SGL Group – The Carbon Company – is one of the world’s leading manufacturers of carbon-based products. We have a comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites.

Our core competencies include a wide knowledge of raw materials, specialized production expertise and in-depth application and engineering know-how. As a result, we have built up a comprehensive technology and product portfolio. We operate on a global scale and are close to our customers anywhere at any time. Supported by this broad base, we offer our customers the best solutions. That is what SGL Excellence stands for.
Our Business Line Process Technology is focused on supporting the technical processes of our globally operating customers in the chemical industry, metal manufacturing and environmental protection technology. A maximum degree of know-how and expertise in corrosion protection, a global presence and full-package systems from a single source: that’s what our customers need – and get from us:

- Long-standing experience and a high level of expertise in process technology
- Comprehensive process, material and design know-how on graphite and PTFE
- Closeness to customers: cost-effective manufacturing to international and local standards at our production sites in Europe, America and Asia and worldwide customer service
- A consistently high standard of quality

Our comprehensive range of products and services extends from process equipment and components made from DIABON® graphite and POLYFLURON® virginal, paste-extruded PTFE, through LICUFLEX® skived PTFE sheet-lined equipment, FLUROFLEX® bellows, FLUROPIPE® pipe systems, FLUROSIC® silicon carbide heat exchangers and DIABON® graphite or exotic metal pumps, to the planning and assembly of complex systems.
Synthesis of hydrogen chloride by burning hydrogen and chlorine has proven to be an economical and reliable operation. This is particularly true in those processes where chlorine is produced as a by-product or where hydrogen chloride or hydrochloric acid is required for on-site use. Typical uses occur in chlor-alkali electrolysis, vinyl chloride manufacturing, pulp and paper production and various metallurgical processes.

Production of 80 t/d of HCl gas and 40 t/d of 37% hydrochloric acid in three pre-assembled units mounted on skids.
DIABON synthesis plants supplied by SGL Group demonstrate their capability in operation through their unquestioned advantages:

- Production of hydrochloric acid in a concentration range of 1 to 38% HCl from chlorine and hydrogen, using water or weak hydrochloric acid as the absorbing liquid.
- Hydrochloric acid or gas produced fulfils any specification ranging from technical or chemically pure quality to food grade quality to electronic grade quality.
- As an HCl recovery measure, HCl gas from other plants can be fed into the synthesis unit and absorbed together with the synthesized gas.
- Chlorine-containing residual gas or “sniff gas” from other processes can be recycled to produce HCl.
- Weak hydrochloric acid can be fed into the absorber and brought up to the required acid concentration.
- Oxygen-containing chlorine can be combusted in our synthesis plants without affecting the service life of the burner or the combustion chamber.
- Synthesis plants in DIABON graphite are also used for the production of dry HCl gas. Anhydrous HCl gas of 99.9 % purity can be manufactured in our desorption units made of DIABON graphite and LICUFLON® steel/PTFE.
- The combustion heat of hydrogen and chlorine in HCl synthesis can be partially recovered in the form of steam or hot water.

Production plants in DIABON graphite fully meet these criteria, proven by our more than 450 supplied plants all over the world.
Synthesis Process
– a Straight-Through Process

The starting substances for the synthesis are hydrogen and chlorine. Hydrogen and chlorine are fed into a burner at controlled rates. The burner consists of two concentric tubes with chlorine flowing through the inner tube and hydrogen through the outer annulus. Above the burner, the gases are ignited to produce hydrogen chloride gas. A hydrogen flow of at least 5% stoichiometric excess is recommended to ensure that a complete synthesis takes place.

The hydrogen chloride gas, at a temperature of 2000 to 2500°C, flows from the combustion chamber into an integrated isothermal falling-film absorber. The HCl gas is then absorbed by water or weak acid. The absorber is either co-current or counter-current depending on the type of synthesis unit.

The hydrochloric acid is normally produced with less than 1 ppm free chlorine. By adjusting the absorption water (weak acid) supply rate, the desired HCl concentration can be obtained. The product acid flows by gravity into a tank at atmospheric pressure.

The considerable heat generated in the synthesis process must be removed, normally by cooling water. The combustion heat is 0.7 kWh per kg of HCl (100%) and the heat of absorption in water is 0.5 kWh per kg of HCl (100%).

Nearly one half of the generated heat can be recovered as steam or hot water.

The unabsorbed gas is fed into a counter-current scrubbing section where absorption water absorbs the remaining HCl. Our synthesis plants are designed to meet the German Clean Air Act (TA Luft) or tailored to meet the requirements of local environmental regulations.

