

7 Decades – 3 Generations

A service journey of a HCl synthesis unit



Introduction

Sometimes we hear something like: “It’s like the grandfather started the unit and his grandchild is operating it” - Resistant, indeed, for three generations. These kind of stories aren’t fiction but can be reality. Let us take you on a journey through the lifetime of a HCl synthesis unit. Our process technology experts will give you practical advice on how you can make the most out of your units with a focused and professional lifetime service approach. In general, let us start here first.

Uptime of installations and equipment is usually rated as a KPI in well managed chemical plants. The ultimate target here is to keep production going in a safe way while minimizing the total costs of operation. However, problems during operation can never be fully avoided. Good management is key. One option we would not recommend is to run from one “firefighting” to the next by continuously relying on and replacing with low-quality equipment. This means not just safety risks, but also high costs caused by production losses. The second, much preferable, option is to control the situation by applying quality products combined with regular maintenance, corrective actions, if necessary, and prevention strategies. The results: Low total cost of ownership and thus a competitive edge.

In this article, we will take you through the lifetime of a HCl synthesis unit with all its ups and downs and give answers to the most-asked questions and challenges in managing this technology competitively and sustainably. As a real case in South America proves, good management can result in generations-long successful operation. Delivered in the 1960s and continuously running for more than 60 years – virtually operated by three generations – this application is a prime example of the potential offered by a quality-oriented approach.

Good to know: What is a HCl synthesis unit?

A HCl synthesis unit is a tailor-made solution for hydrochloric acid production and anhydrous HCl gas generation. H_2 and Cl_2 react at temperatures above 2000 °C (3630 °F) to produce HCl gas. Its main material of construction is synthetic graphite like DIABON®, which enables the necessary temperature and corrosion resistance. To produce hydrochloric acid, the gas is absorbed in water in a falling film absorber. Residual gas is cleaned in a vent gas scrubber. Depending on the application, standards are available from 2.0 t/d up to 155 t/d (nominal output based on 100 % HCl) with many possible design features like heat recovery systems (e.g., steam production)

The Beginning

Every HCl synthesis unit's journey starts with the order placement. A comprehensive service approach starts not with the first repair request after the unit is delivered, it starts right here. Several important questions need to be reviewed with the support and expertise of the supplier before the order is executed.

One core element is the clarification about uptime requirements during operation of the unit and the allowable timeframe for unplanned stops of production, caused for example, by damage to the unit. Here, full transparency is key to come to the correct conclusions. Doubt is well-placed, for instance, when some suppliers claim that damages are very unlikely, or every bit and piece is available off the shelf for fast repairs. Rather, start with the specific allowable shutdown periods and then go through the main damage scenarios and related spare parts, always keeping in mind spare parts availability and specialized fitter support. A good supplier will guide you through this process. They will be transparent about required delivery times and provide you with their full expertise of hundreds of similar installations around the world and past decades. That's what SGL Carbon brings to the table. Apart from long experience, we offer **standardized spare part packages** for different customer requirements as well as **fully customized spare part strategies**. In addition, a global service and production network close to your installation enables fast reaction times in case of damages. This should be considered when deciding on the most suitable supplier. The **need of specialized fitter know-how in case of graphite repair needs** should also be kept in mind. Here, it can be beneficial to train your own maintenance teams for graphite handling basics and quick fixes. Beside training offers and for more specialized tasks, we at SGL provide a broad range of fitter support options from hands-on to advisory supervision.

Once the unit is produced and shipped, it is all about correct **Installation and Commissioning** as this will define the long-term economic success of your investment to a large extent. At this point, SGL provide detailed consulting and access to insights of key elements to be considered for a trouble-free installation and commissioning. This can be done by remote or face-to-face expert meetings according to the customer's needs and preferences.

Before reviewing the installation process, however, we recommend taking a moment to evaluate the supervision of unpacking and inspection of goods at your site. The goal here is to identify any transportation damage and reduce the risk of inappropriate handling, specifically for items made of special materials like graphite which are not commonly known in the industry and need special care.

Expert Tip by Andy Stupica
Technical Service Manager AM



Expert Tip:

Customers should always document the unloading process and any damage observed on the packaging right before unpacking. This is made very easy today with low-cost access to high-quality cameras in smartphones and practically unlimited digital storage capacity. From pictures to videos of the whole process up to and including the lifting and setting of the unit – the more the better should be the motto.

