Sulzer Technical Review
1/2018

Market-driven innovation

Development of algorithms for mixing prediction
New products for industrial pumping and mixing
The innovative NeXRing™ in practical use
Root cause analysis for generator failure
About Sulzer
Sulzer’s core strengths are flow control and applicators. We specialize in pumping solutions and services for rotating equipment, as well as separation, mixing and application technology. Our customers benefit from a network of over 180 production and service sites around the world. Sulzer has been headquartered in Winterthur, Switzerland, since 1834. In 2017, we achieved sales of roughly CHF 3.0 billion with around 14'700 employees. Our shares are traded on the SIX Swiss Exchange (SIX: SUN).

Pumps Equipment
The Pumps Equipment division specializes in pumping solutions. Intensive research and development in fluid dynamics, process-oriented products, and special materials as well as reliable service solutions help the company maintain its leading position in its focus market segments.

Rotating Equipment Services
The Rotating Equipment Services division provides cutting-edge maintenance and service solutions for rotating equipment dedicated to improving customers’ processes and business performance. When pumps, turbines, compressors, generators, and motors are essential to operations, Sulzer offers technically advanced and innovative solutions.

Chemtech
The Chemtech division is represented in all important industrial countries and sets standards in the field of mass transfer and static mixing with its innovative solutions. The product offering ranges from process components to complete separation process plants. The customer support covers engineering services for separation and reaction technology and tower field services to perform tray and packing installation, tower maintenance, welding, and plant turnaround projects.

Applicator Systems
Customers of the Applicator Systems division benefit from advanced solutions in the field of precise applications as well as two-component mixing and dispensing systems for adhesives, dental, healthcare and beauty applications. A global network ensures local knowledge and competence help Sulzer to keep its leading position in its market segments.

Market-driven innovations

We are keeping up with the times and adapting the Sulzer Technical Review to modern reading habits. Starting in 2018, we will publish the Sulzer Technical Review more often – with six editions per year – but with fewer articles per edition. We are also introducing a new format: the Sulzer White Paper. It consists of extremely technical articles written by engineers for engineers. We welcome feedback from you – our readers – to these changes.

Nadia Qaud, Editor-in-Chief Sulzer Technical Review
Reliable prediction tools and accurate measurement techniques are essential elements for an innovative and lean product development cycle. For mixing applications, commercially available simulation tools fail to provide the required speed and accuracy. Therefore, Sulzer engineers developed an in-house tool for reliable prediction of mixing quality.

Mixing occurs constantly all around us – on the earth where we live, within our atmosphere and oceans and even in our bodies. Reducing inhomogeneity by mixing different materials is also an essential part of many processes in the chemical, pharmaceutical, construction, food or general industries. Novel mixing solutions are required for the efficient use of two-component or multicomponent materials. Developing techniques and mechanisms to induce, control and optimize mixing is an important part of the expertise at Sulzer Applicator Systems.

The emergence of new materials in many markets and industries over the last few decades requires novel production or application techniques. Therefore, during the same time period, the application of multicomponent filling, sealing and bonding solutions has grown significantly. Today, numerous customers use the highly efficient mixing and dispensing solutions offered by Sulzer to mix and apply various sealants and adhesives. The products cover a wide range of applications from healthcare to construction, from do-it-yourself to large-scale industrial manufacturing.
Due to the ever-expanding use of two-component materials, the quest for more-effective and more-reliable applicator systems continues. Along the process chain, the mixing system remains a crucial element in the successful use of multicomponent materials. In high-end applications, the mixing performance and quality can influence product reliability and, therefore, has to be extremely precise.

Laminar mixing processes
Sulzer offers various static mixer designs for laminar mixing processes (Fig. 1 and 2). These miniature mixers are cost-efficient and easy to use. However, they might depict suboptimal performance when components have different material properties, such as viscosity. The same applies to cases where there is a lot more of one component in use than of the other. For such demanding applications, dynamic mixers (Fig. 3) are often the preferred choice. In these mixers, fast rotating blades induce high shear forces and enable precise mixing and dispensing. The moving parts of these mixers rotate up to 1’500 rpm. Within the mixer, the axial velocity of the material can be as low as a few cm/s. Sulzer offers various dynamic mixers to overcome the most challenging mixing problems encountered in different areas of life – from a car repair shop to a dentist’s office.

Product optimization using simulation techniques
When Sulzer customers require new mixing solutions adapted to their specific requirements, the development engineers have to keep the development cycles as short as possible. At Sulzer, computational fluid dynamics (CFD) is one of the commonly used tools. CFD is a numerical simulation of fluid state and motion. It has advanced to account for increasingly complex phenomena such as multiphase interaction, phase conversion, fluid-solid interaction, etc. Thanks to the increase of computational resources and advancements in numerical techniques, development engineers increasingly use simulations for design and optimization in various fields.

