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# OVERALL PROTECTION IN A PHOSPHORIC ACID PLANT (a)

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Fertilizer plants are designed to operate continually at high yield. Unfortunately corrosion is limiting the success in the plant performance and is using up a large portion of your maintenance budget.

From the sulfur burning to the storage of the produced phosphoric acid, in each of the manufacturing steps the most economical and reliable material and the proper application is required to limit the corrosion attack and guarantee the maximum operating rate without interruption.

Servicing the fertilizer market for decades with continuous improvement of products and technologies in partnership with the worldwide leading engineering companies and owners of phosphoric acid plants has established SGL ACOTEC to be the competent partner for all question and problem solutions to optimize the corrosion protection from one source.

The product- and service portfolio covers all your major demands. Our "System-Approach" optimizes the material selection, the equipment supply and all interfaces within the complete process of phosphoric acid dealing with corrosive media. This applies for new plants, plant extensions as well as the all around service for service, maintenance and up-grades.

What are the major materials and products required to manage the corrosion problems in the phosphoric acid plant:

- Fire resistant brick lining in the sulfur burning furnace
- Acid proof brick lining of the sulfur absorption tower
- Rubber lining and/or polymer coating and lining of the $H_2SO_4$ storage tank
- $H_2SO_4$ dilution system
- Rubber lining and carbon brick lining in the attack tank
- Rubber lining, carbon brick lining, graphite evaporators and FRP interconnecting piping in the concentration stage
- Rubber lining of the phosphoric acid storage tanks and transport trucks, railroad cars and container ships
- Graphite or metal lined pumps are required in all production steps

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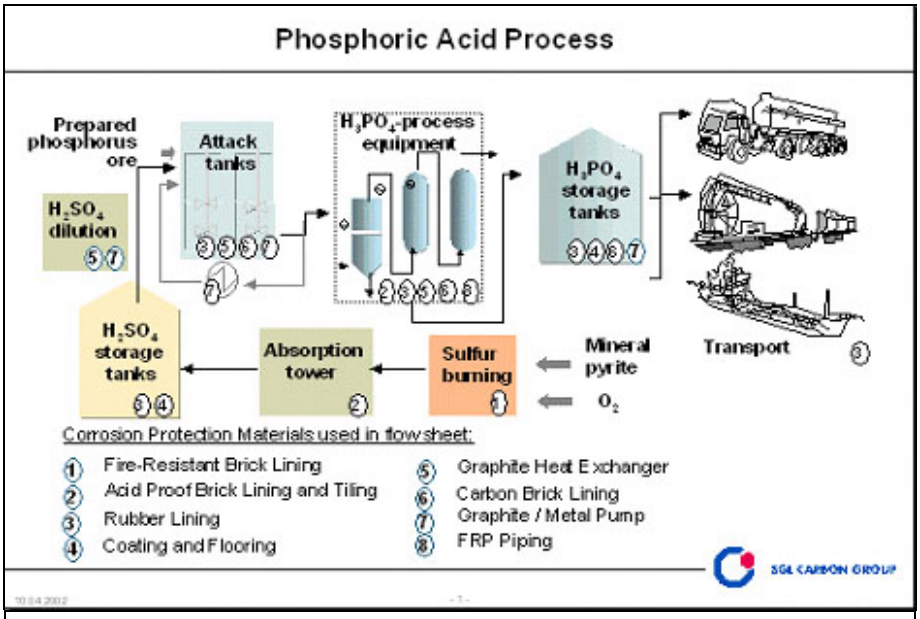
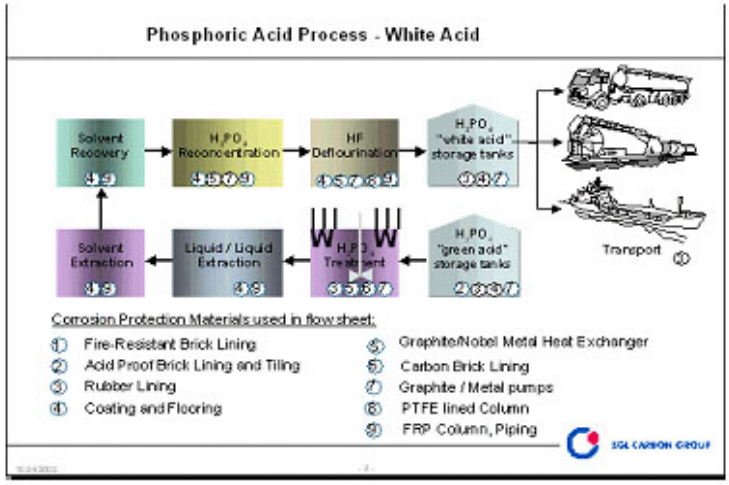
For the “White Acid” production you require:

