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MARITIME ENERGY MANAGEMENT SYSTEM (MARIEMS) II

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Abstract

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There is no standard for the proposed role of the Energy Manager as proposed by the International Maritime Organisation (IMO). The previous project MariEMS (www.mariems.com) was concerned with the development of an energy management job and training specification, primarily for future Energy Managers, specifically for the shipping industry to have a means of continually improving its energy management activities on board their ships with the view to save energy, reduce pollution and to improve the overall quality of energy management in their enterprises. The objective was to develop a specification and training course to train the future Energy Managers how to make more efficient use of energy on board and in their interactions with ports in line with the Energy Management System of ISO 50001 and ISO 19030.

This paper will give an outline of MariEMS project outcomes and will describe how the IMO TTT ship efficiency course material and the materials developed as part of MariEMS are used to review current operations applied in making ships more energy efficient. It contains information on systems such as Wartsila's Eniram and Rolls Royce' monitoring system making special references to the arrangements in place in classification and standards organisations such as ABB for energy management. The paper will also include a review of ship energy monitoring and management with regards to ship types, ship propulsion systems, ship navigation equipment, energy production units, electrical and mechanical parts and circuitry, safety issues, national certification, accreditation and validation of learning materials, pedagogical aspects of learning and last but by no means least online application.

Keywords: Energy, Maritime Transport, Engines, Fuels, Ship Marine Operations, Ship Build, Marine Pollution

1. Introduction

Whilst the first MariEMS paper (Ziarati et al, 2017) concentrated on a training programme for ship energy management system this paper gives an overall vision of how ship builders and operators could use the training programme to increase the application of novel, autonomous and intelligent vessel health management systems viz., to apply the right levels of adaptability and flexibility in the production, improve management and use of energy and electrical power on board marine vessels of all types and drafts.

This technology has enabled higher growth rates in the marine engine management sector as well as the supply chain to successfully respond to the increase in shipping capacity expected by 2030.

In recent years the focus has been on two key issues; i) use of more efficient and less polluting fuels and ii) developing new technology. When commercialised, this technology will provide intelligent management capability that could enable vessels to make significantly faster, more flexible and more cost-effective responses to changes in single shared energy sources and their energy requirements throughout a vessel. It would also provide the means for adaptability to combine energy/power generated from a number of sources.

The MariEMS project funded by the EU ERASMUS + was a collaborative 3-year research project to review the current arrangements with regard to energy management on board vessels. The current arrangements would enable significant improvements in vessel energy usage and operational efficiency, as such they will meet industry challenges and significantly contribute to the strategy for growth for the European marine industries. The main objective, however, was to ensure key competencies for those managing and operating ships are identified and a comprehensive training programme for them is in place. As such it is expected to provide significant cost savings and increase in competitiveness within the marine sector, as a result supporting an important part of Europe's economy.

It will achieve this aim by developing an insight into the data management, information processing and presentation systems directed at improving the vessel and port fault diagnostic as well as prognostic decision-making and management systems that are critical to the overall well-being of the vessel and/or port management. This will be achieved through a comprehensive energy efficiency training programme known as MariEMS.

This project will also build collaboration across the marine sector, between micro, small and large businesses, to improve the viability of the engine management supply chain and create opportunities for smaller businesses to make use of the intelligent systems technology developed in making shipbuilders and operators more energy conscious. It will also enable project partners to make commercial use of their high levels of expertise in voyage energy management and vessel system technologies.

In terms of potential markets, the project outputs will not be limited to individual sections of the marine industry, i.e. they will be applicable to leisure, naval and commercial/merchant marine markets.

It is hoped that more projects will be initiated to make greater use of the A&I-based models that differentiates performance from other systems currently on the market. The crew will be able to assess how much energy is produced and where and how much is used taking into account energy cost and effective delivery expected performance.

Whilst systems such as Wartsila's Eniram, Rolls Royce and C4FF's monitoring system make special references to the arrangements in place, in classification and standards organisations such as ABB for energy management, the research carried out as part of the MariEMS project clearly shows that more can be done in "energy performance management" to provide capability to "optimise voyages for minimum energy usage". This is done by developing and making use of "intelligent decision-support" that could manage vessel energy production and usage performance to enable responsive, adaptable and flexible reactions to changes in energy requirements throughout an entire vessel.

