A NEW ELECTRIC CURRENT TRANSFER SYSTEM

From sliding to rolling contacts for POD-Drive propulsion

IMC Corporate Licensing and Mersen have developed a revolution in electrical power transfer by changing from sliding to rolling contacts, or from slip rings with brushes to an electrical rolling system. On the MT Kratos, the existing slip ring assembly for the power supply of an Azipod thruster was replaced by this new rolling contact system. The system requires less space and maintenance, while increasing efficiency and reducing losses in the transmission of current to the drive motor.

Slip rings with brushes are used to transfer electricity from a rotating device to a stationary device or the other way around. Since the advent and application of electrical systems in the nineteenth century, uncountable numbers of applications have been fitted with slip ring systems. In electric motors and generators, rotating cranes, cars, ships, trains, planes, wind power systems, domestic equipment, and so on; in short, you find slip rings and brushes everywhere.

Although widely used, there are two important disadvantages:

- Wear: As an intrinsic consequence of sliding surfaces, wear will occur on the brushes, requiring regular cleaning and replacement.
- Stand-still problems: When under current load conditions, brushes remain in the same position for longer periods of time. As such, the brushes tend to increase resistivity, creating higher and higher losses and temperature rise. In the worst case, the system will get overheated and will suffer damage.

With increasing electrification worldwide, including in the marine and offshore industry, IMC started the development of rolling surfaces as an alternative to sliding surfaces for the transport of an electric current between a stationary and a rotating system.

To speed up the development, IMC Corporate Licensing, a Dutch innovative engineering company, and Mersen, a major international manufacturer of slip ring and brush assemblies and similar equipment, started a cooperation to develop such a system for the marine market. This solution was tested intensely in the lab under various conditions and now, it is available for the market. Early 2024, the first so-called Rolling Contacts (RoCo) unit has been successfully mounted on an inland tanker, the Kratos, to replace an existing slip ring assembly in powering the rotating pod drive under the ship. It has been in operation since then without any problems.

IMC has licensed this Rolling Contacts technology (via Rotelcon BV) to the international company Mersen.

Development route with ups and downs

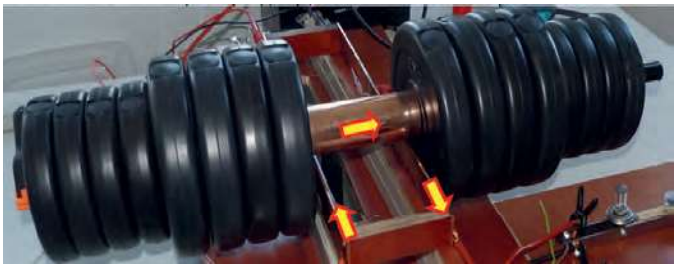
Although the main route in rotating electrical contacts is formed by sliding contacts, there are also examples of rolling contacts, the most well-known are electrical trains. The electricity is first sup-

Photo: On the MT Kratos, the existing slip ring assembly for the power supply of an Azipod thruster was replaced by a rolling contact system (photo Vario Shipping).

plied by overhead lines to the sliding pantograph of the train, next the electricity is "used" in the train to drive the motors and returned to the rail track, but now by using rolling wheel contacts.
This rolling contact is again a proven solution, used only in this specific combination with high contact pressure on the wheels of trains. When these wheels roll regularly over the rails, a shiny surface is achieved, which enables excellent electricity transfer.

Investigating high pressure rolling contacts

Observing this electrical transfer, the basic concept was born using rolling contacts with high pressure. IMC has performed various tests with copper and bronze material to investigate and optimise this rolling performance. As a first prototype, two parallel copper rails where used (one for power input and the other for power output) and a transverse crossing rolling copper pipe with on either side heavy loads, see below.