An even better approach is taking advantage of a supplier's expert **supervision service**. This will ensure correct unloading and provide firsthand witnessing of possible transportation damage thus safeguarding the customer in claiming any damages observed at time of delivery on site to transportation insurances for example. A perfect match for the supervision service is the **training of the customer team** which provides firsthand guidance for the unit's handling and installation. By enabling correct handling, this saves time, effort and money usually needed for considering the risks of damages by wrong handling and related delays/costs etc., such expert charges of a view days are well invested and of high value.

Beside supervision services SGL can also provide a **state-of-the-art data logger program**. Sophisticated data logging is being trialed by SGL experts. A data logger attached to a synthesis unit can keep track of several key parameters such as temperature/acceleration etc. changes over time – in effect giving deep insights into the unit's transportation and for example any temperature shocks which might have occurred, making mishandling provable.



Example of a temperature log profile (left) and real-world application of a data logger at SGL (right)

Expert Tip by Cemalettin Kocak
Technical Service Manager CE



Expert Tip:

Correct transportation is particularly important for components that are sensitive to certain temperature shocks. In the case of rubber-coated steel shells, for example, it is particularly important to avoid sudden temperature changes below 0°C to prevent damage on the rubber coating. With the data logger, this can be monitored from loading all the way to the unit's destination (up to 12 months).

After the unit is offloaded and checked on-site, it is assembled and installed – often with expert fitter support, either hands-on or in a supervisory activity. In both cases, customers and their teams benefit from not just shorter installation times and lower workloads, but also receive full documentation of the process. The very key element here is an optimal installation, which in turn enables a low total cost of ownership (TCO) by minimizing start-up risks, ensuring a trouble-free operation, and thus increasing reliability and lifespan.

The Art of Commissioning

During the commissioning of the HCI synthesis unit, service teams of experienced fitters, installation supervisors and service specialists ensure the highest safety and quality standards are applied. The simplest part of this process is the pure mechanical installation, along with the pipe work and pressure tests with water. The start-up itself, however, including the I&C checks and fine-tuning of the equipment and system installation, requires both in-depth engineering expertise and long-term experience. Our SGL engineers providing **commissioning service** are on-site with you, verifying the full operational capability and product quality with performance tests and, if necessary, giving support on troubleshooting and answering any remaining questions you or your team may have.

Remote Services can also be an important complement option or even standalone support solution, depending on the complexity of the delivered synthesis unit. SGL provides a state-of-the-art remote expert service in combination with local on-site support for complex tasks requiring specialized expertise around the globe.

Case story:

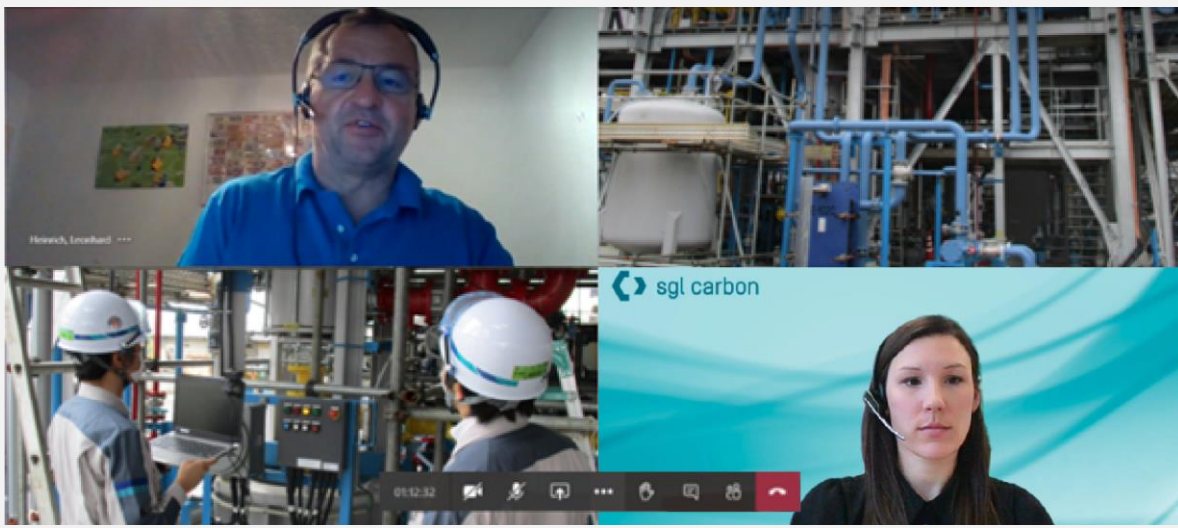
Commissioning of an HCl synthesis plant in Japan using state-of-the-art technology

Monday morning, 6 am in Bavaria. A little earlier than usual, Leonhard Heinrich from Process Technology (PT) starts his day and looks at his screen at home over a first cup of tea. His PT colleague Birgit Rauh has also joined the daily online video conference from home.