Using state-of-the-art cluster computers, the CFD calculation time for a static mixer takes 48 – 72 hours. The capacity of a cluster computer equals the capacity of 150 – 200 personal computers. This gives us an idea how complex the calculations are and how many computational resources are needed for such applications. Despite the advances in calculation possible by using commercial software, the laminar mixing process cannot be predicted accurately. The process of laminar mixing depends on the generation, division and stretching layers of material inside the mixer (Fig. 4). These layers are increasingly refined and mixed over the mixing length.
It is quite difficult to represent these layers with conventional CFD grids. The prognosis of a mixing pattern is challenging for any CFD tool because of excessive numerical diffusion. This numerical diffusion results in an overestimation of the mixing quality and a blurred appearance of the mixing patterns (Fig. 6). This stands in contrast to the measurement where the distinct borders between the two materials are still recognizable (Fig. 5).

**Diffusion-free particle tracking**

Sulzer engineers aimed to overcome these limitations in the past years to speed up the development process for mixers and obtain accurate mixing performance.

A well-known approach to overcoming the problem is to assess the mixing pattern and concentration field by using discrete particles colored by concentration. The red and blue colors in Fig. 8 represent different concentrations. The particles are used to calculate how materials with different concentrations move through the mixer. This allows high-resolution mapping in static mixers. This method and implementation has been already developed and used in the past for static mixers. Fig. 5 shows a mixing pattern obtained in measurements. In Fig. 6, you see the calculated mixing result of commercial CFD, and in Fig. 7, the result of the in-house tool.
Particle tracking for dynamic mixers

Unlike in static mixing tips, in dynamic mixing tips, the flow field within the mixer varies over time. Therefore, the previous approach of offline tracking of a limited number of particles based on steady-state flow field is no longer applicable. In addition to an unsteady flow field, the multiscale nature of the problem poses further practical challenges. The moving part of these mixers rotates with up to 1’500 rpm. The axial velocity of the flow within these mixers, on the other hand, can be as low as a few centimeters per second. Covering the simulation time required for filling the mixers and capturing the rotation with sufficient accuracy proves to be a challenge.

Fig. 9 Dynamic mixer – blue and red lines symbolize the particle tracking.

<table>
<thead>
<tr>
<th>Plane A</th>
<th>Plane C</th>
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<tr>
<td><img src="#" alt="Picture of real mixing result" /></td>
<td><img src="#" alt="Picture of real mixing result" /></td>
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<tr>
<td><img src="#" alt="Simulations calculated with conventional CFD." /></td>
<td><img src="#" alt="Simulations calculated with conventional CFD." /></td>
</tr>
<tr>
<td><img src="#" alt="Simulations calculated with in-house tool after implementation of algorithms." /></td>
<td><img src="#" alt="Simulations calculated with in-house tool after implementation of algorithms." /></td>
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</table>

Fig. 10 Comparison of real mixing results with conventional CFD and in-house tool for dynamic mixers.

**Video 1**
Click here to see a video of a simulation calculated with conventional CFD.

**Video 2**
Click here to see a video showing real mixing results.
Methodology and algorithms

In earlier attempts, the Sulzer engineers tried to couple the particle tracking online with the flow field in the dynamic mixer. The approach, which is theoretically sound, fails due to the limitations of computational resources. Such simulations require computational time and memory beyond the practical limits. Therefore, Sulzer engineers examined further alternative approaches for the offline coupling of particles similar to those used in static mixers. However, the challenge is the unsteady nature of the flow in dynamic mixers. This limitation has been overcome using the periodic nature of the flow.

This allows the engineers to construct the solution for any length of time using the solution obtained from one rotation. The periodic essence of the solution enables the engineers to perform offline particle tracking for dynamic mixers with a rather limited number of particles. For the calculation, the particles are released at plane B and tracked backward to the inlet (plane A) to obtain the concentration.

Verification and validation

Prior to their use in product development, all in-house numerical tools are carefully verified and validated by the Sulzer engineers. Both measurement and computational setups should be carefully constructed in order to achieve the ultimate reliable comparison. The predicted mixing quality is compared to optically assessed mixing patterns in measurements. The blue and red lines in Fig. 8 symbolize the particle tracking inside the dynamic mixer. A mixing simulation inside a dynamic mixer – obtained with a conventional CFD program – is shown in video 1. The validation study confirms the applicability and accuracy of the method (Fig. 9 and video 2).