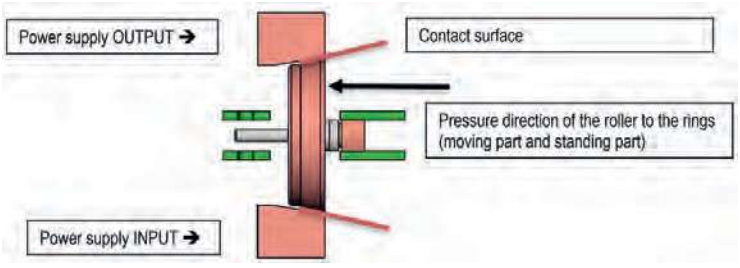


Picture of first prototype with rolling contacts with high pressure and current flow by arrows.

These tests disclosed an interesting phenomenon; that even with small contact surfaces (only a thin line of contact between circular wheel and rail), the measured electrical resistance was extremely low. The reached resistance level was much lower than normally found in solid material with the same cross section.

Pressure loaded conical wheels

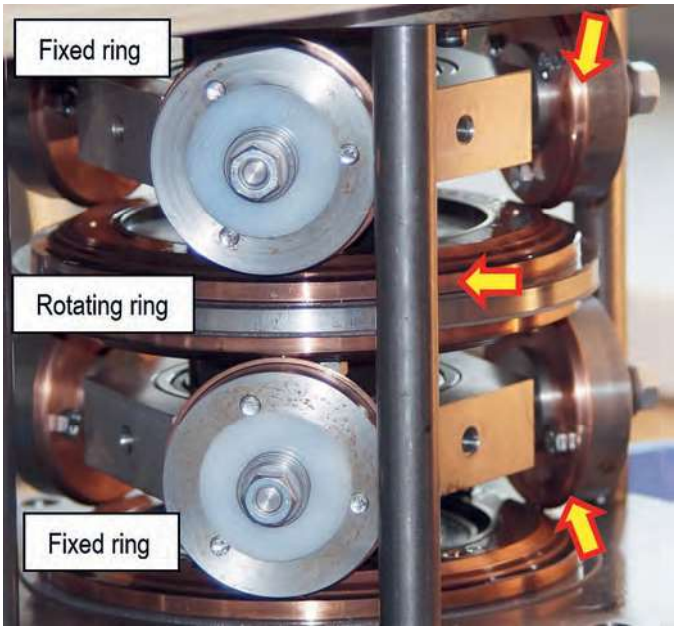
Instead of using gravity forces with heavy weight, Mersen and IMC developed a new rolling setup with conical wheels squeezed between two rings. This enabled a compact and relatively light structure (significantly less heavy than typical slip ring arrangements).



Schematic view of roller in RoCo.

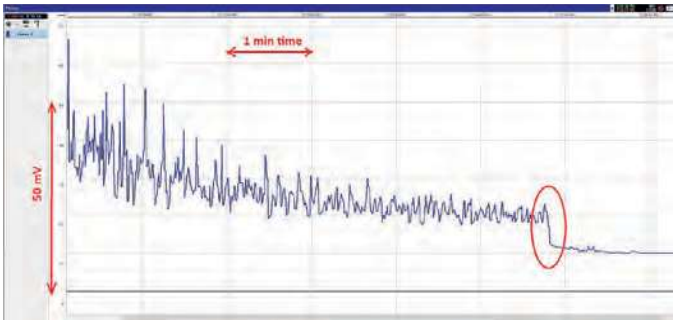
In the configuration of using rolling wheels with special material combinations, Mersen could design a system, which is basically transmitting the current from a stand-still disc, over rollers to a rotating disc without friction. Power is input via the fixed top and bottom ring, the middle ring rotates between the upper and lower rollers and provides the power output via the hollow central bore. The special shape allows a system to transmit the current with just fifty per cent of electrical losses compared to a traditional slip ring. Moreover, without wearing the contact medium.
In addition, the losses are even lower at stand-still application, which is good for the cooling aspect. Due to this phenomenon, the system does not need external cooling even at high power transmission.

Even with small contact surfaces, the measured electrical resistance was extremely low



The second prototype that IMC developed.

One example of the measured voltage drop in the prototype over time with adjusted higher wheel pressure is shown in the graph on the next page, disclosing a sharp drop in resistance after six minutes running (marked by red oval shape) and subsequent lower variation (noise).



