The shipping organisation IMO and the EU obligate ship operators to use fuels with a maximum sulphur content of 0.1 percent in the Baltic Sea starting 2015. Today, that would affect up to 2,200 ships per day. On the global level, the emission standards will also become much stricter by 2020. Liquid natural gas (LNG) is considered a more environmentally compatible fuel of the future in the shipping industry. The LNG specialists from Marine Service and the RS coupling experts have jointly developed a highly flexible solution to enable ships to switch over to LNG as a fuel.
1 The starting situation

Marine Service GmbH, a Hamburg engineering office, has been implementing projects for the use of liquid natural gas (LNG, Liquefied Natural Gas) as a ship fuel for many years. In 2010, Marine Service developed an innovative concept for using LNG based on a tank container.

The key to the feasibility of this proposal was the connection between the container and the on-board pipework and fittings. It required a coupling system that is safe, easy to operate and handle which could cope with the extreme requirements of the cryogenic medium in the maritime environment. Up to then, no such solution existed anywhere in the world.

This is where RS came on board as a coupling expert.

Safety

Safety and LNG

LNG is stored at temperatures of -165 °C. If it escapes into the atmosphere, people and the environment are at risk. Furthermore, chilled LNG poses a danger to the ship’s hull. If it touches steel, the steel immediately becomes brittle. Crack formation in steel hulls is the consequence. Therefore, strict safety regulations apply to handling cryogenic media such as LNG.

2 The challenge

Marine Service commissioned RS with the development of the connector systems for the planned LNG tank container – a decisive aspect of the overall project. The requirement was for a flexible connection offering the same level of safety as a fixed pipe fuel line. As the process coupling, it had to be designed for a continuous, one-week fuel flow and to handle the extremely high requirements of the cryogenic temperature range. After all, LNG is loaded and stored at temperatures as low as -165°C; the coupling was tested at -200 °C.

A coupling for cryogenic temperatures

Cryogenic temperatures are a genuine challenge for the mechanical properties of the coupling system. Safe handling of the low-temperature LNG requires that all coupling processes and the opening and closing of the flow cross-section function absolutely reliably at all times. To accomplish this, the material selection and the design have to be perfectly matched to a temperature range of between -200 °C and 60 °C.

In particular, the sealing system in the coupling had to meet the strictest requirements of the cryogenic application since only minimal leaks are permissible in this area. The previous RS seals based on elastomer O-rings were not suitable. At -165° C, they lose their elasticity and no longer perform any sealing function. So a material with outstanding thermal and mechanical properties in the cryogenic temperature range had to be found.

Environment

LNG as ship’s fuel

Compared to previously used heavy fuel oils, the combustion of LNG creates a considerably lower emission of pollutants and CO₂.

In view of stricter environmental provisions and rising heavy fuel oil prices, LNG is considered as the fuel of the future in the shipping industry. Studies assume that LNG use in shipping will increase massively on a global scale up to 2020.
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3 The solution
To meet this range of requirements, RS cooperated closely with Marine Service to develop an innovative coupling system specifically for low temperature applications – the TCC series. The innovation turned conventional hose lines into an extremely safe transfer system for cryogenic media.

The dry disconnect coupling: The heart of the transfer system
The TCC dry disconnect coupling is at the heart of the LNG transfer system. It must connect the tank container securely to the LNG line throughout the fi lling and unloading process, guaranteeing an optimum media fi ow rate. In addition, extreme requirements regarding manufacturing processes, such as tolerance and dimensional stability had to be met. RS managed to do that by using high-precision lathing technology, methods for surface fnishing and special low-temperature materials. Cost-eff ectiveness, performance and user-friendliness of the TCC dry disconnect coupling were ensured at the same time. This was made possible by technical characteristics such as low-optimised coupling geometry, freedom from icing and excellent ergonomics.

The breakaway coupling: Security against overloading
One risk factor of the system was handling the transfer line. Unwanted product leakage had to be excluded here. To maximise mechanical safety, RS integrated an emergency breakaway function into the dry disconnect coupling. For example, if an LNG tank container that is still connected to the ship by the transfer line is lifted off by the crane, the emergency breakaway coupling is automatically activated. Before the transfer line can fall off, it is disconnected at a defined point. The non-return valves immediately close the fi ow cross-section. The product leakage is prevented and all other components are protected from damage.

The hose line: An intelligent connection
Naturally, the hose line itself was a key component in the development of the LNG transfer. In this case, RS used a twin-walled, vacuum-insulated metal hose. This guarantees the best insulation and uncompromising safety.

The TCC series provides maximum safety and performance from -200 °C to 80 °C.

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The design: Durable and robust for the high seas
The especially robust structure of the TCC series was designed for a maintenance interval of 2.5 years. As a consequence, it complies with the requirements that apply to commercial shipping operations on the high seas and the associated harsh handling and weather conditions.

At a glance
- The TCC series offers a choice of breakaway couplings, enabling safe operation for all low-temperature applications down to -200 °C.
- Simple handling, good ergonomics
- A constantly monitored vacuum between the exterior hose cover and the medium-carrying interior hose insulates it perfectly. If the interior or exterior hose is damaged, the vacuum immediately collapses. The electronic monitoring instantly detects the collapse of the vacuum and triggers an alarm. Due to the twin-walled structure of the transfer system, the automatically detected damage can be rectified before it leads to product leakage.

Find out more here
4 The result

From the cooperation of Marine Service and RS arose an innovative overall design for LNG supply for the shipping industry - upgradeable, flexible and safe. RS is expanding its portfolio with the TCC series for cryogenic application areas. And it is not merely this project that stands to gain. With the novel coupling system, RS is setting new standards in all fields of application that involve cryogenic fluids.

5 The outlook

Consumption of LNG will continue to grow. This will open up new potential applications for the TCC coupling system. Future applications for instance lie in energy generation on power barges and external power generation on ferries. Another field of application is loading LNG. RS developed the TC series specifically for these requirements. From vehicle refuelling through to rail tank wagon loading and all the way to ship loading, the TC series optimises the loading process.

Apart from LNG, the TC system can also be expanded to include all technical gases. As a result, RS provides ideal solutions for handling liquid oxygen, nitrogen or argon.
At a glance
The complete RS product range