Fast and lean mixer development

After numerous tests and measurements, the Sulzer engineers were able to develop a reliable in-house tool that they trust. The newly developed and implemented algorithms enable the engineers to assess the mixing quality in dynamic mixers with increased accuracy. Furthermore, these calculations can be realized within the practical limits of available computational resources. The tool is used to accelerate the design and optimization cycle for new and existing products. It enables our engineers to realize innovative designs and solutions for the ever-expanding application of two-component materials in all aspects of our modern life.
How does Sulzer develop product portfolio to meet customer requirements? Being aware of the customers’ criteria in selecting pumps and agitators for industrial processes is the first step. The second step is to translate this knowledge into product ideas and features. We can offer more reliable and energy-efficient products that save our customers a lot of costs over the product lifetime.

Last year, Sulzer introduced the new Inline Single Stage Centrifugal (SIL) pump range and the AGISTAR™ SSA agitator. Both were developed to provide better products for general and industrial applications.

When tradition meets innovation
When developing new products for the markets, engineers need the ability to look into the past and the future at the same time. Expertise is mainly based on empirical past values – in other words – the knowledge of the company that has been amassed over the years. Anticipating future needs and the ability to transform these needs into innovations is the key to successful product development. The main focus for both products was to reduce the energy consumption, increase efficiency and minimize the total cost of ownership (TCO).
New SIL pump range
Sulzer’s portfolio contains process pumps for all industries – no matter how demanding the process is: big flows, high pressures, hot liquids, particle-containing suspensions, etc. The new SIL pump range is ideal for pumping clean or slightly contaminated liquids, viscous liquids up to 250 cSt, and fibrous slurries up to 1% consistency.

High efficiency leads to energy savings
The SIL pumps have new, highly efficient hydraulics resulting directly in energy savings. The components that most significantly contributed to the optimization of hydraulics were the casing and the closed impeller. The design of the sealing chamber improves the hydraulics as well. Outstanding is that the new hydraulic design ensures efficient pumping across the whole pump range.

Designed for reliability
High reliability and minimized maintenance pay off for the customers. Fewer parts equal less trouble. It is as simple as that. This is why a monoblock construction has been chosen, where the bearing unit between the SIL pump and motor is eliminated. The result is that the system is rigid, needs no bearing lubrication and less maintenance. The high reliability of the SIL’s shaft sealing also contributes to the high reliability of the whole pump. An optimized sealing chamber and impeller-balancing holes guarantee improved conditions for the shaft seal. This results in a better lubrication of the seal and maximizes its lifetime. The rigid and reliable pump is available either with an integrated motor (Fig. 1) or with a standard IEC motor (Fig. 2). The SIL pumps are easy and fast to install, in either a vertical or a horizontal position. If the installed motor power is below 15 kW, they can be even installed without a baseplate – directly in-between the piping. The engineers attached importance to making the SIL pumps compact. Because the pumps require little installation space, it is easier for customers to fit the pumps into existing installations.

Minimized total cost of ownership
The market is asking for trouble-free operation and reduced total cost of ownership (TCO). How do SIL pumps meet this demand? Remarkable cost savings over the whole pump lifetime are achieved thanks to the low energy consumption of the SIL pumps. The monoblock construction reduces installation, operating, maintenance and spare part costs. The back-pullout design of the pump allows quick access for servicing without detaching the pump from the piping.

Regulations for energy-related products
The European Union has the strictest regulations around the world for energy consumption for standardized water pumps. These regulations for energy-related products (ErP) specify the minimum efficiency values for water pumps, with the target of reducing the energy consumption. The minimum efficiency index (MEI) defines the standard that has to be reached for newly installed pumps. All SIL pumps have been designed to exceed the MEI 0.4 requirement.
Market-driven design for the agitator AGISTAR™ SSA

When choosing a new agitator, the total cost of ownership (TCO) is a decisive factor for customers. For an agitator, the energy cost is the largest part of the TCO, as illustrated in Fig. 5. The hydraulics of the newly developed EX3 propeller leads to reduced energy consumption and costs. Breakdowns quickly increase the TCO. Therefore, all of Sulzer’s design calculation consider first-class reliability for demanding industrial environments. Two patent applications are pending for AGISTAR SSA – a proof of Sulzer’s innovative strength.

The very first unit of AGISTAR SSA started operation in February 2017. Since then, it has been running trouble free with a low vibration level. Our client in Sweden reported substantial energy savings. The agitator operates with a variable frequency drive and the operating speed was reduced when installing the AGISTAR SSA. This resulted in a substantial cut of the energy bill, saving several kilowatts out of the installed 15 kW motor.

Jouni Lehtinen, General Industry Sales Management, Finland

Stir it up – with AGISTAR SSA

AGISTAR SSA is a side-mounted agitator that is installed through the tank wall (Fig. 4). The seal, bearings and motor are dry installed, which allows regular and easy inspection. The agitator generates a horizontal flow inside the tank, designed to meet the required process flow conditions. This type of agitator is used in many different industries but is very common in the pulp and paper industry.

