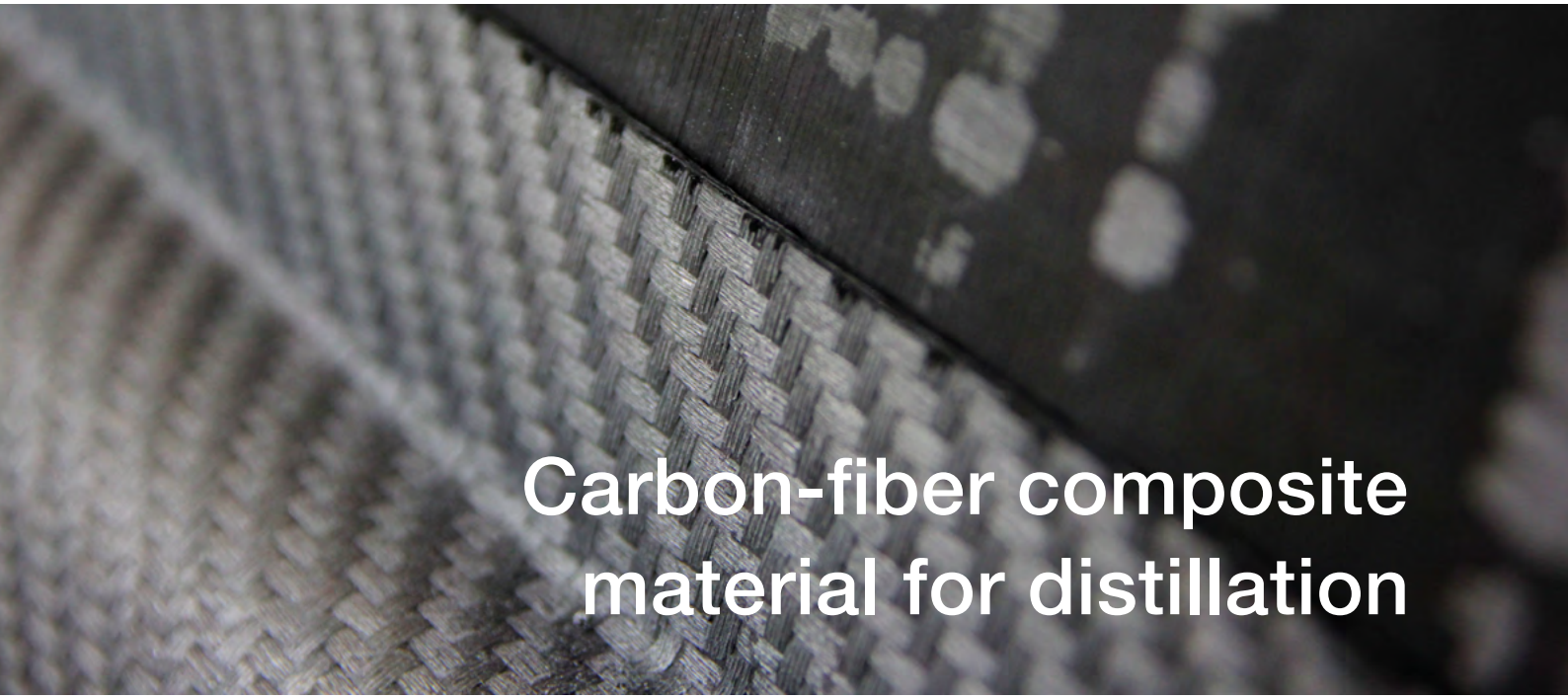

Carbon-fiber composite material for distillation

Carbon products are used whenever other materials such as steel, aluminum, copper or plastic fail due to their limited material properties such as temperature and corrosion resistance. Launched in 2017, the MellaCarbon internals for separation columns allow customers to build higher-capacity plants which can be operated at lower cost.

Innovation is not limited to design changes. Customers can benefit tremendously when known parts are executed in a new material or composite. Sulzer Chemtech is a leader in providing internals for distillation separation columns. The column “internals” or “packings” are commonly made from metal, plastic or graphite.

MellaCarbon — the corrosion-resistant material

Sulzer has developed a new range of internals from corrosion-resistant carbon fiber composite (CFC) material for separation columns. Introduced in 2017 under the existing brand MellaCarbon, the new internals are as resistant as the known graphite internals, but they are lighter, stronger and stiffer. They withstand higher temperatures than any plastic material and cost less than special metals. An innovative connection system allows the easy production of larger diameters, enabling customers to build bigger columns with a much higher capacity.

Features of carbon and carbon fiber composites

Carbon fibers are obtained by the thermal decomposition of plastic fibers, which are first oxidized in air at 180 to 300 °C under tension. Heating the fibers under nitrogen to 1’600 °C produces amorphous carbon. Further heating up to 3’000 °C gives the fibers a crystalline structure. The individual carbon fibers have a diameter of 5 – 8 micrometers. At the same weight, the fiber strength is far superior to the strength of steel. The density of carbon is 1.8 g/cm^3, while aluminum has a density of 2.7 g/cm^3, and steel 7.8 g/cm^3.

Further advantages of carbon are its good electrical and thermal conductivity. Carbon fiber composites (CFC) are widely used. In CFC production, the fibers are used as multifils (threads with several individual fibers), which are further processed into ribbons or fabrics. They are then impregnated with plastic monomers (epoxy resins, thermoplastics) and polymerized. The process results in lightweight, stable and molded products that are highly resistant to tension, bending and corrosion.

