

Permanent magnets offer generation solution

Coupling a permanent magnet shaft generator with a frequency converter can enable vessels to optimise their engine and propeller efficiencies

The need to conserve energy wherever possible in marine applications has affected most areas of marine propulsion, causing more than its fair share of headaches along the way. However, one positive aspect of the requirement to drive down energy consumption has been that it has made shipowners and operators more open to innovation. Shipping can be a somewhat conservative industry, so this has often meant the adoption of technologies that have proved their worth in other sectors first.

A recent example of this sort of technology transfer can be seen in the successful development, test, and now sale, of a permanent magnet (PM) direct-drive marine shaft generator, allowing ships to gain greater efficiency over the entire speed range.

The generator's developer, Finnish company The Switch, has been offering PM solutions in a number of areas for some time, but has only recently branched out into the marine sector. One reason for this, according to the company's sales and marketing director Jussi Vanhanen, is: "When you are holding a hammer, everything looks like a nail." The hammer, in this case, is the PM technology used by The Switch, for which the company saw uses beyond wind energy in the marine sector.

Currently, the largest permanent magnet generators (PMGs) already exceed 10MW in power. The field of application is large, ranging from wind power generation, marine propulsion, and elevators to hybrid cars and much more. PMGs are especially well suited for low speed applications, where asynchronous machines cannot be used as their efficiency and power factor would be far too low.

Traditionally, of course, electric power generation in ships has been carried out by using either separate auxiliary gensets or so-called shaft generators connected to the main engine. Auxiliary gensets typically consist of a constant speed, four-stroke diesel engine equipped with a standard asynchronous or synchronous generator.

The shaft generator has been successfully



Capable of operating in a speed range from 0-100 rpm, the permanent magnet machine has a constant power of 1.5MW (credit: The Switch)

used on board ships for the past 30 years. The main benefit of adding one is the ability to produce electrical power with the main engines. These have lower fuel consumption and run on cheaper heavy fuel oil, thereby significantly reducing the use of auxiliary generators. The downside, however, is that the propulsion machinery can only be run at constant speed.

The other option has been to operate without a shaft generator. In this case, ships continue to take advantage of the main engine's variable speed operation while auxiliary generators produce electricity on board. The downside is that the ship operator pays a premium in higher fuel costs as well as auxiliary generator maintenance costs.

Merchant vessels can now get the best of both worlds by using a solution that combines advanced control with The Switch's PM machine and frequency converter technology. This enables vessels to produce electricity with better efficiency for the entire ship's network, lowers costs by keeping auxiliary generators off, and allows the main engines to operate at variable speed and generate electricity. In total, the solution represents major operational savings for vessels with four-stroke engines and,

in particular, those with two-stroke engines.

PM machines are already being used in electric propulsion, but The Switch is at the forefront of using the technology for shaft generators. The company's experience suggests that the technology can provide unmatched power density, energy efficiency, design flexibility and operational reliability compared with induction machines. Its offering means advanced drive train packages that provide a power source that under most conditions generates cheaper energy than auxiliary diesel generator sets, the company claims.

In late November 2014 in Vaasa, Finland, the first two of four PM shaft generators successfully passed a rigorous bench test. Each machine weighs 18 tonnes without the shaft and features a nominal power of 1.5MW and a speed range of 0 to 100 rpm. Nominal speed is 80 rpm.

"The efficiency performance during testing was an outstanding 97 per cent over the entire speed range, surpassing even our expectations," says Mika Koli, marine business development manager at The Switch. "What is unique about our bench test set-up is that we can immediately do full-power testing to check efficiency across the entire speed range. In fact, we carried

out extremely comprehensive testing to receive certification from Lloyds Register, one of the top authorities in the marine sector. This has really been worth the effort, because we strongly believe this product will be seen on many ships in the near future."

The PM machine has a constant power of 1.5MW between the nominal speed of 80 rpm and 100 rpm. The PMM 1000 direct-drive marine shaft generator is located on the propeller shaft between the prime mover and the propeller. No bearings are required and the generator rotor is connected to the propeller shaft using a shrink disk type coupling. The Switch offers PMM 1000 shaft generators in various power ranges from 0.5MW to 7MW at speeds of up to 100 rpm depending on requirements.