Fig. 4 Side-mounted agitator AGISTAR SSA.

Fig. 5 Example of total cost of ownership for AGISTAR SSA agitator, used for a pulp tank, motor power reduced from 15 to 11 kW.
High flexibility thanks to modular design
AGISTAR SSA is currently available in a power span of 7.5 – 75 kW (10 – 100 hp). Its design is based on a modular system, and all the wetted parts are made of stainless steel. The agitator has a free-hanging shaft (cantilever type) and is equipped with a robust belt drive. To suit all types of applications, there are various seal options. Single and double mechanical seals are available from Sulzer, but seals from other suppliers can also be installed without modification.

The performance of the high-efficiency propeller is adjusted by installing the blades at about ten different angles. The blades are reliably fixed with six screws and bolts (Fig. 6). Because the customer can easily adjust the blade angles, power savings can be achieved without any investment at all. In addition, it is possible to improve the performance by modifying the rotating speed via the belt drive.

Tested propeller efficiency
To develop the new EX3 propeller, Sulzer engineers used the latest computational fluid dynamics (CFD) tools. After heavy load tests with a full tank of paper pulp in the test laboratory, the EX3 propeller was tested at different customer sites.

The new EX3 propeller has exhibited a better performance than the previous state-of-the-art MX4 propeller used in the SALOMIX horizontal agitator range. With a smart retrofit kit, the EX3 propeller can be either retrofitted on existing installations or installed to new SALOMIX units. The propeller can be used for various applications and results in either energy savings or increased capacity with the same motor.

Application know-how knocks off energy thieves
Even the most efficient propeller can be an energy thief. The agitator has to be selected properly to fit the actual application. The experienced Sulzer sales engineers know which agitator is suitable for different industries and can configure agitators accurately for customer-specific applications. A correctly dimensioned agitator can save energy costs.

First class reliability
Continuous operation in an industrial environment normally amounts to about 8’600 hours annually. The bearing lifetime for AGISTAR SSA is designed to last 200’000 hours. This figure illustrates the reliability and rigidity of the complete agitator design. The shaft, seals, frame, drive system and the EX3 propeller are all designed for a long lifetime in tough conditions. The efficient agitator hydraulics creates thrust and turbulence — just where it is aimed. This results in fewer vibrations, and therefore prevents the whole system from wear and increasing tolerances.
Many companies are already using the innovative high-performance random packing NeXRing™. The main advantages reported by Sulzer customers using NeXRing for their separation processes are an increase in the capacity, lower pressure drop and less fouling tendency.

In the 3/2017 edition of the Sulzer Technical Review, we reported on the enlarged application range and theoretical advantages of the NeXRing family. While theoretical know-how is helpful, practical examples from the field are, however, more convincing. Sulzer is grateful to all the customers and other industry parties who share their experience with us.

Fig. 1 Design of different ring types used for random packing.

**NeXRing for carbon dioxide absorbers**
Random packing is widely used for the removal of carbon dioxide (CO₂) and hydrogen sulfide (H₂S) from natural gas or biogas. This separation is achieved by contacting the gas with amine-based solvents such as monoethanolamine (MEA), diethanolamine (DEA), methyl diethanolamine (MDEA) and MDEA/piperazine mixtures (activated MDEA). A common characteristic of all these solvents is their strong tendency to foam, which disturbs the gas when passing through the column.
The NeXRing is the latest generation Sulzer random packing. It has the highest efficiency because it has the most open and accessible surface area compared with conventional random packings such as P-Ring and I-Ring (Fig. 1 on the previous page). This better-used surface area of NeXRing high-performance packings leads to separation that is more efficient with a lower pressure drop.

Thanks to the lower pressure drop, the hydraulic impact of foaming is reduced, and NeXRing can be used to debottleneck the column performance. Figure 2, based on calculations done for a European customer, shows examples how NeXRing could lead to improvements such as a reduction in pressure drop or an increase in gas and liquid load. Using a smaller ring size and keeping the pressure drop the same leads to increased column efficiency.

<table>
<thead>
<tr>
<th>Packing type</th>
<th>Capacity</th>
<th>Pressure drop</th>
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<tbody>
<tr>
<td>I-Ring #50</td>
<td>70.30%</td>
<td>40.45 mbar</td>
</tr>
<tr>
<td>NeXRing #2</td>
<td>63.50%</td>
<td>30.8 mbar</td>
</tr>
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</table>

* Sulzer usually recommends 80% capacity as a maximum.