> *The SGL Group, a worldwide manufacturer of carbon-made products, was glad to expand its cooperation in the field of column internals based on SGL's carbon fiber composite materials (CFC). The new column internals, introduced by Sulzer under the brand name MellaCarbon, are as corrosion-resistant as graphite liquid distributors used to date, but they are at the same time lighter, stronger, stiffer and more temperature-resistant than plastics. At the same time, they can be offered/produced at lower cost than special metals.*
>
> **Ralph Spuller,** SGL project manager for the cooperation project, Meitingen, Germany.

Cooperation with SGL

The new carbon-fiber-based internals family was jointly developed with the SGL Group. SGL is a market leader for the production of carbon and carbon composite materials. About 70% of the SGL Group staff is employed in Europe. The entire global research and development activities take place at the Technology and Innovation Center in Meitingen, Germany. The main headquarters is in Wiesbaden, Germany.

The key to the innovation is that the team was able to build on and improve a well-known Sulzer product. Sulzer provided the design, testing and installation knowledge. SGL provided the manufacturing know-how with the carbon fiber composite material and the first customers to purchase early prototypes. For over three years, the Sulzer team worked tirelessly with SGL to design and manufacture the first usable products made from the new material. This process involved rigorous testing in the Sulzer lab and test rig to understand how the material behaves. Fig. 1 shows the testing device for the flow measurement in Meitingen, Germany.

Advantages of the new material

The state-of-the-art carbon fiber composite material called SIGRABOND® provides an innovative and economical solution for Sulzer customers and their demanding applications. With the new design, the weight of the grids can be reduced by an incredible 90%, while the open area of redistribution can be increased by 60%. The design (Fig. 2) allows Sulzer to build column internals for customers with a diameter of over one meter that can be installed easily via a manway. The new carbon fiber composite material allowed SGL and Sulzer to expand into new markets and reach new customers with structured packing and internals. The team has submitted two patent applications so far to protect the manufacturing and functionality of the new development.

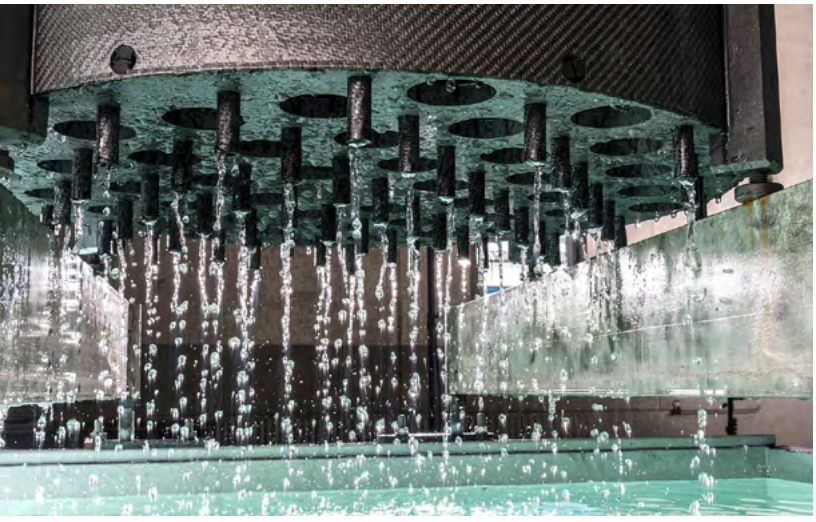

Fig. 1 Flow measurement at a liquid distributor for testing. Source: SGL Carbon GmbH, Germany.

Fig. 2 Details of the MellaCarbon internals.

An innovative idea born in Sulzer's kitchen

In one of the first meetings, it was not clear how much liquid would diffuse through walls made of carbon fiber composite material. So, the kitchen sink close to the meeting room was used as a testing device. The team, consisting of five people, filled a test trough with water and placed it on the table in the meeting room for the day.

By the end of the day, everyone in the meeting room was convinced of the material's promising strengths because very little liquid got through the walls compared with the flow through the distributor. To convince the management of the capabilities of the carbon fiber composite material, the innovation team made a model distributor permanently available below the tap of the team's kitchen to showcase the distribution effects. This was a long-term feasibility study.

Learning by cleaning

"I knew about the electrical conductivity of carbon fibers (Fig. 3), but it was just university knowledge. When I started my career as a development engineer, I was asked to run a test with carbon fibers and check how the stiff fibers behave on a warping creel. The test ran well, although some fibers split off during the test.

Fig. 3 Bobbin with carbon fibers. Source: SGL Carbon GmbH, Germany.

The next morning, my colleague started up the warping machine in the test center. A firework sound shook him and me awake. Electric arcs were visible. We wondered what on earth had happened! The split-off microfibers in the air had spread around the room, and some had landed on the electrical boards of the test machine. The conductivity of the fibers had led to short-circuits on the boards. Later, I learned that when using carbon fibers, the electrical cabinets should be operated under negative pressure to avoid the intrusion of the microfibers. It took a whole week to clean up the entire test center, and I promised myself to take adequate precautions if I ever worked with carbon fibers again."

Nadia Qaud, Textile engineer and Editor-in-Chief of the Sulzer Technical Review, Winterthur, Switzerland.

From model to market launch

With SGL, Sulzer found a perfect partner with experience in this special area of material technology and with the required know-how to manufacture the carbon fiber composite products. Once the contractual basis was defined, the path was clear for an efficient cooperation between SGL's materials experts and Sulzer's engineering specialists.

Christian Bachmann
Winterthur, Switzerland

Johannes Rauber, Senior Application Manager of Sulzer Chemtech, explains: "To make this kind of R&D partnership successful, open and dynamic communication between the teams and individual specialists of both companies was decisive. We already had many ideas for technical solutions, and after settling the cooperation contract, an open discussion developed that allowed us to overcome the biggest technical challenges quickly."

This development, which won a Sulzer innovation award, helps customers to extend the lifetime of their column internals. The market success since the launch of MellaCarbon speaks for itself.