at low and medium temperatures, sulphuric acid pickling.
SIGUSS	G-X 90 SiCr 15 5 ASTM A518	Highly corrosion-resistant, chrome-alloyed iron silicon alloy with good resistance to wear and high chemical resistance. The material is chemically resistant in H_2SO_4 of all concentrations up to boiling point.

Plastic Materials

Mainly polyolefins and fluoropolymers are used in pump technology. Their good resistance to acids and alkalis at low to medium temperatures is an advantage. To absorb external forces, these pump types are surrounded by a metal armour.

Plastic pumps are often used in the low concentration area, for example for pumping washing acid, a mixture of 15 to 75 percent sulphuric acid and sulfur dioxide. In this area, the plastic material is superior to most metallic materials, except for SIGUSS.
The plastic polytetrafluoroethylene (PTFE) has a corrosion resistance comparable to SIGUSS. However, depending on the construction size, the stability is only given up to max. 180 °C (356 °F). PTFE reaches its limits when the acid to be pumped is loaded with solids. The plastic is significantly softer compared to metal, accordingly PTFE pumps would wear faster when pumping contaminated media.

Polyolefins

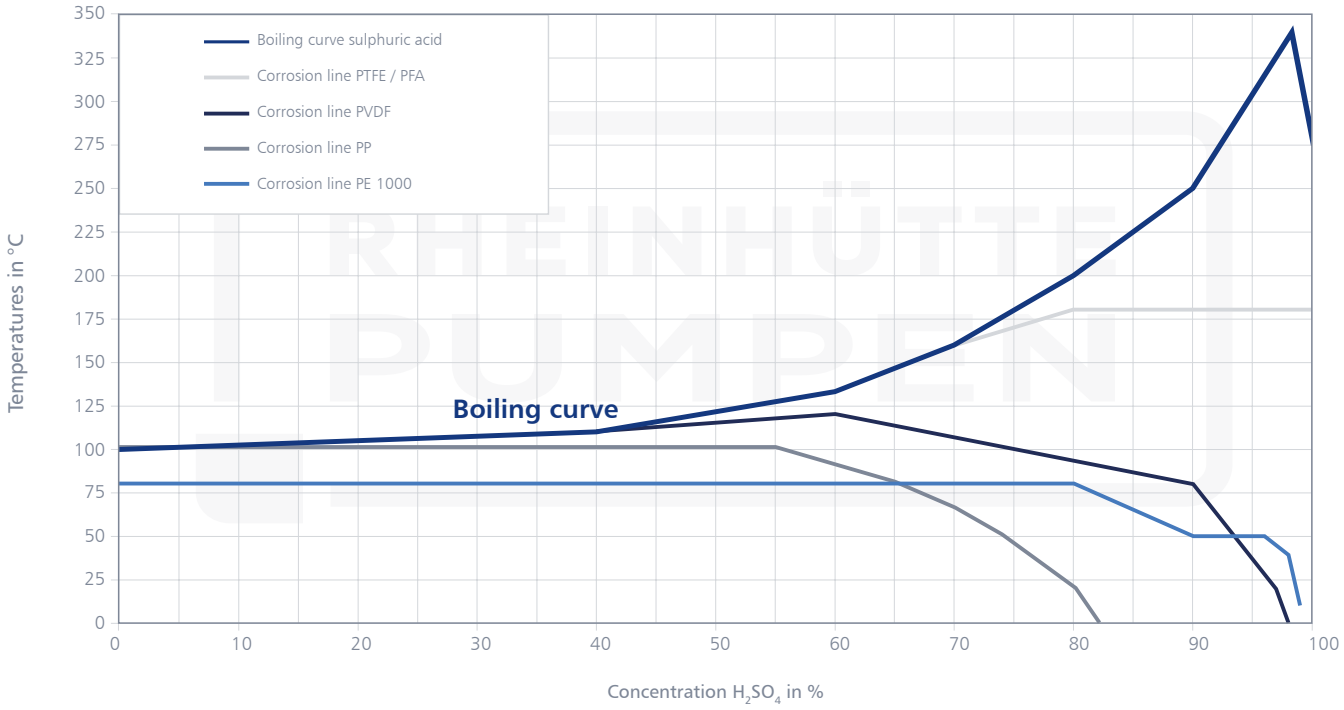
Material	Properties and use
PP Polypropylene	PP is an alternative to metallic materials in many applications. The material is suitable for conveying sulphuric acid with a concentration of up to 70 %. PP can be used for operating temperatures up to 50 °C (122° F).
PE 1000 Polyethylene UHMW-PE	Ultra-high molecular weight low-pressure polyethylene is used exclusively. Its temperature range is between -50 °C (-58 °F) and 80 °C (176 °F) . Its general corrosion resistance in some cases exceeds that of PP. Due to its excellent wear resistance, centrifugal pumps made of PE are very often used in media that are both corrosive and wearing at the same time, such as in flue gas cleaning.