NeXRing for methane separation after coal gasification plants

The worldwide gasification capacity is expected to grow significantly in the near future, with the primary growth occurring in the Far East and Asia. After coal gasification, the next step in the process is usually methane separation. In these plants, the feed gas stream is produced from coal, and it consists mainly of carbon monoxide (CO), hydrogen (H₂) and methane (CH₄). The column used for methane separation splits these three components into two different streams. One stream contains CO and H₂. The other stream is liquid methane (CH₄), which is sold commercially as liquefied natural gas (LNG). The liquefied gas can be easily transported in this condensed form. Fig. 3 on the following page shows the working principle of such a methane separation installation.
Practical experience in methane separation

A customer in China was operating a column for methane separation (Fig. 4) with four different separation sections (A, B, C, D) in the process. The operating conditions for the layout of the original column were based on a feed composition of 24.5% of CO, 58.7% of H₂ and 16.8% of CH₄. In practice, the customer used a different coal for gasification and the feed composition to the methane separator changed remarkably: 24.5% of CO, 51.5% of H₂ and 24% of CH₄. The separation capacity of the existing column was not sufficient to process the feed gas with this composition because of the increased load at the bottom sections (C and D).

Sulzer revamped the column and replaced the Nutter Ring #2 with NeXRing #2 random packings in section C and D. The customer was happy with the result. The change increased the separation capacity for the overall installation by 20%. Now that the column has been revamped with NeXRing random packings, the existing liquid distributor of section D has proven to be a bottleneck; if not for this, the customer would be able to increase the separation capacity even further.
Use of NeXRing in wastewater treatment

Sour water and sour gas are waste products produced from atmospheric and vacuum crude columns at refineries. Hydrogen sulfide (H₂S), ammonia (NH₃) and hydrogen cyanide (HCN) are typical components in sour water that need to be removed before the water can be reused elsewhere in the plant. Wastewater stripping towers are used to remove these components from the sour water. Applying heat, in the form of steam, releases H₂S and NH₃ from the sour water and both gases exit at the top of the tower.

Practical experience in wastewater treatment

An integrated power plant of a refinery in Asia could not achieve the governmental standards for the treated discharge water with its previous installation. Sour water and sour gas from the upstream process were being fed into the stripping tower. The customer observed fouling since the particles and dust inside the sour water had accumulated inside the random packing. These particles had caused an increase of the column pressure drop after a short time.

The company asked Sulzer specialists for help. Sulzer recommended a revamp of the random packing in sections B and C (Fig. 5), where the fouling was occurring. In 2017, the customer replaced the P-Ring #2 in both sections with NeXRing #2 random packings. After half a year of operation, the customer had not observed an increase in pressure drop in the revamped installation. Compared with the P-Ring, the NeXRing has a very open design. This allows small particles to pass through so that they do not stack up, and no fouling occurs in the sections. Additionally, the pressure drop in the column with the NeXRing was lower than with the previous setting using P-Ring in all sections. The customer regularly checks the pressure drop for quality assurance to ensure that the government standards are maintained.

Improved flue gas treatment with NeXRing

Sulfur dioxide (SO₂) gas is generated when burning fossil fuels that contain sulfur. Governments all over the world have set rigid standards to reduce global air pollution through SO₂ emissions. An Asian customer running a refinery plant could not meet the new standard for SO₂ emission with his existing installation. A new column had to be built to reduce the SO₂ content in the flue gas.
Practical experience in sulfur dioxide removal

Sulzer made calculations and created a design as to how the customer could meet the government standards with Sulzer products and a new process setup of the column. The new process (Fig. 6) uses water and caustic solvent in several stages within the column to remove the SO\(_2\). The goal was to lower the SO\(_2\) content of the vent gas below 50 ppm. The original column design contained I-Ring #40. For the new, optimized column design, NeXRing #1 high-performance packings were used. They provided similar capacity to the I-Ring #40 random packings but offered higher efficiency. Since some amount of dust is expected in the process, the anti-fouling performance of NeXRing also provided an advantage.

Based on the calculations, the customer was convinced that Sulzer products would meet the strict requirements and invested in a column equipped with NeXRing only. The column now operates successfully, and the SO\(_2\) content has even been reduced to 35 ppm. The overall pressure drop is 40% less than required. This leads to remarkable energy savings and cost reduction over the operation time of the column.

Calculation tool for customers

To calculate efficiencies, Sulzer has collected experience and test values over years. Based on this know-how, the Sulzer engineers have developed a design program called Sulcol\(^\text{TM}\) for our customers. It allows customers to design columns themselves; similar to the programs offered to design furniture, customers can configure columns in different sizes with different internals. With the help of the Sulcol program, the hydraulic capacity of these columns is calculated. Customers can configure columns with different random packings, trays or valves. Interested customers can ask for access to download the latest version of Sulcol from our website. Access is only granted to companies who are already using Sulzer products.