- Rubber and carbon brick lined tanks with special metal heaters for an additional treatment to upgrade $H_3PO_4$
- Graphite and/or noble metal heat exchangers and FRP columns are used in the $H_3PO_4$ re-concentration
- The HF de-fluorination process requires graphite heat exchanger, PTFE-lined column, FRP duo-laminate column and vessels
- Piping, armatures in rubber lined, FRP duo-laminate and pumps in graphite or noble metal combine all production steps
- The concrete floors of all plant sections have to be protected with synthetic resin coating and tiles.



## REFRACTORY MATERIALS

In the first production process sulfur is burned to sulfur dioxide in the furnaces. At temperatures of up to 1500°C it is necessary to apply special refractory materials to protect the furnace shell of carbon steel. The fire proof bricks are formed to the exact shape and joint together with fire-resistant cements, fireproof mortars and fibers. Manufacturers and operators of sulfuric acid plants worldwide require a reliable and competent partner in everything to do with the planning and implementation of complex and efficient schemes for optimum protection.

## ACID PROOF BRICK LINING

The drying and absorption towers of sulfuric acid plants require an efficient protection against corrosion. The first measures involves applying a sealing layer to the steel jacket. SGL uses special developed rubber sheeting like the quality BS or thermoplastic polymers (®Repanol) for this purpose, depending on individual requirements. The sealing layer has to be protected from the effect of heat, direct contact with acid and also mechanical stresses. The towers are completely lined with acid-proof ceramic bricks, often several layers thick, and the accompanying laying and jointing materials are based on silicate cement such as ®Keranol. The aim here is to develop individual solutions where the key factor are life-time and cost-efficiency.

## HIGH PERFORMANCE SELF-SUPPORTING DOMES

SGL has been very successfully using self-supporting domes in the packed towers of sulfuric acid plants. The use of supporting grid with its acid-proof ceramic dome bricks makes it possible to dispense with any form of supporting pillar structure. This construction material offers two advantages:

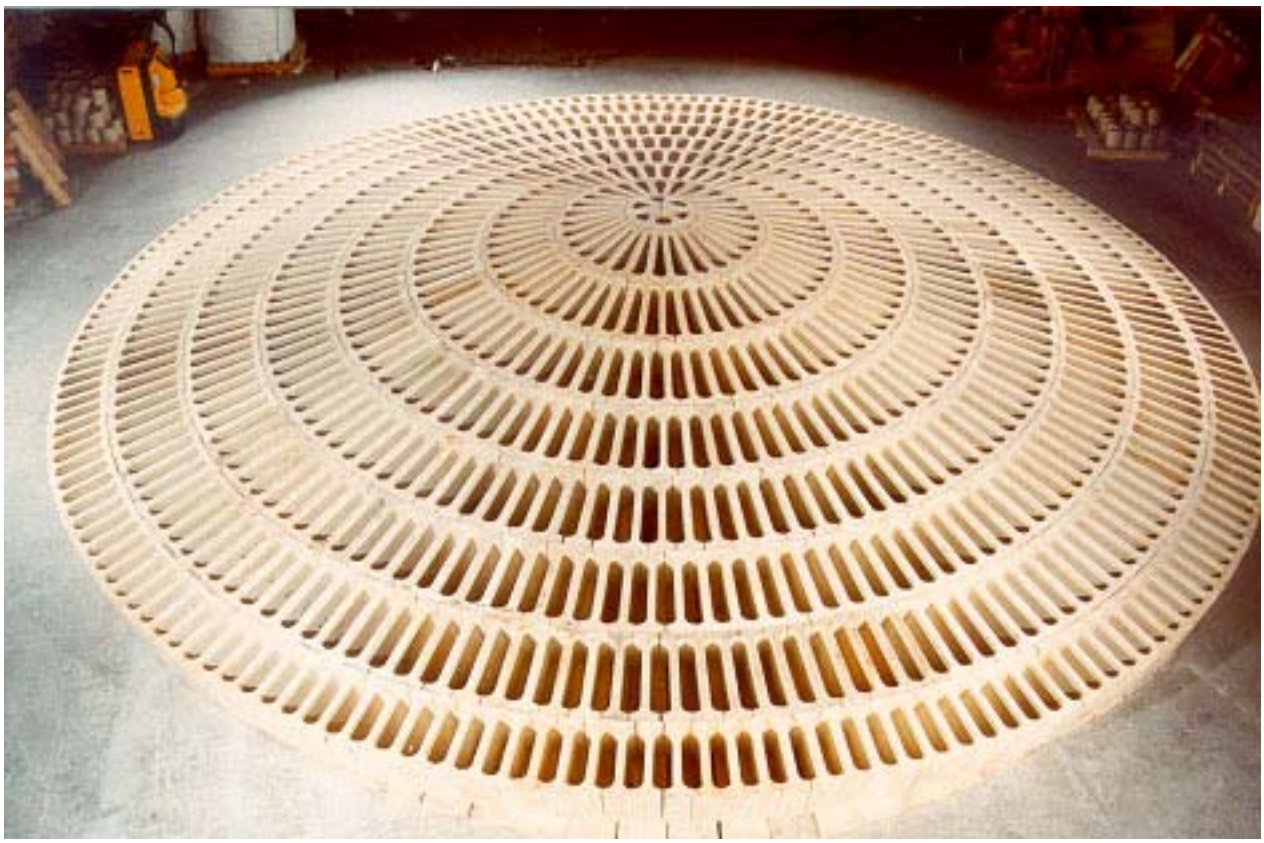
- it allows a substantial cost-saving on supporting elements