"This is the next big thing in marine," says Mårten Storbacka, managing director of Finland-based WE Tech Solutions. "Over the past three years WE Tech has been developing a complete system solution, together with The Switch and other close suppliers. The main advantage of this technology is that it significantly increases marine energy efficiency. Depending on how you calculate it, fuel savings are approximately 20 to 30 per cent. Since this technology lowers the need for installed power on a ship, energy

generation and weight are reduced significantly, thereby lowering fuel consumption and the need for maintenance."

The first pair in an order for four PM shaft generators is part of a system being delivered by WE Tech Solutions to Wallenius Lines of Sweden. The first four PMM direct-drive marine shaft generators will be delivered to the Wallenius 8000 series of post-Panamax high-efficiency pure car truck carriers (PCTCs) being built in China. The first vessel is due for completion in the last quarter of 2015. Additional orders have been placed by WE Tech for delivery to Terntank Rederi of Denmark and Torvald Klaveness of Norway.

The shaft generator will be delivered with WE Tech's WE Drive variable frequency drive to allow the ship's electrical network to be generated with the same high efficiency throughout the full speed range of the main engine.

Martin von Sydow, vice president for ship design at Wallenius Marine, explains why the decision was made to opt for this technology. "Compared to existing shaft generators, this system offers us increased efficiency and a much greater span in terms of speed range, allowing us to run much more efficiently at variable speeds."

This last point is of particular value

to shipowners. Mr von Sydow says: "The technology is very interesting for us since the variable speed range it makes possible would make slow steaming much more economical."

Clearly, environmental considerations are a key element in the decision-making process. Mr Koli continues: "I think we are really lucky that we are doing this at a time when shipbuilders, owners and operators are receptive to ideas that offer both economic and environmental benefits."

Mr Storbacka is realistic about the likely uptake of this technology, saying: "The marine industry can be conservative and we obviously have a job to do in terms of convincing our potential customers of the value of this solution. We already have one customer for it in Wallenius, but we also have a lot of interest from other areas. We expect this technology to be very successful for us."

One perceived drawback to PM solutions is that the rare earth materials needed to manufacture them tend to be hard to come by and expensive. However, the market has stabilised of late, and The Switch claims that its presence in China means that any potential restrictions in terms of the export of such materials will not affect it. **MP**

Standby power for marine applications

UPS Systems has supplied 25 UPS systems for installation in maritime vessels and offshore installations

Electronic equipment, such as navigation, bridge and communication systems, depends upon a reliable source of uninterruptible power to ensure the safety of marine vessels and offshore installations. UPS Systems plc has a longstanding reputation for supplying marine-approved uninterruptible power supplies (UPS) to the industry, offering technical advice and ensuring critical systems are maintained in the event of mains power loss.

Since 2009, UPS Systems has worked closely with Marine Electrical Installations Ltd (MEI), in Kirkintilloch, Glasgow. Established in 2001, MEI offers comprehensive mechanical and electrical engineering services for a wide range of marine applications, including the new build, refit and refurbishment of offshore oil and gas rigs, cruise ships, ferries and tankers worldwide.

MEI's customer, a global oil and gas company, requested the refit of several UPS onboard part of its oil and gas tanker fleet. UPS Systems provided technical advice and marine-approved equipment

that met the specific requirements of the marine industry. When MEI specified its requirements, several factors had to be taken into account when choosing the right system, including shape, size, weight, and stability during sea conditions.

Providing standby power for computer-based electronic chart display and information systems (ECDIS) was the primary use for the UPS. This vital electronic equipment is used by vessels to provide continuous position and navigational safety information, and alerts personnel to navigational hazards. Position, heading and speed are integrated with electronic navigational charts (ENC) or digital nautical charts (DNC), while radar and automatic identification systems (AIS) may also be interfaced and displayed by ECDIS.

During 2014, UPS Systems supplied MEI with 25 UPS systems for installation in maritime vessels and offshore installations. Each vessel was equipped with three DNV Type Approved Eaton 9130M 1000VA UPS, along with marine electronic noise filters, mounting kits and vibration absorbers.

The UPS were installed aboard several large oil tankers to provide a continuous source of back-up power in the event



During 2014, UPS Systems supplied MEI with 25 UPS systems for installation in maritime vessels (credit: UPS Systems)

of a power failure aboard ship. The systems ensured that essential electronic equipment, particularly the ECDIS navigation systems, remained online and operational at all times.