2. An Overview of Ship Energy Prime Movers' Efficiency

Approximately 95% of commercial vessels are powered by diesel engines, and to lesser extent, the auxiliary engines on board to power various systems other than the main propulsion.

Considering that diesel engines are at best 51% efficient, it means that the power available to the tail shaft that moves the propeller is also 51% of the burned energy inside the cylinders of the propulsion engines. The rest of the energy (49%) is lost by conduction, convention and mainly through the exhaust gases emitted into the atmosphere.

Subsequently, from 51% of the energy delivered to the tail shaft, it is only possible to extract approximately 23%, the remaining 28% is lost in the propeller through the friction and incidence losses as well as the water drag on the hull of the ship.

From the above, there are two perfectly defined areas on the ship where improvements could lead to higher efficiency of the ship; these are the hull and the main and auxiliary machinery where improvements could lead to reduced consumption and lower harmful engine emissions. The manufacturers of diesel engines are aware of these improvement areas and various researches are underway to take advantage of some of the heat losses wasted in exhaust gases and where resistant to motion can be reduced. Good examples of these are given in Ziarati's Lecture (Efficient Ship - IMarEST TV, 2017 - https://www.imarest.org/tv).

For auxiliary machinery and lighting it is of great importance that the compressors, fans and pumps work with speed regulators to adapt the power delivered to the electric motors that drive them according to the load rather than a general running condition. Use of LED lamps that have lower power consumption than electric resistance and fluorescent lamps are recommended. In relation to the hull of the vessel, there are multiple improvement measures to reduce fuel consumption, among which are the uses of antifouling paints, cleaning of the hull, bulbs on bow appendages, lubrication air, etc. The energy saving measures on the propeller can be the following: use of more resistant and less heavy materials, use of bow and stern accessories on the propeller, use of nozzles and improvement of the rudders.

During the operation of the ship the energy consumed can be managed more effectively by properly planning the route to follow, the speed of the ship to avoid waiting times in ports, the trim and the ballast of the ship, etc.

All of the above should be of interest to all the people involved, naval engineers, ship owners, merchant seamen, personnel of the port authorities, etc. These are all the measures that exist for improvement of the ship operation efficiency which also will reduce the emission of harmful pollutants.

As an example of application, some of these measures were taken into account in the construction of the passenger ship ILLETAS JET, of Spanish flag, with a polyester resin hull reinforced with fibreglass (FGRP). ILLETAS JET has been designed and adapted to the route that is going to operate, between the islands of Ibiza and Formentera, with the main objective of maximising energy efficiency by complying with the required navigation requirements. The hull has been constructed by the process of lamination by infusion, making the laminate more homogeneous, compact and without air bubbles, with greater resistance. With this procedure, the amount of resin used has been reduced by 30% and a reduction in the weight of the hull by 9.5 tons. What this means is a reduction in the ship's weight of 11% when comparing it with the traditional lamination system means of construction.

It is worth reminding all the operators of the ship's compressors, fans and pumps that these are driven by means of frequency variations to adapt the power consumed to the necessity of each condition and adjust the consumption to the requirements for given running conditions; hence, avoiding having these systems running at 100% of the load when it is not necessary.

The new ship takes account of the above recommendations which has been compared with previous practice. The capacity of load (300 pax) with speed of 27 knots has led to reduction of 18% in fuel consumption translating to a 15 litres for each navigated nautical mile.

3. Recent Example of Efficient Ships

Ferry companies in Baltic use divers to clean ship's hull and propellers in summer time (April- October). For winter months, ice takes care of this but brings new energy efficiency problems as time schedules are tight and ice is hindering the smooth sailing with limited economy speeding. The VIKING GRACE engine powered by 4 x 7,6MW, the newest ferry on route from Turku, Finland to Stockholm, Sweden, was built to use LNG as a fuel, so being already the most energy efficient vessel on that line it also had installed new energy efficiency "Norsepower rotor sail" on her deck. This rotor sail was tested earlier on a ro-ro vessel, ESTRADEN. The Viking Line says that this 25-meter-tall rotor will allow VIKING GRACE to save up to 900 tonnes of fuel annually and the newly built cruise ferry under construction will have two of the Norsepower rotors; does this foreshadow the use of LNG and wind power as means of making ships more energy efficient?

Short interval ferries with several departures and arrivals a day, including turnings, may find good energy efficiency on propellers for open sea sailing. Unfortunately, they lose that good energy efficiency while turning due to long lasting turns. Therefore, there is still plenty of room left for engineering companies to find the most energy efficient solution.