Flow sheet

Flow sheet of a series 81 hydrogen chloride synthesis unit made of DIABON® graphite
Reliability and Safety
at Low Operating Cost

Criteria that count
Our extensive expertise and many years’ experience allow us to design a plant that will meet all of your requirements.

- State-of-the-art design of the synthesis units and tailor-made engineering of instrumentation, piping and steel structure for optimal performance.
- Total operational safety to ensure safe processing of chlorine and hydrogen.
- Our expertise allows us to supply cost-effective plants.
- Reliable operation. Our units have uptimes higher than 99.9%.

Dependable: operational reliability
Regardless of the design, whether manually operated or computerized and fully automatic, our synthesis units offer a maximum of operational safety.

- Flame failure monitors which automatically shut off the hydrogen and chlorine supplies by rapid-closure valves if the flame is extinguished.
- Automatic shutdown of hydrogen and chlorine in the event of pressure failure.
- Automatic purging of the system with nitrogen before any startup and shutdown.
- Incorporation of a flame trap to prevent back flashing into the pipeline.

Arrangement of the burner: easily accessible at ground level
A special feature common to all synthesis furnaces in DIABON graphite is the bottom-mounted burner and upward-pointing flame.

- Only this bottom burner design allows the production of high-purity acid because condensate forming in the furnace and containing free chlorine cannot mix with the product acid and is evacuated separately.
- The safety disc overpressure system is located at the top of the furnace in the safest location.
- The burner, all gas feed lines, control systems and safety systems are located near the base of the combustion chamber, making operation and monitoring of the unit easiest and most reliable.
- Burner tubes can be flushed during operation and impurities removed while avoiding shut-downs.

**Versatile: the design series**

Synthesis plants in DIABON graphite are available in two different designs which differ mainly in the design of the falling-film absorber:

**Series 81**
The cylindrical block elements incorporate a chimney-shaped aperture in the center connecting the combustion chamber with the safety disc. The HCl gas absorption is counter-current in tubular passages surrounding the chimney. Integrated tunnel trays on top of the synthesis unit accomplish final gas cleaning.

**Series 91**
HCl gas is absorbed co-currently in tubular passages surrounding the chimney. A separate vent scrubber is used for gas cleaning. The weak acid leaving the vent scrubber is fed to the primary absorption section to produce the strong acid.

Common to both series is a liquid distributor ensuring proper feed of the liquid into the absorption blocks.
**Superior design combined with high-performance materials**

Our synthesis units owe their excellent design to our continuous further development program and many decades of experience.

- Only high-performance materials such as DIABON graphite are in contact with HCl gas or acid.
- All graphite parts are contained in a cooling water-flooded steel shell.
- The graphite section containing the burner and auxiliaries is extra robust with thickened walls.

**Flexible: a range extending from equipment to complete systems**

Synthesis units in DIABON graphite can be supplied as equipment only or as pre-assembled and ready-mounted skids including:

- Instrumentation
- Automatic ignition system
- Automatic process control
- Piping and fittings
- Steel structure

Skid-mounted units minimize erection and pre-commissioning times.
# Synthesis Unit
## Series 81

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<thead>
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<th>Type</th>
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<th>d [mm]</th>
<th>h₁ [mm]</th>
<th>h₂ [mm]</th>
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[^]: Nominal output, based on 100 % HCl gas
[^[^]]: Operating weight; dimensions given in the table are not binding
**Synthesis Unit**

**Series 91**

### Dimensions

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<th>Type</th>
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* Nominal output, based on 100 % HCl gas  
** Operating weight (in kg); dimensions given in the table are not binding
Advantageous Details of a Flawless Design

Operation of the plant at ground level
The burner, and therefore all feed gas lines control and safety systems, are arranged at the bottom. This allows easy and safe control, monitoring, operation and maintenance at ground level. The design guarantees regular and reliable inspection of the plant by the operation staff.

Plant without rotating parts
SGL Group plants do not need acid recycle and product pumps due to their design and the elevated acid product outlet. Therefore, the added capital and maintenance costs of additional equipment such as tanks and pumps are obsolete.

Safety disc
HCl synthesis units require an excess pressure safety device. Therefore, a DIABON safety disc is located at the top of the synthesis unit. A specifically designed chimney between combustion chamber and safety disc guarantees a controlled pressure release in case of excess pressure. Fumes are released at the very top of the plant, far away from the operator’s working area. Splashing acid is completely avoided.

Gas traps
At the highest point of every available design of synthesis units, unburned hydrogen and inerts can accumulate. Only SGL Group designs its synthesis units so that this hydrogen is continuously vented through the scrubber to avoid hazardous situations.

