

Permanent magnet shaft generators

— IMPROVE —

vessel energy efficiency

Flexible permanent magnet shaft generators offer superior energy efficiency that enables shipowners and shipyards to futureproof their vessels. Juha-Pekka Kivioja, ABB's Global Product Manager for large motors and generators, takes a closer look at the advantages of this proven technology.

According to the Organization for Economic Cooperation and Development (OECD), ocean shipping carries around 90% of traded goods, with volumes set to triple by 2050. At the same time, shipping accounts for almost 3% of total greenhouse gas (GHG) emissions, which will also triple by 2050 if the industry takes no countermeasures.

It is well established that using the main propulsion engine to produce power for a vessel's electrical network is generally more efficient than running auxiliary gensets. This is accomplished by mounting a generator directly onto the propulsion shaft. To take energy efficiency to the next step the conventional rotor winding arrangements of the shaft generator can be replaced with permanent magnets.

Permanent magnet (PM) shaft generators are smaller, lighter, and easy to install, making them a highly appealing technology for shipbuilders and system integrators. They can be used to equip new vessels to a higher standard or upgrade existing vessels with reasonable time and labour costs, while operators benefit from ongoing savings on fuel and maintenance.

The improved energy efficiency, flexibility and lower emissions help vessels meet current and future environmental regulations. The versatile permanent magnet technology also presents more options for powering a vessel and its equipment.

In addition, it helps ships comply with the International Marine Organisation's Energy Efficiency Design Index (EEDI) and future-proofs them as shipping builds a more sustainable future.

Reducing fuel consumption

A PM shaft generator should cut fuel costs by 3 to 4% immediately, but these figures could be increased by operating the vessel's engine more efficiently. In fact, while the potential energy saving is significant at full load, it could reach as much as 10% at partial load. PM shaft generators offer a much better power-to-weight ratio than induction generators.

A permanent magnet, winding-free rotor also reduces downtime and maintenance costs with its robust construction and fewer components to service. This design has already proven reliable in various applications, especially offshore wind.

Because of the smaller size of PM shaft generators, they require 20% less space than an equivalent induction or electrically excited synchronous generator. They are also between 10 and 30% lighter, making them easier to install on a vessel.

For additional plug-and-play simplicity, ABB has developed a quick installation procedure that is easy to integrate into existing and newly built vessels. ▀



Figure 1 – Permanent magnet generators are more efficient than induction generators at all power levels