About 9,400 kilometers farther east, in Japan, it is already 1 pm. Following a fortifying lunch, Mitsui Masahito from SGL in Japan, together with our customer's technicians, drives a camera through a newly installed HCl synthesis plant. During cold commissioning, they carry out the final steps before the plant is ultimately put into operation. The eyes of our PT experts in Germany attentively follow what is happening on-site via online video conference. Leonhard Heinrich routinely sketches the next steps for his colleague in Japan on a virtual whiteboard. At the same time, Birgit Rauh focuses on the detailed checklist, ticking off each item in turn.

In an initial test run during the cold commissioning, water flows through the plant. Afterwards, the final test is carried out under realistic conditions: hydrogen and chlorine are added to produce hydrochloric acid. On the monitor the values for temperature and flow rate slowly increase. The plant goes into operation as planned, now remotely controlled online for the first time.

“Normally, the team would have needed to board a plane to Japan for this. However, due to the coronavirus pandemic, we were unable to simply travel to our customers. But even under these circumstances we were able to provide our full expertise. We took up the challenge of a remote commissioning and carried it out successfully in cooperation with our on-site colleague and the customer,” says Gerald Mehlretter, Director Project Management and I&C in the BU PT



The Operational Phase

Start-up and commissioning are finished, the HCl synthesis unit is running according to specifications – well done. Now let us take the next step on the unit's journey.

During the first years, no special requirements are usually to be expected. If the synthesis unit is operated within the specified range of feed gases and liquids, including utilities like cooling water, electricity etc., a stable operation is typically assured. This first period of operation, however, is the best time to get familiar with the **right contacts in your supplier's After Sales team**. The installation and commissioning experts are not always the same contacts for support throughout the lifetime of the unit. Having the direct contacts to the right people in After Sales will help you if emergency troubleshooting is ever required or if a technical question arises during operation – and quickly, since time matters in many such cases. With our SGL approach, you won't have to ask for your After Sales contacts – we will introduce our support options and pro-actively provide direct contact details to our After Sales experts right at the beginning of the operational phase. Just a reminder: At this time, it would also be good to think about spare part requirements depending on your specific downtime acceptances. Spare parts may take several weeks/months to be delivered.

Due to fluctuations in feed gases or other operational factors, pressure shocks on the process side represent the highest risk. This is not unlikely and can result in bursting of the rupture disc located at the top of the Synthesis unit as a safety device, or a breakage of the burner tube occurs where the H₂ and Cl₂ is mixed for combustion. These

damages can be repaired by a trained maintenance team. For optimal results, the manuals provided by your original supplier must be available and strictly followed – so keeping these documents ready and accessible is critical.

Exchanging burner tubes and burst disks are usually tasks that need to be repeated over the years. Until your own maintenance team has built up sufficient experience, support and training by an experienced fitter is beneficial. First-hand know-how about the process and important do's and don'ts will always pay off. Thus, it might be a good idea to order a specialized fitter for the first few cases.

After **reaching 2-3 years of operation**, it will be time for your HCl synthesis unit's first **regular and preventive inspection service**. While we know that systems and synthesis units are typically inspected throughout the year by your operational team, keep in mind that special materials like graphite and PTFE need special know-how to identify early indicators of upcoming problems or specific installation requirements.