- the efficiency of the plant is markedly improved because the gas flow is no longer impaired by the supporting pillars.

The ability of the gas stream to permeate the tower packing is aided by the special construction of the bricks. The free passage through the SGL self-supporting domes is at least 55 percent, from diameters larger 7 meters even 60 percent.

SGL supply a comprehensive performance package for all diameters from 0,5 to 10 m:

- early comprehensive consultation
- detail planning and design
- structural analyses including all construction drawings
- supporting framework for the construction of the dome
- if requested, turn-key installation of the dome by qualified SGL fitters or installation supervision

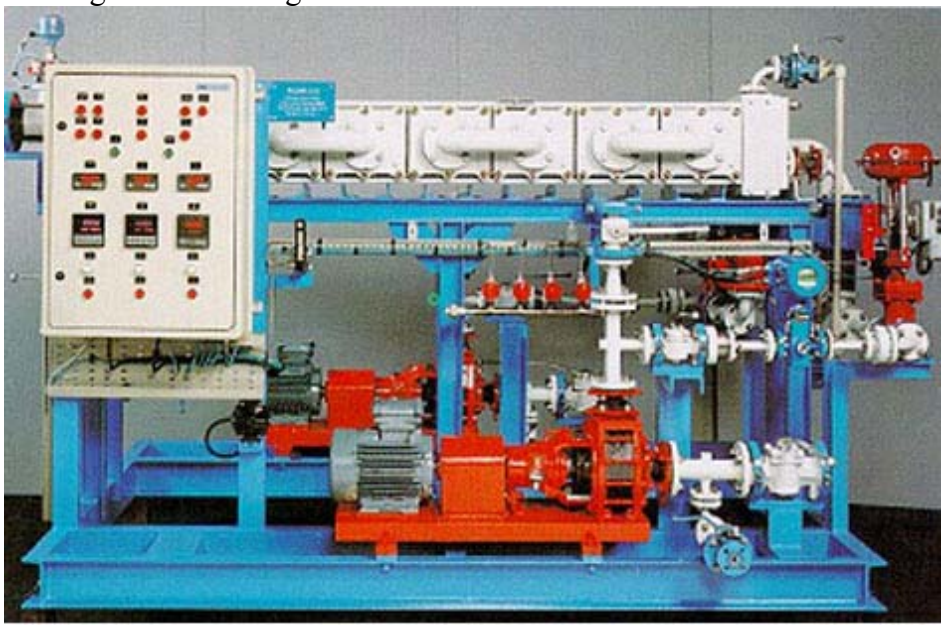


Self-supporting dome

## SULFURIC ACID DILUTION UNITS

For some processes in the fertilizer plant the highly concentrated sulfuric acid has to be diluted to the required concentration. SGL offers skid mounted units