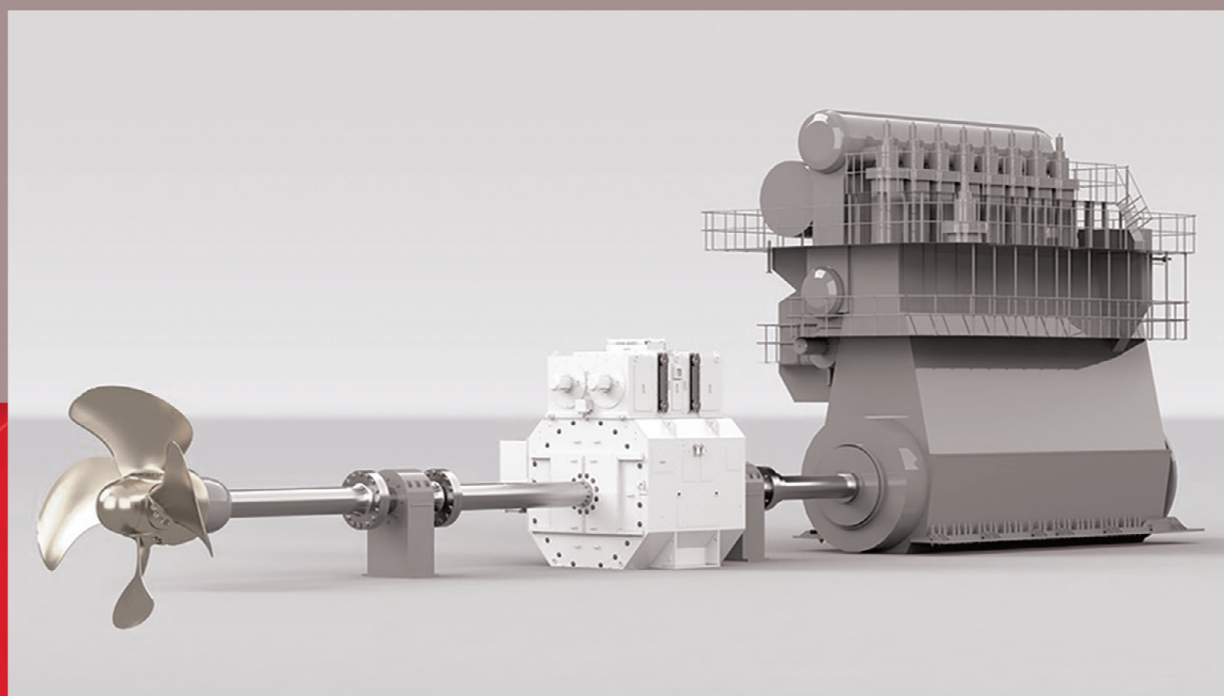


Figure 2 – Permanent magnet shaft generators are small, light, and easy to install

Other benefits of permanent magnet technology

The absence of carbon brushes in permanent magnet generators eliminates the need for frequent replacement, as would be the case in electrically excited synchronous generators. They also reduce the vessel's overall maintenance costs by minimising the need to run auxiliary gensets. Plus, fewer operating hours mean less wear and less servicing – another saving on operating expenditure (OPEX).

Equally, drawing more electrical power from the main engine and its PM shaft generator reduces capital expenditure (CAPEX) on auxiliary genset installations. The support provided by the generator may also enable a lower-powered main engine to provide the required performance.

Variable speed for added efficiency

Previously, shaft generators required the main engine to operate at a constant speed to deliver a fixed frequency to the grid. This is relatively inefficient at partial loads – where vessels spend much of their operating time – as the propeller and engine are less efficient when running at low loads but high rpm. Adding a variable speed drive (VSD) makes it possible to use the most efficient speed/propeller pitch combination.

Because the main engine runs at a more favourable operating point, variable speed operation can achieve fuel savings as high as 40% compared to fixed (direct-on-line) running. This reduces both CO₂ and nitrogen oxide (NO_x) emissions. ABB's PM shaft generators are ideal for running at low rpm: because they are

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engineered for minor magnetisation losses, their efficiency remains high even at low speeds and partial load.

Shaft generators generally offer three operating modes – Power Take Off (PTO), Power Take In (PTI), and Power Take Home (PTH). PTO or generator mode uses the energy-efficient main motor to produce power; PTI covers peak power in situations like heavy weather; while PTH provides redundancy and safety in emergencies.

Vessels with PTH capability can accommodate a battery to enable all-electric operation in port manoeuvres or in sensitive areas where greenhouse gas (GHG) emissions and noise pollution are undesirable.

Latest developments

ABB's newest permanent magnet shaft generator system, the AMZ 1400, will be fitted to a fleet of twelve 210,000 DWT dual-fuelled bulk carriers owned by Bermuda-based Himalaya Shipping. The package includes ABB ACS880 VSDs to optimise the vessels' performance concerning speed variation, bulk freight weight and electrical load.

Besides the features and benefits already discussed, the generators include a built-in water jacket and heat exchanger. This enables

the most effective cooling method and reduces the generator size needed for the cooling unit. Offering effective and redundant cooling removes heat from the system and the engine room, an aspect crews operating in tropical areas will undoubtedly welcome. It also saves on the expense related to ventilation and air conditioning systems.

Shipyards and owners choosing to upgrade to permanent magnet shaft generators, whether in new builds or retrofits, will find the installation procedure straightforward and economical. An innovative yet simple five-step assembly and installation procedure, plus the generator's compact dimensions and low weight, guarantees easy installation.

The IMO's goal is to reduce international shipping's total annual GHG emissions by at least 50% by 2050 (compared to 2008). The organisation tightens requirements every five years to achieve this and promote continued technical development. Ship owners and operators investing in permanent magnet shaft generator technology will take a significant step toward reaching this target. ■

For further information, visit:
www.abb.com/motorsgenerators/permanent-magnet-shaft-generator