



12

Low voltage motors

With vessels required to meet **increasingly stringent international regulations** on emissions and energy efficiency, **LV motors can make an important difference**, explains **Jukka Hannuksela**, ABB's global standards and certification manager

In 2014, the International Maritime Organization published the Third IMO Greenhouse Gas Study, produced by its Marine Environment Protection Committee (MEPC). According to the study, international commercial shipping emitted just less than 800 million tonnes of CO₂ in 2012 – around 2% of total global CO₂ emissions that year. Although this is a very small percentage of the world's total emissions, the IMO has recognised that the shipping industry needs improved energy efficiency and effective emission controls if sea transport is to meet its environmental responsibilities as it expands along with growing global trade.

In response, the IMO is introducing progressively tighter restrictions on ships' emissions. Its 'Regulations on energy efficiency for ships' came into force in 2013 and apply to all ships of 400 gross tonnage and above.

The Energy Efficiency Design Index (EEDI) is mandatory for new ships and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. By 2020, up to 200m tons of annual CO₂ reductions are estimated from the introduction of the EEDI for new ships and the SEEMP for all ships in operation, a figure that, by 2030, will increase to 420m tonnes annually.

Furthermore, in October 2016 the MEPC approved a roadmap for developing a

comprehensive IMO strategy on the reduction of greenhouse gas emissions from ships – which foresees an initial reduction strategy to be adopted in 2018.

In Europe, the emissions from maritime shipping became legally subject to the new International Convention for the Prevention of Pollution from Ships (MARPOL) directives in January 2015, with Europe's Sulphur Emission Controlled Area zone increased in size to include the North Sea, Scandinavia and some parts of the English Channel. This area will include all the Republic of Ireland's international waters in 2020, making all of Western Europe subject to the MARPOL directive.

One area that offers significant possibilities for improving energy efficiency is the many applications on board a ship that use electric motors, including seawater cooling pumps, chilled water pumps, ballast pumps, thrusters, compressors and engine room ventilation fans. The type of vessel determines which applications and motors have the major electrical loads and are therefore the largest energy consumers.

For a passenger vessel, heating, ventilation and air conditioning represent a significant source of energy consumption, while for a tanker the ballast pumps and crude oil pumps are major energy users.

High-efficiency motors

In recent years, energy-efficient motors have received a boost with the global development of Minimum Energy Performance Standards (MEPS). The MEPS in force in the European Union cover LV motors up to 1,000V from 0.75kW up to 375kW and with two, four or six poles, intended for 50Hz operation. Since this regulation applies only to 50Hz rated motors it is not useful for motors installed on ships.

The latest standard, IEC 60034-30-1, has a wider scope than Regulation 640/2009 as well as limits for 60Hz supply, and could therefore be used for the energy-efficiency classification of motors on ships.

At the start of 2017, the final stage of the EU MEPS scheme was implemented, meaning that all new electric motors must meet the mandatory IE3 efficiency level – or IE2 when operated with a variable speed drive. MEPS with different scopes now cover around 80% of the global LV motors market but the amount of IE3 motors on vessels is unknown.

It might be useful to adopt a true international regulation for ships in order to improve the effect of the EEDI.

In fact, it should be appreciated that the lack of a common marine regulation is a contributory reason for the shipping industry lagging behind, as IE1/IE2 efficiency class motors are still used widely, while many other industries have moved to high/premium efficiency IE3/IE4 motors. Since a motor in a marine application should be expected to last at least 15 to 20 years, depending on its loading and operating environment, this can potentially result in decades of inefficient operation.

Increased reliability

High-efficiency motors are not just about lower energy consumption. They are also more reliable, due to their lower losses. Losses in electric motors are dissipated by heat, vibration and noise.

The mechanical and electrical design of highly efficient motors is optimized, which means lower temperature rises, cooler running, reduced temperatures in stator windings and bearings, and a lower noise level. Cooler running and a reduced stator winding temperature guarantee trouble-free running over the motor's design lifetime, since every increase of 10°C in the stator winding reduces its lifetime by half. On the other hand, reduced bearing temperatures mean longer re-greasing intervals and less maintenance, since every 15°C decrease in bearing temperatures doubles the re-greasing interval.



Hannuksela: Promoting energy efficiency

Many electrical motors used with pumps, fans and compressors are often oversized in order to account for a maximum demand that is seldom needed. They also normally operate at a fixed speed, with their output adjusted by mechanical throttling such as a valve.

The efficiency of these applications can be greatly enhanced by using variable speed drives (VSDs), which adjust the speed of the motors according to demand.

While VSDs offer important benefits, a decision to install them should not be made on a standalone basis, but rather as part of an overall review of the ship's systems as there can be unintended consequences, such as the introduction of harmonics that can disturb sensitive electronic systems.

Important considerations

When it comes to looking at energy-efficient motors there are a few important considerations that need to be highlighted.

First, dimensioning the application properly is key and this includes the selection of the

correct components to enable both the optimum performance of the application and overall savings.

Secondly, it is sometimes perceived that the choice of an IE3 motor or an IE2 motor and drive are interchangeable solutions. But they are not the same. If there is a real need to control the speed then the choice of a VSD is going to be the best solution. If the application does not require speed regulation or control then you should always specify the highest efficiency motor possible in order to achieve the savings available.

Third, when changing to a high-efficiency motor with lower losses and slip it is possible that other modifications to system components, such as the fan, may be needed due to a higher speed, and this will result in a higher input power. It is possible that even a small increase in speed will outweigh the potential energy savings.

And finally, to achieve the full potential of energy-efficiency measures it is vital to ensure the correct maintenance of the motors as well the equipment they drive.

As an example of what can be achieved, ABB worked with Pullmantur Cruises to optimize the energy efficiency of its *Sovereign* luxury cruise liner that weighs in at just under 74,000 tonnes. *Sovereign* has two cooling systems operated by four pumps for its four propulsion engines. Previously, the cooling system pumps unnecessarily functioned at full power whenever the ship was in operation.

An analysis showed significant potential for energy savings if the operation of the pumps was adapted to the actual cooling needs, which only required the pumps to operate at 40% capacity. However, the existing electric motors driving the pumps were incapable of making this adjustment.

ABB installed a new system with high-efficiency electric motors, controlled by VSDs, to drive the pumps in accordance with requirements at any given time. This has resulted in an average saving of 40% – approximately 100,000kWh per annum. This is equivalent to an annual reduction of 50 tonnes of CO₂ emissions, in addition to the reduction in costs associated with lower fuel consumption.

Summary

The shipbuilding industry is not yet accessing the huge potential for energy savings in the many low-voltage motors that drive vital ancillary systems onboard vessels. High-efficiency motors not only save energy and reduce CO₂ emissions, they also offer tangible operational benefits in the form of increased reliability and reduced maintenance needs. ■