THE SWITCH

Mika Koli
Key Account Manager/
Business Development

Feel you're in a sinking ship? You're not alone. Multipurpose vessels, especially those that operate primarily at part loads, have been facing immense pressure when it comes to making money in today's grim business environment. Returning to times of cushy profit margins will not happen soon without finding a radically different approach. Using permanent magnet technology for electric propulsion systems is one bold – yet proven – way to save ship owners money due to lower fuel costs, less maintenance and fewer failures.

Advancing drive trains for marine electric propulsion

Sailing on gold by slashing operational costs

A novel approach is needed, especially for multipurpose service vessels that operate primarily at partial load conditions.

As cost pressures mount and environmental regulations become more stringent, the need for a novel and smarter approach is becoming ever more apparent. This is especially the case for multipurpose service vessels that operate primarily at partial load conditions. Instead of just tweaking conventional technology, such as induction motors, to try and invent a better solution, results prove that there's a much better way to save on operational costs.

Using permanent magnet (PM) motors and generators as key elements in advanced drive trains allows ship owners to take advantage of a more flexible, modular, efficient and lightweight propulsion system.

Although new to marine applications, PM technology has in fact been a game changer for many years in other industries, such as wind power, where it ensures the highest energy efficiency and lowest costs of operation. As a bonus, this technology helps future-proof ships when it comes to even the strictest environmental legislation.

PM technology enables ships to lower their operational costs by optimizing fuel consumption through superior efficiency, reliability and design flexibility.

Switch to permanent performance at sea

For electric propulsion, PM technology based solutions are ideal for seafaring vessels, such as ferries, cruise lines, tugboats, offshore, research vessels, icebreakers and more. The technology enables ships to lower their operational costs by optimizing fuel consumption through superior efficiency, reliability and design flexibility.

THE SWITCH

Higher system efficiency

A synchronous PM machine contains Neodymium-Iron-Boron (NdFeB) magnets, which are materials with a very high flux density. This makes them ideal for variable speed motors and generators throughout the entire speed range. The magnet field is created with almost zero rotor losses.

More power

A PM machine gives high-efficiency performance over the entire operating range, significantly cutting back on fuel consumption. The PM machine is typically 2–4% more efficient at full load and 10% more efficient at part load when compared with induction machines. These efficiencies result from a lack of current losses in the rotor, the absence of an exciter, and reduced winding losses.

A PM machine is typically 2–4% more efficient at full load and 10% more efficient at part load.

PM propulsion motors and their inverters efficiently turn available energy into thrust. Although standard induction motors can reach good efficiency in a narrow band around their nominal working area, PM motors are designed to deliver even higher efficiency in a much wider speed and torque range. This is crucial to cutting back on total fuel usage.

Lower fuel consumption

In a recent study of two 1250 kW diesel-electric propulsion trains, PM motors achieved an annual fuel savings of >3% with the same Z-drive thruster. PM motors also make it possible to use an L-drive thruster, which results in fuel savings by an extra >1%, along with length and weight savings thanks to the stacking ability.

Better, adjustable speed control

A frequency converter offers the accurate and adjustable speed control needed for dynamic positioning and demanding load cycles in offshore and special vessels. The high energy density of PM technology and resulting lower rotor inertia are beneficial when the ship needs high maneuverability and a DP class propulsion system. This results in optimum fuel efficiency and lower levels of exhaust.

The high energy density of PM technology results in optimum fuel efficiency and lower levels of exhaust.

Highly pulsating power demand also poses a serious threat to the lifetime of a vessel's engine. The ability to deliver to a combination of short full-power bursts and longer low-power demands is extremely wearing.

To handle highly fluctuating load cycles, guarantee longer engine life, cut back on fuel consumption and reach lower exhaust values, adjustable speed control is ideal. This avoids the low or no-load running of generators, which minimizes engine heat stress, reduces fuel consumption and eliminates undesired start/stop engine cycles.