For more information: www.sulzer.com/sulcol

Many Sulzer customers have realized that the NeXRing helps them to reduce capital and operational costs in several applications. Meanwhile, Sulzer installs over 90% of new columns with NeXRing random packings.
Sulzer’s repair specialists were tasked with minimizing the idle time in the harbor of Aberdeen, Scotland, and speeding up the repair of an icebreaker. The failure of an exciter pack within the shaft generator put the working vessel out of order. Sulzer performed a root cause analysis and in-depth investigations. To prevent further failures, the company that owns the icebreaker plans to implement the solution on similar generator units across the fleet.

An icebreaker’s time at sea is valuable, and any time spent at the dock needs to be minimized. A Scandinavian shipping company that owns and operates several ships and icebreakers contacted Sulzer to repair the shaft generator of the working vessel. The vessel itself supports the icebreaking function, and, at the same time, works as an anchor handling tug.

1897
The first modern seagoing icebreaker, Yermak, was built in England.
Some interesting facts about icebreakers

Icebreakers are ships that are specially designed to break through ice-covered waters, thus creating safe waterways for other boats and ships. To be considered an icebreaker, a ship requires three characteristics lacking in most normal ships. These properties are a strengthened hull, an ice-clearing shape, and the power to push through sea ice. The first modern seagoing icebreaker, Yermak, was built in 1897 in England.

There are two different types of icebreaker constructions. Conventional icebreakers use the bending fracture method, moving their bow upon the ice and breaking it under weight load (Fig. 2). Other icebreakers are built with a Thyssen-Waa-bow and with three sharp skids below the vessel. The skids break the ice with a shear fracture and the ice is moved then to the side of the icebreaker (Fig. 3). Because the shear fracture force of ice is lower than the bending fracture force, conventional icebreakers need more energy to clear a path through the icy surroundings. In rough seas with no ice, conventional icebreakers are easier to steer and navigate.

A non-exciting exciter pack

Sulzer’s field service engineers were invited aboard to investigate the failure of the exciter pack on one of the vessel’s shaft generators. The need to repair the generator was immediately apparent. The damaged components were taken from the port in Aberdeen, by the Local Service Center field technicians (Fig. 1), then on to Sulzer’s Falkirk Service Center, where they were overhauled and rewound.

Following discussions between the customer and the Sulzer technical team, the refurbished exciter pack was tested under load in the presence of the customer and its insurance company. Following a successful load test, the components were refitted by the same engineers that removed them from the ship.

However, to find the root cause of the exciter failure, investigations into the other component parts of the generator setup were necessary. A root cause analysis is a systematic approach used to identify the reasons for a failure and to define corrective actions for the future.
Investigations with ice-cold and sharp minds
Immediately after the commissioning process of the revised parts was completed, Sulzer launched in-depth investigations that focused on three main areas: the winding configuration, the serviceability of the automatic voltage regulator (AVR), and the electrical control system. Throughout both processes — the investigations and the repair — the Sulzer teams communicated intensively with the customer. Sulzer’s technical design team looked at the evidence and concluded that the failure mode was consistent with a sudden spike in exciter load. This peak had led to the catastrophic failure. One important clue came from the commissioning engineer who reported that the only active alarm during the installation related to low voltage.

Finding the culprit
Sulzer engineers thoroughly examined and systematically eliminated every possible failure mode associated with the winding. The stator and rotor coils (Fig. 3) were copied and produced as closely as possible to the original design, so they were not the culprit. As part of the analysis,

Sulzer Service Centers in the United Kingdom
Sulzer is a leading independent service provider for large rotating equipment around the world. With technically advanced and innovative service and maintenance support solutions, Sulzer provides a turnkey service that provides its customers with the peace of mind to focus on their core operations. Sulzer service centers cooperate very intensively. Customers of the Sulzer Service Centers benefit from the highly efficient and dependable high-voltage coil manufacturing and supply service from the Birmingham Service Center, UK. It is recognized for producing high-quality coils for high-voltage motors and generators. These are designed, manufactured and shipped by a highly skilled and dedicated team to ensure fast and reliable service.

Due to the breadth and depth of the UK Service Center network, customers can receive fast and expert electromechanical services regardless of their location. With large field service teams coupled with comprehensive workshop facilities, Sulzer Electro Mechanical Services can meet even the most stringent of customer requirements at any time of day or night.

Ross Barraclough, Regional Operations Director (North) at Sulzer Electro Mechanical Services
the automatic voltage regulator (AVR) was sent by Sulzer to the local UK agent for testing. Although it was not possible to carry out the tests under load, the unit passed the tests that were performed, and it delivered the correct performance. Not being able to fully load test the generator/AVR combination outside of the vessel itself, the AVR remained the most probable cause of the failures.