Fluoropolymers

Material	Properties and use
PVDF Polyvinylidene fluoride	PVDF stands out for its excellent general corrosion resistance, high resistance to stress cracking and good UV resistance. Its temperature range lies between -20 °C (-4 °F) to 130 °C (266 °F).
PFA Perfluoralkoxi	PFA is a perfluorinated alkyl vinyl ether. Centrifugal pumps lined with PFA can be used up to 180 °C (356 °F). With a few exceptions, the material has a universal chemical resistance.
PTFE Polytetra-fluorethylene	PTFE has high resistance to most organic and inorganic media over a wide temperature range. Centrifugal pumps made of PTFE can be used from -50 °C (-58 °F) to 180 °C (356 °F).

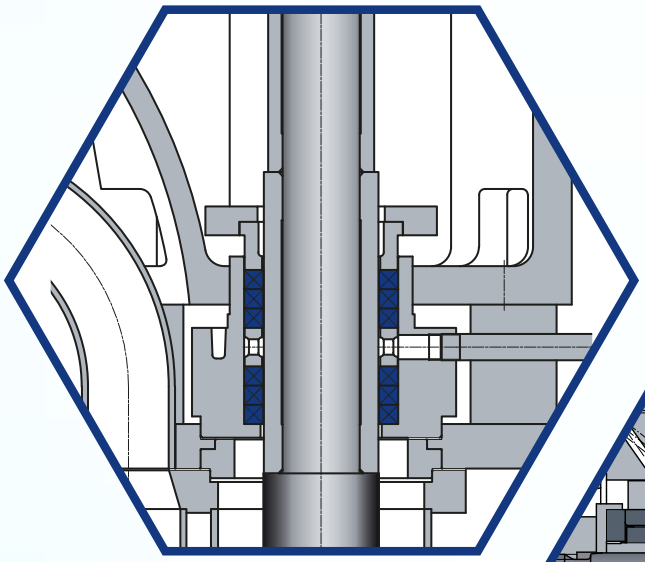
ISO Corrosion Diagram for Plastics in H_2SO_4