A regular expert inspection significantly reduces the risk of unplanned shutdowns. Potential problems can be identified and solved before they materialize. Reduced operational costs and a maximum of lifetime and performance of valuable assets are the result. We provide a modularized inspection program to ensure a structured, documented, and professional execution based on, for instance, product specific checklists and reports. Four modules make up the core of SGL's approach:

- The **mechanical module** focuses on checks of mechanical installations and safety relevant components such as springs, connections, support elements. It also reviews available spare parts in terms of quality and quantity
- The **I&C module** is concerned with the I&C installations and safety relevant control devices operating in synthesis units and systems made by SGL
- The **performance module** offers engineering calculations and benchmarks of current performance level with expected performance level as well recommendation of actions
- The **LAB inspection module** provides access to our leading graphite laboratory in Germany, enabling for example a destructive graphite sample analysis to evaluate graphite parts' ageing and gain insights into their potential remaining lifetime

Besides providing detailed documentation via a structured **inspection report** and **inspection certificate**, expert inspections also support you with keeping up to date regarding all laws and regulations which are essential in corrosive and critical applications. One further main aspect worth mentioning is the support provided to you in generating meaningful maintenance and budget plans and documentations for your installations.

Expert Tip by Didier Nuzillat
P&S Head MED



Expert Tip:

Good documentation of deviations and potential shutdown risks by an external party will enable a fact-based argumentation for maintenance budget planning. Costs can also be significantly reduced if different equipment inspections can be bundled during a single inspection visit.

The first crisis – Emergency Repairs

Good maintenance and preventive actions will reduce the risk of damages and unplanned shutdowns significantly, but it will never be nil. Out-of-spec feeds or other unplanned boundary conditions may lead to the DCS systems' safety control suddenly stopping the HCl synthesis unit. Typical trigger elements include a blow-off of the bursting disc, a sudden temperature rise in the furnace chamber or anomalies in the cooling water.

But what was the root cause and what is to do in such situations? Enormous time pressure can generate stress in such sensitive situations, thus adding another dimension. Fast and efficient initial support is crucial to determine

the necessary steps for agile and proper damage control. Questions like, “can it be repaired on-site or does it have to be shipped to the manufacturer’s site” must be decided. Depending on the solution reached, these can have a high impact on downtime and costs. Here is where having the right direct contact to your supplier’s After Sales team at hand pays off.

Expert advice at the right time, at the right place, at the right costs is of crucial importance for efficient and agile handling in this scenario. To enable this critical alignment, which can limit the scope of immediate damage and prevent knock-on effects, SGL provides a **Remote Expert Service**. Our After Sales experts can set up a direct connection to your own company mobile within minutes, even while on the move and including camera functionalities to instantly support you via live stream. We are especially focused on enabling a live connection between our experts and your on-site situation without any dedicated hardware – only an internet connection and your mobile is required. If necessary, additional specialized experts can be connected instantly from all over the world to analyze your problem and identify the best solution as well as the next steps.

Knowing the actual on-site situation supports our experts in making the correct judgement whether, for instance, a re-start without any corrective action is reasonable or a quick fix by the local customer team is maybe necessary. Further required actions may also include on-site repair by expert fitters or even, often as a last resort, an in-house repair at our own facilities. Quick fixes or emergency repairs might be enabled by remote expert guidance. For your HCl synthesis unit this could mean helping your team with the correct exchange of the rupture disc or burner tubes.

If direct **field service** support is necessary, availability of the needed expert fitter is crucial, but the most common bottleneck is the spare part availability at the synthesis unit’s site of operation. While some standard spare parts may be available off the shelf, other constraints like logistics, customs, export control regulations and approvals or special tooling requirements on-site may limit the agility of such services and affect the downtimes. This reinforces the advantages of an early joint review of potential damage scenarios with your supplier to assess downtime limitations and resulting needs of spare parts and preparation.

For large scale issues, an **in-house repair** of the synthesis unit or its parts may be necessary. First, a thorough in-house damage analysis will reveal the needed details. The final repair strategy and scope will depend on your specific requirements. SGL aims for full transparency and partnership with you at this stage. **Remote inspection** of the damage and a discussion with our repair expert via live stream from our workshop to the customer’s desk can be of high value to identify the repair scope.



Remote Expert Service at a HCl absorber unit

Full transparency on damage evaluation (step-by-step guidance through damage assessment and repair options, e.g., leakage testing, spark testing etc.), discussion and alignment on repair strategy and scope, as well fast and transparent cost-/ benefit analysis of repairs are key elements to be executed to support you in your further decision-making. Once the repair is finished, an **electronic factory acceptance test (e-FAT)** is the economic and

ecological option to acceptance of repaired parts before shipping. Our Remote Expert Service proves its effectiveness again in this scenario, providing you with a proven tool to make e-FATs possible remotely from your desk.