**Implementing and spreading the solution**

At the same time, Sulzer engineers inspected and tested the electrical control system, including the switchgear, and found it to be within the manufacturing tolerances. This continued to indicate that the automatic voltage regulator (AVR) was, in some way, responsible for the failure. Further investigations were carried out using the drawings and operating manuals provided by the customer. Sulzer engineers studied the original AVR manual: It specified a minimum field resistance of 9Ω, which conflicted with the onboard installation value of 6.753Ω. Operating below the indicated resistance, the AVR had the potential to become unstable and fall below optimum performance.

To resolve this situation, Sulzer provided 2.2Ω resistors that could be fitted in line with the DC exciter field. During the commissioning of the newly repaired exciter pack, the AVR manufacturer sent an engineer to supervise the installation. This engineer confirmed that the shaft generator displayed excellent voltage control. Another conclusion from the investigation related to the overcurrent protection offered by the AVR. At the time of the failure, this protection was not being utilized. Sulzer engineers recommended using the overcurrent protection and several other safeguards on all generators of the company’s ships to prevent similar failures in the future.

All marine vessels need to minimize their time in the harbor, and Sulzer worked closely with all of the stakeholders to deliver a reliable and long-term solution within the shortest time frame. The customer was pleased with the overall project conclusion. Once the ship was back at sea, the ship’s chief-engineer placed a separate order with the Sulzer service center to cover further electrical maintenance.
Sulzer Chemtech, a market leader in separation and mixing technology, and SGL Group, a leading global manufacturer of carbon-made products, are joining forces. The companies are expanding their cooperation in the field of column internals based on SGL’s carbon fiber composite materials (CFC), which go by the brand name SIGRABOND®.

When do carbon and graphite products come into use? They are utilized whenever other materials such as steel, aluminum, copper or plastic fail due to material properties like, for example, temperature and corrosion resistance. The CFC structured packing has already been marketed successfully under the Sulzer brand name MellaCarbon™. The existing CFC column internals portfolio – mainly support systems – has now been expanded with liquid distributors, collectors and feed pipes made of SIGRABOND®.

In recent months, more than 30 new CFC liquid distributors have been designed, manufactured and successfully commissioned for industrial applications – often with the associated MellaCarbon™ packings, support grids and feed tubes. This is the first time that a complete family of CFC-based column internals has been made available to customers of the cooperation partners worldwide. The often-difficult combination of materials, especially for corrosive applications, is no longer necessary.

The new column internals are as corrosion resistant as graphite liquid distributors used to date, they are lighter, stronger, stiffer, more rigid and more temperature resistant than plastics. Also, they cost less than special metals. An innovative connection system enables the realization of larger diameters and allows cost-efficient production.

Ralph Spuller, SGL Project Manager for the cooperation project
Doubled capacity of high-voltage test-bed at Falkirk Service Center

Performance testing of high-voltage motors and generators is usually carried out to determine benchmark data following a major repair. However, increasingly, customers are requiring this information as part of a problem diagnosis or to verify performance figures for a component when its essential data has been lost. To keep up with growing demand, Sulzer has made a major investment at its Falkirk Service Center, UK, that will allow the test-bed load capacity to be doubled.

Until now, the Falkirk site has used a 1'250 kVA diesel generator that operates through two step-up transformers to provide 3.3 – 11 kV via high voltage switchgear to the test cell. This setup ensures a reliable power source for testing that is not affected by local demand on the power grid.

The new investment by Sulzer will add a 2'000 kVA and a 700 kVA generator to the site that will be synchronized through a 4'000 A LV switchboard, as well as a new 2'500 kVA transformer, that will double the capacity of the test bed.

The test area is equipped with the latest monitoring controls and safety equipment that provide the test engineers with remote visualizations of the sensor readings. A customer viewing area is also available, from where owners of equipment can watch to ensure that the entire process is transparent and straightforward.

The original capacity of the service center was 1'000 kW in load testing, of which 800 kW could be used for testing vertically oriented motors, across a full range of voltages from 400 V up to 11 kV at both 50 and 60 Hz. The installation of the new equipment will increase the load testing capacity to 2'000 kW for horizontally oriented motors, as well an increase in voltage to 13.8 kV. The majority of the equipment tested in the additional capacity will be large, high-voltage, AC motors, but the possibility to test DC motors up to 600 V, with a loading up to 800 amps will still remain.

Furthermore, an additional test-bed area is now in place to allow multiple motors to be tested alongside each other. This means that if the testing of one motor needs to be extended, it will not hold up other projects. The new test-bed offers customers the possibility of load testing generators using a slave motor to turn the generator and connecting the output to a load bank. In this way, generators that have undergone major repairs can be tested to ensure that they are fit for purpose before they are reinstalled and recommissioned.