Reliability

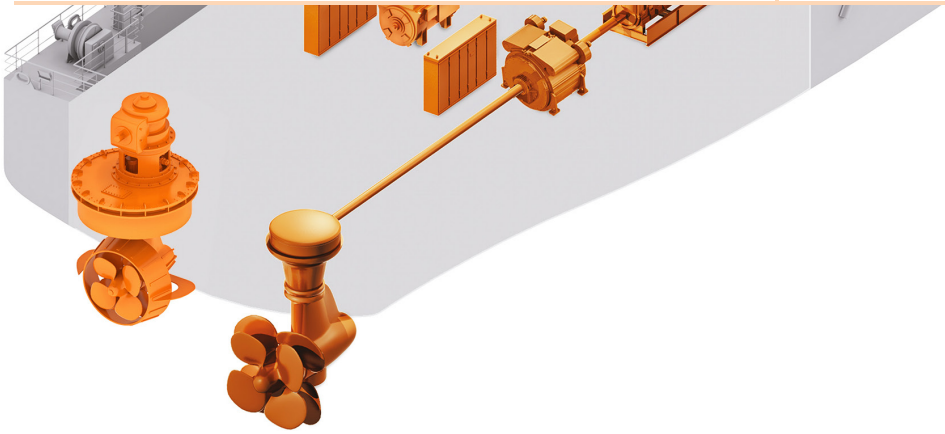
PM machines have proven their high reliability and durability.

PM machines have proven their high reliability and durability under extremely harsh operating conditions in many industrial applications. For example, they have even been used in wind turbines, which operate in a much harsher environment than the challenging marine market.

Fewer failures, less maintenance

In direct propulsion systems, no gearbox or accompanying slip rings and brushes are needed, as with other synchronous machines. Therefore, the PM propulsion line machine experiences fewer failures and requires significantly less maintenance.

THE SWITCH



Modular, design flexibility

PM solutions are compact, with lower weight and volume than conventional drive trains. They offer unsurpassed flexibility and a smaller footprint for all types of configurations, especially when space is a critical factor. Additionally, PM solutions comply with low environmental footprint requirements.

PM solutions are compact, with lower weight and volume than conventional drive trains.

By using a PM generator as part of a genset, significant weight savings can be achieved, and the total length of the genset can be reduced. On the propulsion side, using a PM machine as a propulsion motor combined with an inverter can lead to weight savings and switchboard length reductions.

In all, this radically changes a typically packed machine room into an easily accessible space for machines, crew and maintenance personnel.

Frequency converters

The Switch frequency converters are optimized to work with PM machines for the best overall system efficiency. The electricity produced is of better quality with low flicker, reduced electrical noise emission and THD <1.5%. Additionally, PM drive trains have always demonstrated superior grid connection behavior, even in distributed environments.

PM drive trains have always demonstrated superior grid connection behavior.

The frequency converter features a rugged IP54-class cabinet, which is a higher class to withstand the harsh sea environments. It can be easily accessed for installation and maintenance.

Case 1: Ferries take advantage of modular electric propulsion

In a ferryboat, a technical comparison of a system that uses standard AC-bus converters and air-cooled inverters, motors and generators, and a similar DC-bus setup that relies on PM technology showed powerful results.

The DC-bus setup weighed approximately 61% less than the AC-bus, while component volume was approximately 62% less. Fuel consumption calculation showed a cut back by about 8% when not changing the operation profile of propulsion and generators. By also changing to variable speed operation on the gensets, fuel savings as high as 15-20% could be reached. A system failure mode and effects analysis revealed improved fault ride-through, even if the power management system was off-line.

Fuel savings as high as 15-20% could be reached.

In the end, the comparison affirmed the superiority of the PM-based DC-bus system. The specifications of the PM inverter and machine far exceeded those of the AC-bus setup, proving that the PM-based DC-bus system is much more effective in the marine environment.

THE SWITCH

Case 2: Inland vessels save significant weight and volume

To examine the difference in performance between a standard DC-bus and a compact distributed DC-bus using PM technology, a comparison was carried out on an inland vessel with 2 x 500 kW of propulsion.

The compact DC-bus proved to lower weight by nearly 40% and component volume by almost 63%.

In addition to reducing fuel consumption by approximately 5%, the compact DC-bus proved to lower weight by nearly 40% and component volume by almost 63%. All of which – once again – confirmed the superiority of a PM-based DC-bus setup in the marine environment.

Taking a proven track

In the marine industry, efficiency can be increased in many areas, all with the greater goal of reducing the cost of operations. It is also clear that there is room for improvement in the environmental friendliness of ships.

PM machines have a proven track record of efficiency and environmental friendliness in many demanding industrial applications.

PM machines have a proven track record of efficiency and environmental friendliness in many demanding industrial applications, including marine. They far outperform induction machines. Not only have PM drive trains shown that they lower fuel consumption and provide more power, but they are also proven to last longer and require less maintenance. Additionally, the compactness of PM drive trains leads to significant weight and space savings.

By turning to PM drive trains, players in the marine industry can peacefully push off from shore, knowing that they are sailing on a sea of gold with the most effective propulsion system on the market.