Nitrogen flushing
Purging with nitrogen is carried out from the bottom to the top of the synthesis unit. Unburned feed gas mixtures are removed automatically and completely after shutdown, ignition failure or planned shutdown. This guarantees a safe restart of the unit.
> Safety interlock system
The safety interlock system will safely shut down the plant in case of any failure, e.g. feed gas pressures, flame failure, cooling water flow, absorption water flow and safety disc monitoring.

> Automatic ignition and control
The automatic ignition system, together with the automatic control of the H₂/Cl₂/absorption water ratio guarantees trouble-free operation under any operating conditions.

> Flame arrestor
Flame arrestors for vertical installation in the hydrogen feed gas line prevents the flame from flashing back into the main pipeline and the pipeline to the pilot burner. SGL Group supplies a specifically developed flame arrestor suitable for HCl synthesis units. Only this kind of flame arrestor is in accordance with the European Directive 94/9/EC and the European Standards EN 1127-1 and EN 12784.

> High-performance burner
SGL Carbon’s proprietary burner is capable of burning the chlorine with only 5 % excess of hydrogen. However, depending on the on-site conditions, e.g. the performance of the instrumentation, it might be necessary to increase the excess to 10 %.

> Burner flushing
The arrangement of the burner at the bottom also allows the installation of a flushing system. The burner can be flushed in operation (without stoppage) to remove salt incrustations which are drained separately.

> High-quality hydrochloric acid product
Condensate is formed in every cooled combustion chamber, independently of up- or downward firing. The unique SGL Group design allows this condensate to be drained off separately from the acid product, thus improving product quality.

> Highest payback due to heat recovery
The combustion of H₂ and Cl₂ to give HCl is a strongly exothermic process that releases 0.7 kWh for each kg of hydrogen chloride produced. This energy can be partially recovered in the form of steam (all pressure levels achievable) or hot water. Depending on plant size and energy a payback time of only 1-3 years can be achieved for the heat recovery system.

Flow sheet

Flow sheet of a series 91 hydrogen chloride synthesis unit with steam generation system
Customer Service
with a Full Package of Benefits

Our continuing partnership with customers is based on the excellent services and system solutions we provide. These are a key part of our commitment. All items of SGL Group’s DIABON process equipment are quality products manufactured in our own plants from high-grade materials using the latest technologies. If a product still fails to meet your requirements, SGL Group’s worldwide network of service centers will be on hand to help. We see every problem as a fresh opportunity. Give us the chance to prove it.

Spare parts and repairs
SGL Group’s responsibility for its products doesn’t end when customers take delivery of DIABON equipment. In fact, we give our customers systematic support all the time it’s in use. This support is a key part of our customer service.

The long service life of our graphite equipment depends crucially on its high quality and the servicing and/or cleaning it gets when in contact with highly corrosive and contaminated media.
As a manufacturer of carbon and graphite products, process equipment and systems for the chemical industry and environmental protection technology, SGL Group maintains a targeted quality management system designed to attain and meet the product quality standards demanded by customers. Our quality management system meets the requirements of DIN EN ISO 9001:2000 and Pressure Equipment Directive 97/23/EC Annex III, Module H/H1 and has been certified by the approved associations of DQS and TÜV SÜD. In process equipment construction, Quality Management is responsible for the testing and approval of semi-finished graphite products, impregnating resin, cement components, outsourced parts, process equipment and components.

Synthetic resin impregnation, cementing and assembly are all subject to continuous monitoring. Appropriate marking of the semi-finished graphite products before and after synthetic resin impregnation, during machining and thereafter until assembly of the complete equipment or plant provides comprehensive evidence of the semi-finished products employed. Consequently, they meet the traceability requirement of specification AD 2000-Merkblatt N2 for pressure vessels made from electrographite and hard burned carbon. The conditions for synthetic resin impregnation of the semi-finished graphite products and those for cementing of the components are stipulated, monitored and checked.

Evidence of the quality characteristics of the material grades employed, as required by specification AD 2000-Merkblatt N2, is provided in a report issued by the testing laboratory of TÜV SÜD Industrie Service GmbH.
Process Technology Brochures

- Process Technology – We Combat Corrosion – from Process Equipment and Components to Complex Systems
- DIABON® Graphite for Engineered Process Equipment
- DIABON® Shell and Tube Heat Exchangers
- DIABON® Block Heat Exchangers
- DIABON® Plate Heat Exchangers
- DIABON® Economizers for Heat Recovery
- DIABON® and LICUFLON® Columns and Column Internals
- DIABON® Hydrogen Chloride Synthesis Plants
- DIABON® and Exotic Metal Pumps
- DIABON® Safety Disks
- Systems – Solutions for Corrosive Processes
- ECOPOR® Porous Burners