- with plate, block or shell and tube heat exchangers and pumps in ®DIABON, proven resistance to corrosion and high temperature
- manual, semi-automatic or fully automatic controlled and monitored units
- all flow rates and concentration possible
- single or multi-stages units



## PLASTIC COMPONENTS

In sulfuric and phosphoric acid plants the key components (evaporator, filter, cooling towers, storage tanks, gas ducts and piping systems) are subjected to many different corrosion-related parameters. The chemical, mechanical and thermal stresses differ from case to case and need special adapted concepts for each situation in order to protect the plants.
SGL uses high-quality ®KERAVERIN or KERA components very successfully to give effective and long-lasting protection against corrosion. KERAVERIN is a fiber glass-reinforced plastic (FRP) with a thermoplastic lining. Equipment fabricated in KERA, which is a thermoset material, is based on phenolic or furan resins reinforced by glass or carbon fibers.
The advantages are self-evident.

- The plastic components have excellent chemical, thermal and mechanical resistance.
- The low weight makes for ease of handling while also ensuring simple, reliable processing.
- Potential weak points – such as flanged joints on lined metal pipelines – can be eliminated or greatly reduced by using welding and laminating processes to join the plastic component systems.
- The high resistance to vacuums, based on the high-strength bond between the liner and FRP laminate substrate.

⇒ The result is a reduction in maintenance expenditure and high plant reliability. This ensures optimum cost-efficiency.

KERAVERIN can be supplied with following materials as internal liner:

- PVC, FEP, PVC/C, E-CTFE, PP, PFA, PVDF

Where advisable because of the prevailing conditions, SGL can supply a modified PTFE as an innovative lining material in a FRP composite. The result of continuous further development work, this product provides greatly improved protection against chemical and thermal stresses.

KERAVERIN reaction vessel

KERAVERIN piping

LICUFLON columns and vessels are used successful for absorption, extraction , rectification and distillation of products containing hydrofluoric acid or highly concentrated, hot phosphoric acid. The load bearing steel parts are lined with a 4 mm skived PTFE sheet in loose lining technique.
The butt welding of the PTFE sheet without any thermoplastic welding material allows the production of any diameter up to 3,5 m. Column internals in DIABON, like trays, liquid distribution, feed pipes, support grids, etc. are designed to meet the process guarantee. LICUFLON column are in operation up to 250 °C.

LICUFLON columns

**FLOOR COATING SYSTEMS**

Effective anti-corrosion and surface protection measures in sulfuric and phosphoric acid plants are by no means confined to original plant segments. Durable floor coating in the whole area of the plant is absolutely essential for safety and also environmental protection. A suitable coating can prevent undesired penetration by chemical substances into the concrete floor slab, as well as any resulting corrosive attack on the concrete or pollution of the groundwater.
In our own facilities in several continents, SGL uses the latest technology to produce a range of synthetic resin coatings ideally suited to treating the floors of acid plants. The synthetic resins possess equally high chemical and thermal resistance properties. They can be applied in the form of spreading, casting, brushing or spraying compounds. The synthetic resins can be used to coat not only the floor area but also any walls likely to be exposed to corrosive stresses. In addition, the coatings – those applied with ®CEILCOTE, ®KERAPLAN or ®KERACID, for example – can function as a sealing layer in any specially installed secondary containment systems or run-off trenches constructed from acid-proof ceramic or carbon tiling that is bonded and jointed with synthetic resin cements.

**PROPERTIES OF SYNTHETIC RESIN MATERIALS (COATINGS)**

- Chemical resistance and impermeability
- Resistance to atmospheric corrosion and ageing stability
- Mechanical and/or thermal tolerance under load
- Crack-bridging capabilities
- Physiologically non-hazardous
- Electrically discharging
- Antiskid properties and facility of decontamination
- Visually pleasing appearance

Secondary Containment with Epoxy Resin Floor

Polymer Lining in Concrete Settling Tanks

**SURFACE PROTECTION WITH RUBBER LININGS**

When phosphoric acid is produced both steel and concrete surfaces need to be properly shielded from the influence of the aggressive media.

SGL has been using a number of special rubber lining systems to cope with problematic process situations. These linings are notable for their high effectiveness and reliability, as well as long-lasting resistance to the various influences. These features make them highly cost-efficient.