Marc Stuart, Falkirk, Great Britain
Sulzer acquired JWC – a leading supplier of wastewater equipment

Sulzer acquired JWC Environmental, LLC (“JWC”). JWC is a leading provider of solids reduction and removal products such as grinders, screens, and dissolved air flotation system for municipal, industrial and commercial wastewater applications. The acquisition strengthens Sulzer’s wastewater treatment offering through complementary equipment and improves its access to the key US municipal wastewater treatment market. The enterprise value is USD 215 million.

JWC, headquartered in Santa Ana, California, US, achieved revenues of USD 82 million in 2017. The company generates the vast majority of its revenues in North America with a growing presence in other world areas. The company employs around 230 people. JWC operates the main manufacturing site at its headquarters and three smaller assembling sites in Burnaby (Canada), Congleton (UK) and Hangzhou (China).

JWC is known for highly engineered, mission-critical grinding and solids separation equipment that protects and ensures the efficient operation of key downstream equipment such as pumps. The company has a fast-growing and recurring aftermarket business that provides a complete offering of parts and services to a large installed base that has been built up over the last 45 years. The transaction allows Sulzer to grow its wastewater treatment offering through complementary equipment as well as to improve its access to the municipal and industrial wastewater market in North America.
A single mixing tip — MIXPAC™ T-Mixer Colibri plus

The T-Mixer Colibri plus is a mixing tip with integrated 360° rotation and up to 180° bendability. It mixes and precisely applies multicomponent dental materials. It can be used for four different applications: reconstruction with root post and core buildup, impressions of root canal, cementation of root posts and post cores, and impression-taking of preparations and cavities.

For all these applications, dentists need now only a single mixing tip: the T-Mixer Colibri plus. Until now, the mixing tip was only available for smaller cartridges (2.5–10 ml). The flexible T-Mixer Colibri plus works with cartridges from 18–75 ml. The proven advantages of the mixing technology of the T-Mixer™ are now combined with the advantages of the bendable Colibri™ application cannula, which is made from medical stainless steel. The Colibri mixing tip allows dentists to work fast, ergonomically and in a highly professional manner on areas that are difficult to access. They save time, too, because there is no need to change the tip. Even bent, the Colibri mixer has a consistent inner diameter, resulting in consistent and homogenous dispensing results.

Sulzer continues to fight plagiarism for the benefit of both patients and dentists. “Thanks to our information campaign, dentists and medical buyers are increasingly becoming aware of the risks and drawbacks associated with using copied products,” explains Daniel Ferrari, Senior Head Business Segment Dental at Sulzer. He adds, “This not only concerns the safety of patients but also that of the dentist. It does not pay to jeopardize one’s reputation for such marginal savings.” Recently, Sulzer obtained a court ruling against eleven companies. The ruling stated that certain colored dental mixing tips infringed Sulzer’s trademarks. A label in the protected Sulzer “Candy Colors” is intended to further simplify the recognizability of the originals.

Mariella Devrient, Haag, Switzerland
Upcoming events in 2018

Sulzer takes part in numerous events, exhibitions and conferences. Just check our event calendar to stay tuned. Use the new calendar export function to add the events that are interesting to you into your personal calendar.

For more details please visit www.sulzer.com/events

Contest for new subscribers

If you sign up by April 15, 2018, you will automatically be entered in our drawing to win an Apple Watch Nike+ (Series 3, GPS). The winner will be randomly selected and informed by e-mail on April 17, 2018.

Sign up under www.sulzer.com/str-newsletter

Terms and conditions
The prize is an Apple Watch Nike+ (Series 3, GPS). The winner will be chosen randomly from all participants who subscribe to the STR newsletter between November 16, 2017, and April 15, 2018. The winner agrees to have his/her name published in the next Sulzer Technical Review. There is no written information about the contest. Limit one entry per person. Sulzer employees and their family members are excluded and cannot participate in the contest. Exclusive place of jurisdiction is Winterthur, Switzerland.

Newsticker

+ + + In 2017, Sulzer’s order intake grew by 2 % organically and 12 % including acquisitions. Sales increased by 5 % on acquisitions. + + + The GEKA mascara brush burlesqueBEAUTY won the Innovation Tree award at the MakeUp exhibition in Los Angeles in February 2018. + + + Sulzer will expand GEKA site in Bechhofen, DE, and will generate more than 250 new jobs. + + + Awarded for the fifth time: T-Mixer of Sulzer Mixpac won the Best-Value Product Award from the independent testing institute The Dental Advisor. + + +