IMC measurement with the second prototype; vertical axis voltage drop versus horizontal axis time.

By measuring the resistance compared to the traditional system, the rolling contact system shows fifty up to 75 per cent lower losses. And in standstill, the results are even better. The observed effect is well suited to high power transfer under low movement or even stand-still operation.

Development and prototype testing by Mersen

To develop the system, Mersen has conducted more than ten unit tests over the past three years taking over 10,000 hours in its test laboratories in Austria. The aim was to understand the behaviour of the system over the whole life time. Prolonged in-house duration tests have shown very good results with extremely low resistance and minimal wear: The results of these duration tests are outstanding.
In contrast to slip rings with gradually increasing resistance, the rolling contacts showed gradually decreasing resistance.

Mersen duration prototype test; vertical axis total voltage drop versus horizontal axis time.

Demonstration of RoCo on inland vessel Kratos

Since March 2024, the first RoCo system has been installed on an inland vessel called Kratos with a capacity of 1200 tonnes as a field test. Under this vessel, two outboard POD drives are mounted, see picture above. Current needs to be transferred from the fixed ship's engine room to the freely rotating POD by means of a slip ring or RoCo.
This ship has two separate power installations on each side, with one generator per POD drive and, thus, provides the opportunity to compare both systems directly with each other. The setup maintains one original slip ring on the port side propulsion system, while a RoCo has replaced the other slip ring on the starboard side.
The rolling contacts have been working for nearly one year without any problems and demonstrate this new technology under real conditions.

Outboard V-POD drive.

Original slipring with large vertical cylindrical box.

Power part	4 rolling contact rings	3 phase rings - 880A + 1 ground ring
Hydraulic part for POD cooling/lubrication	6x ½" hydraulic lines	5 hydraulics + 1 suction line
Signal part	230V slip ring, CAN BUS	For a PLC system, 5 channels

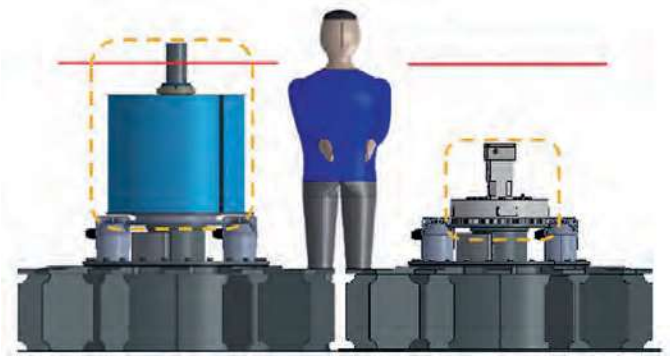
RoCo technical parameters.

New compact RoCo system.

Detailed view of RoCo with at half height the rolling contact box, below the support frame and on top the connector box.

Future newbuilding applications of RoCo

As can be seen above, the demonstration RoCo had to be fitted on an existing frame/lay-out of a slip ring system. This required some modifications and additional installation height below the RoCo.
In case of a dedicated newbuilding, the full advantage of the smaller dimensions can be obtained, see the picture below, showing on the left side a standard slip ring unit and on the right side the compact and lower height RoCo system. The lower installation height



Comparing the size of an inboard rotating electrical connector, left: large original slip ring, right: compact new Mersen RoCo.

also enables mounting of the RoCo on vessels with limited inboard height, like certain navy vessels and luxury yachts.
The RoCo mounted on the inland ship is the first promising step for this new rolling contact in the marine industry to show the advantages of this new system.
Future applications may also include oscillating systems, in situations where prolonged standstill occurs with high current (removes the problem of brush welding), such as in PODs and cranes, Lan connection for ships, high power battery cable connectors at the cable wheel system, single point mooring (SPM) systems for ships and various offshore connections for ships.

Dr.ir. Markus van der Laan
Director of IMC Corporate Licensing, an innovative engineering company active in the marine industry,
mla@imcgroup.nl

Edwin Heemskerk
Sales manager of Mersen, which develops and produces a wide range of electrical components,
edwin.heemskerk@mersen.com