4. Efficient Ship Crews

Captain and officers are having new instruments to monitor and manage their vessels. Optimum trim, shallow water, weather routes and so forth are not only followed onboard many vessels but in companies like Eniram. The system uses substantial amount of information to gather data onboard for monitoring and efficient and safe management of the ship. Due to several tasks onboard most of this data is used efficiently. Due to digitalisation, this information is now transferred to "computer office" which is constantly analysing all data and merging the information from different vessels. For example, it takes exact weather information at certain sea areas and makes recommendations on the most energy efficient route to choose. Following this thought, further are the energy efficient autonomous ships.

5. Authorities and Efficient Shipping

IMO and flag states are setting new rules to make ships more energy efficient. EU MRV (Monitoring, Reporting and Verification) regulation entered into force on 1st July 2015, and it requires ship owners and operators to annually monitor, report and verify CO_2 emissions for vessels larger than 5,000 gross tonnage (GT) calling at any EU and EFTA (Norway and Iceland) port. Data collection takes place on a per voyage basis and starts 1st January 2018. The reported CO_2 emissions, together with additional data, are to be verified by independent certified bodies and sent to a central database managed by the European Maritime Safety Agency (EMSA). The aggregated ship emission and efficiency data will be published by the EC by 30th June 2019 and every consecutive year thereafter.

6. Efficient Ships and Fuel Type

The International Chamber of Shipping recently noted that meeting IMO's goals – a 70% efficiency improvement on average across the fleet, and a total CO_2 reduction by the sector of at least 50% by 2050 regardless of expected growth in maritime trade – can only be achieved with the development of genuine zero CO_2 fuels.

This will require the adoption of 'radical and as yet unproven technologies' including Hydrogen, Methanol and batteries, with LNG or conventional biofuels playing only a transitional role. Development of these new fuels requires co-operation between shipbuilders, engine manufacturers and classification societies, with research into new propulsion systems facilitated by governments within an IMO framework.

Fully battery driven small ferries for 400 passengers are in Norway and for example, renewed research vessel ARANDA, has batteries to execute the research activities when utmost silence is needed using only batteries and not main engines.

Biomethanol is the most attractive choice of the future biofuels, with no SO_x and lower PM emissions than biodiesel and CO_2 emissions are lower than those of LNG. Plenty research projects are starting with new biofuels.

7. Engine manufacturer

M/S HAMMERSHUS, a new 158 meters long, 25 meters wide, having 1500 lane meters car and passenger ferry delivered to Danish operator Mols-Linien. She is the first ship powered by two 8-cylinder Wärtsilä 31 main engines. The ship was built at the Rauma Marine Constructions (RMC) shipyard in Finland and is due to enter into service September 2018. The ferry will sail on Danish waters between Rønne on the island of Bornholm and Køge, and between Rønne and Sassnitz. The selection of this particular engine was based on the efficiency for the required output and also the favourable maintenance intervals it allows, says Flemming Kristensen, Technical Director, Mols-Linien A/S. These Wärtsilä 31 main engines are the first ever ship installations in the world since they were introduced to the market in 2015 and has been recognised by Guinness World Records as being the world's most efficient 4-stroke diesel engine. This efficiency was cited as being a key consideration in the award of this contract to Wärtsilä. Another feature of the Wärtsilä 31 is the modular design that enables a reduction in maintenance requirements and costs. For example, the first major overhaul is scheduled at 32,000 running hours.

8. Conclusion

While the ship engine manufacturers and system developers such as Eniram, Rolls Royce and C4FF are developing intelligent systems to make ships more energy efficient, the role of ship operators and crew in managing these systems effectively and efficiently cannot be overstated. The MariEMS project has identified the key Learning Outcomes and a comprehensive training programme for those in charge of the ship energy efficiency role; a comprehensive training programme for those involved in monitoring and managing the data on board vessels of different size and shape as well as varying degree of complexity. Some 32 modules were drafted and published in MariFuture platform as Development Papers see http://www.marifuture.org/Reports/Development-Papers.aspx. The 32 chapters were transformed into a book available from www.mariems.com.

The work carried out as part of MariEMS is continuing and a new proposal named MariEMS Plus is being developed to continue with the ongoing developments and to include more intelligent system development for ship energy management into consideration.

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on MariFuture, http://www.marifuture.org/Publications/Papers/IAMU_MariEMS.pdf.