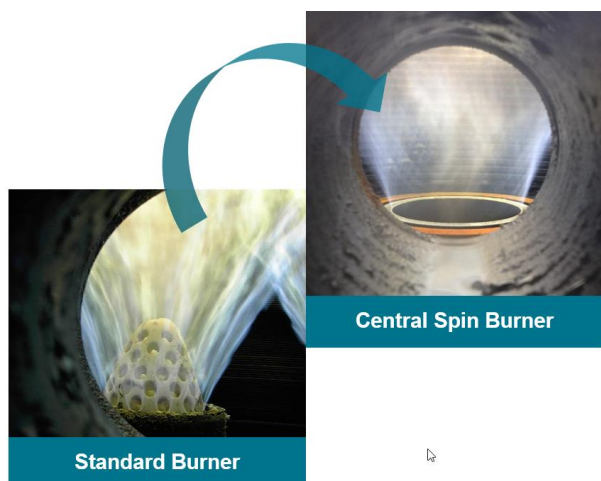


Example of SGL Remote Expert Services for in-house repair

After years of operation, there's no reason to lay back – upgrading options ahead!

Staying in regular contact to the original supplier through inspections significantly improves the uptime of your synthesis unit by identifying problems before they materialize. But there's a second big advantage: Helping you stay right at the cutting edge of technology developments. These innovations are not just fancy new gimmicks, but rather technological improvements providing real value. For example, a recent upgrade option for synthesis units is an innovative **central spin burner made of DIABON graphite**.

Traditionally, burners used in synthesis units are made of a glass-like ceramic material. Through intensive research and development, our SGL experts have designed a completely new burner made entirely of graphite material. This new spin burner cuts operational costs with its more robust design and practically reduces the risk of damage. It also benefits from our specialty graphite's higher resistance compared to glass-like ceramics if wet feed gases are used. With its higher turbulence generation, it also enables a better conversion rate of Cl_2 and H_2 . As a result, H_2 excess can be reduced while keeping Cl_2 values in the product minimal. The burner's innovative design also enables a more homogeneous and stable flame even at lowest burn settings. All these benefits can be provided at the same or even lower investment costs compared to the traditional designs. Our **upgrading services** enable the use of this new spin burner in existing synthesis units – a real win-win case showing the potential for both customers and suppliers.



Comparison: standard burner (left) and spin burner upgrade (right) in action

Other beneficial upgrade options for synthesis units provided by SGL include automatic burner flushing or automatic ignition systems. Whatever upgrade is chosen, staying in regular contact with the supplier along the lifetime will also enable you to be close to the latest regulatory requirements, trends and changes and therefore safeguard you and your installation in terms of safety – which is crucial in critical applications like H₂ and Cl₂ processing.

The end – or not?

Sooner or later, there comes the time to review whether a HCl synthesis unit should stay in use. This can happen for various reasons. For one, damage incurred during operation can make a repair unprofitable when compared to simply getting a new unit. For another, overall conditions might reach a point where a safe operation is not ensured anymore. Or there just isn't as much demand for HCl anymore. For SGL, an end-of-life strategy is just as much an elemental part of the life cycle as reliable support during the commissioning and operating phases. As a sustainable manufacturer, we see it as our duty to provide smart solutions for products nearing or at the end of their life cycle. Our comprehensive **End of Life Service** thus offers individual and customized solutions for this phase.

To reduce your end-of-life costs, we leverage our many years of experience as an equipment and systems combined with the necessary detailed material knowledge and component know-how. For example, our After Sales experts can reduce costs and improve your spare part strategy by making the best possible (re)use of components and assemblies. Overall, three elements should be put into focus here:

- a qualified return and evaluation process
- professional reconditioning if reasonable
- certified disposal if necessary

The first step in the process is usually a detailed alignment of our experts with the customer about the project's requested scope. This can be done in combination with an on-site pre-inspection to evaluate the feasibility of the synthesis unit in question. Once the target is clear and feasibility is confirmed, the unit needs to be extracted from the installation, decontaminated, packed, and shipped to an SGL workshop. We will support you with guidance on extraction and handling, reasonable partial disassembly possibilities for transportation purposes and decontamination requirements as well as packaging and loading advice and guidelines. Once the unit has arrived at our workshop, it is disassembled and assessed. A complete disassembly down to component level and individual assessment and categorization as per the parts list will ultimately result in an offer showing the options of repair/reconditioning of reusable components as well scrapping needs.