Theoretical information without guarantee

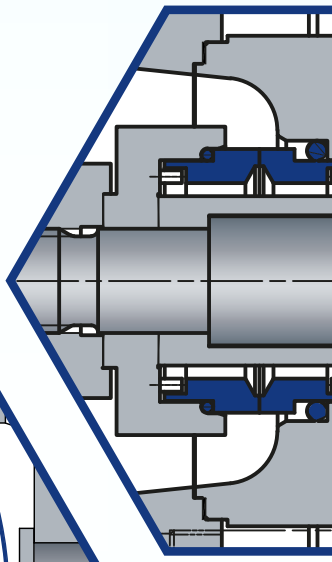


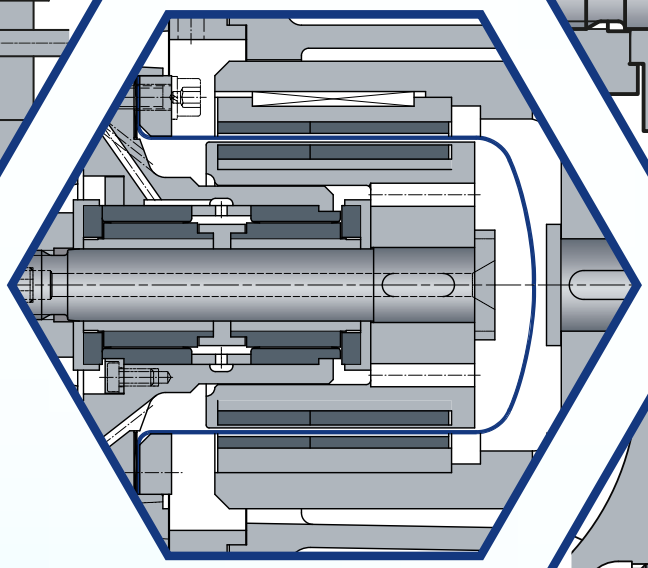
Suitable Sealing Systems

Perfection through combination

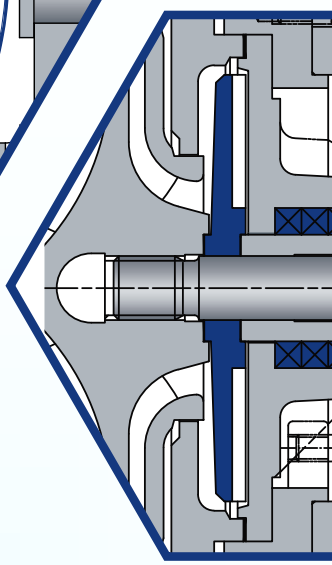


Mechanical Seal ➦
Single-acting, double-acting
and stationary versions

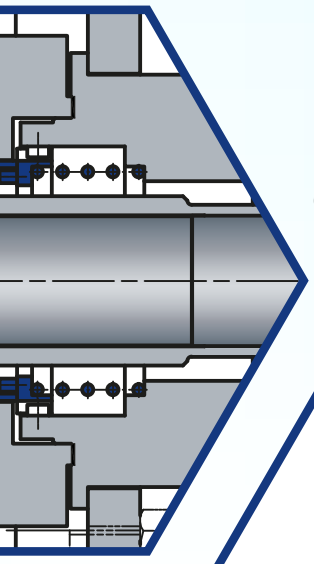




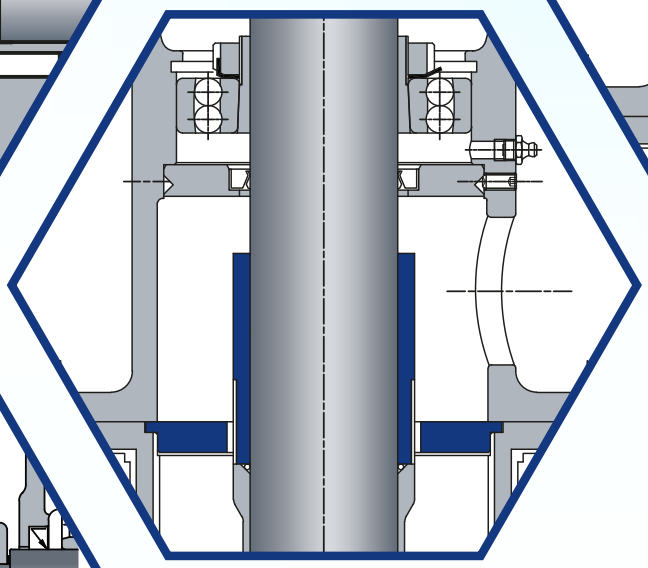
Stuffing Box Packing ➧
In standard, heatable,
refrigerable or gas-tight

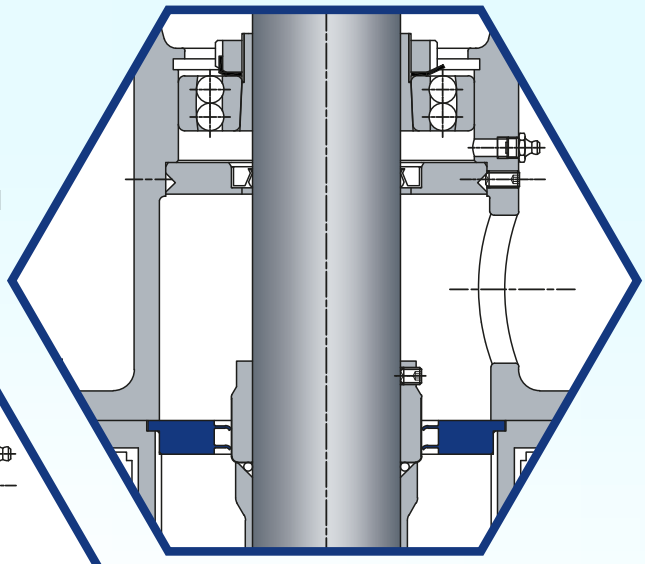


Magnetic Coupling ➧
Sealed by a spacer can
in a range of materials

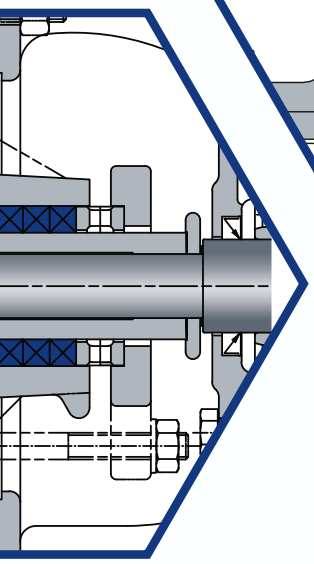


Labyrinth Seal ↓
Contact-free seal for nonpressurised container systems





Lip Ring Seal ↕
Sealed by dry-running or shaft seal rings



↩ Hydrodynamic Shaft Seals
Using an impeller with back blades or one or more auxiliary impellers and a variety of stationary systems

Wide Range of Sealing Systems for Pumps in Sulphuric Acid Applications

If the plant is to work safely and economically the pump design and sealing system must be perfectly matched with each other. A wide variety of seal variants is available when designing pumps.

We will be pleased to advise you on the selection of the optimum seal for your specific conveying conditions.

RHEINHÜTTE PUMPEN

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