As a result, the lined segments are completely stable to vacuums and elevated temperatures up to a constant 125˚C for the rubber material as well as for the bonding system.

The crucial factor is the use of a bonding system tailored to the individual lining material. This is the only way that an optimum bond can be created between the rubber lining and the surface of the respective segment of the plant, or between two extruded rubber sheets.

Different rubber linings, both hard and soft, are required. SGL's ®VULCOFERRAN or ®KERABUTYL products can be used wherever the steel and/or concrete surfaces of vessels and pipelines need to be protected effectively against corrosion. An additional soft rubber layer can be applied to the first rubber sheeting as protection against abrasive wear.

All the SGL rubber sheet manufacturing sites extrude the rubber sheet in the roller head machine to the standard thickness from 3 to 6 mm. The most successful quality grades in the phosphoric acid industry are the soft rubber in bromobutyl VULCOFERRAN 2206 and KERABUTYL BS and the hard rubber VULCOFERRAN 2194 since 1982. In this period more than 200.000 square meter are successfully applied in this industry. These qualities are suitable to be applied on site or in work shop. The lining is vacuum resistant and the rubber is chemically bonded to steel.

Roller head extruder for rubber sheets

Lining of a storage tank with rubber sheets and carbon bricks

## CARBON BRICK LININGS

In the reactors and other vessels used in phosphoric acid plants, the application of a rubber lining is not the only measure needed for lasting and effective protection against corrosion. Other measures Carbon brick linings may be installed to prevent abrasion of rubber linings, along with the appropriate laying and jointing materials based on synthetic resins – especially furan resins. Carbon bricks give the necessary protection against abrasive wear, and at the same time resist the hydrofluoric acid occurring in the production process.

SGL has an ideal basis for ensuring the highest quality standards: to be the largest carbon and graphite manufacturer world-wide.

Rubber lined tank with brick protection

## DIABON HEAT EXCHANGER

Heat exchangers in phosphoric acid plants perform important functions as heaters, coolers, condensers, evaporators or absorbers in various production phases, depending on the circumstances. This DIABON heat exchangers are available in shell and tube, block or plate design. Special design features are combined with materials with high resistance to virtually all organic and inorganic substances. Together they ensure optimum operational reliability, high heat transfer levels and great cost-efficiency.

SGL heat exchangers have synthetic resin-impregnated graphite tubes in standard quality (®DIABON-.NS1) or alternatively wrapped with highly pre-tensioned fibers on the outside surface (DIABON-HF1). This is a design feature that not only brings a marked improvement in operational reliability but also noticeably expands the range of use of shell-and-tube heat exchangers in critical applications. The reinforcement does not impair resistance to corrosion because the chemical resistance of the reinforcement is identical to that of synthetic resin-impregnated graphite. Owing to the extreme elasticity of the carbon fibers the tension on the reinforcement is retained even under sharply fluctuating load or stress surges without material fatigue. As this reinforcement with carbon fibers markedly improves the mechanical properties of graphite components and the reliability, most evaporators in the phosphoric acid plants are now supplied by SGL with carbon fiber-reinforced tubes and tube sheets.

Fracture behavior of glass-, standard graphite tube and fiber reinforced graphite tube

DIABON P2O5 evaporator

DIABON plate heat exchanger

## PUMPS

Pumps are imperative to circulate and transport the aggressive media sulfuric and phosphoric acids. Corrosion resistance and reliability are the main features required. DIABON pumps meet these demands in addition to temperature and dimensional stability. They enable pumping liquids with volumetric flow rates from 5 to 2000 $m^3/h$ and discharge heads up to 100m. SGL pumps are fitted with single or double mechanical seals. The first mag-driven pumps are tested and in service.

Alternative to DIABON pumps SGL can also offer exotic metal lined pumps in Titanium, Hastelloy, Zirconium or Nickel.

The advantages are:

- most competitive manufacturing process
- materials microstructure are more homogeneous and have higher strength with better corrosion resistance
- full vacuum design
- short delivery time

DIABON pump

## SUMMARY

SGL know-how, experience and competence in corrosion resistant materials, process equipment and services is your benefit in the phosphoric acid plant. We offer a complete system from a single source – from optimized material selection through interface management, production, delivery and installation right up to the warranty. You can save yourself time and trouble in the future by taking advantage of a partner, who offers comprehensive, system-based range of products and services.