Expert Tip by Philip Maierhofer
Technical Service Team Lead CE



Expert Tip:

Repair or reconditioning of parts of a stopped/scrapped unit which will be replaced can be an interesting option from an ecological and economical point of view: saving resources while yielding low-cost spare parts for the new equipment or system.

Non-reusable components will be separated into several materials fractions, depending on the country and site requirement. These are then sampled, analyzed, and certified to enable legally and environmentally correct disposal procedures.

Besides stripping down and partially reusing the HCl synthesis unit as a source of spare parts, a **complete refurbishment** can also be a reasonable option. A crucial factor for the planning of extensive field services such as refurbishments is a clear communication between operator and OEM. A comprehensive risk evaluation plays a key part, keeping in mind any potential damage during disassembly and defining adequate precautions and countermeasures well in advance.

Expert Tip by Philip Maierhofer
Technical Service Team Lead CE



Expert Tip:

"Prevention is better than cure." Before even thinking about disassembly of graphite equipment, make sure you align with a specialist to know about potential risks and particularities of your graphite equipment. Covering at least the minimum requirements of a visual inspection beforehand to assess small steel parts and clamping elements, such as tie rods, springs or bolts for their further usability will save time and resources. You should also have a new set of gaskets available for resealing.

To start with, SGL experts provide guidance to the operator when it comes to sufficient preparation of required equipment and tools. Apart from these, a large variety of OEM spare parts will need to be available. We know this and thus can provide everything from common components to customized parts such as repair nozzles, fitting pieces for graphite piping or repair plugs which are universally usable and simply built "just in case". Also, part of SGL's standard procedure are specialized tools developed in-house by our experts. These are made available for a successful and efficient refurbishment job.

Case Story:

Refurbishment of 1987-built Synthesis Unit in Taiwan

*This large synthesis unit was produced at the SGL site in Meitingen, Germany, in 1987 and subsequently delivered to Taiwan. After more than **30 years** in service, SGL recommended an overhaul of the by-then old unit to our valued customer. We proposed to exchange the biggest graphite part, the combustion chamber, against a new one on-site.*



On May 25, 2019, SGL fitters cooperated with the customer's engineers and started dismantling the synthesis unit. All preparation works were done the week before, and our fitters explained every step to the operators. Starting from the bursting disc on top, most of the unit's parts were slowly removed with a mobile crane. Our experienced fitters guided the operators through the full process and supported them with hints and best-practices.



Finally, the unit was reassembled and passed the leakage test on-site. Its performance was improved by the refurbishment; we saw a significant decrease temperature on the combustion chamber's graphite wall, which means the thermal conductivity of the graphite material is showed better performance than before.

Expert Tip by Nicolas Zhang
P&S Head AP



Expert Tip:

The key to a successful equipment refurbishment is fully transparent technical clarification before the job starts. Preparation works that should be done beforehand are, for instance, task assignments, tool choice and methods alignment. We believe a project that has a good start is already halfway on its way to success.

Summary

This journey through the lifetime of a SGL HCl synthesis units shows, “After Sales Service” does not just mean executing a reactive repair job if required. There is much more service our SGL experts can provide to our valued customers, starting right from the moment talking about the customers’ requirements, going all the way to the end of the product lifetime, and beyond. A sustainable lifetime service approach bringing the TCO to a minimum will always require a close partnership between the supplier and the customer. The supplier must provide reliable quality products as well the necessary elements and structures for value-added services, whereas the operator/customer needs to put their focus on quality products while being ready to invest relatively small budgets into regular preventive services as well as reasonable spare part availability. If both matches, a win-win situation is established that can last seven decades or three generations ...and the grandchild is still a happy operator!



BU Process Technology | SGL CARBON GmbH
Sales Europe/Middle East/Africa | pt-europe@sglcarbon.com
Sales Americas | pt-americas@sglcarbon.com
Sales Asia/Pacific | pt-asia@sglcarbon.com
www.sglprocesstechnology.com

03 2019/0,2 E Printed in Germany
® registered trademarks of SGL Carbon SE

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should therefore not be construed as guaranteeing specific properties of the products described or their suitability for a particular application. Any existing industrial property rights must be observed. The quality of our products is guaranteed under our “General Conditions of Sale”.