sciendo International Conference KNOWLEDGE-BASED ORGANIZATION
Vol. XXVI No 3 2020

NAVAL ENERGY MANAGEMENT SYSTEM

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Abstract: *The paper analyses the role of control and monitoring of electro-energetic equipment in order to reduce operational costs, increase profits and reduce carbon emissions. The role of SCADA and EcoStruxure Power systems is presented and analysed taking into account the energy consumption and its savings. The paper presents practical and modern solutions to reduce energy consumption by up to 53%, mass by up to 47% and increase the life of the equipment by adjusting the electrical parameters. The Integrated Navigation System has allowed an automatic control and an efficient management. For ships, the implementation of an energy efficiency design index and new technologies was required for the GREEN SHIP project.*

Keywords: energy management, electrical energy, integrated system, equipment, navigation

1. Introduction

Full control and monitoring of equipment and electro-energetic naval installations are necessary in order to reduce operational costs for seagoing vessels, smaller crews and to optimize the service of the ship or shipping company. Reducing carbon emissions requires good management of the energy distribution chain, from those that generate to consumers [1,2,3].

From an electromechanical point of view it is considered: the management of alarms and electricity; auxiliary components and liquid management for the main and auxiliary engines; lubrication circuits, ballast, compressed air, fuel and oil, fire fighting pumps, transfer and drainage pumps and technical and sea water management [2,4,5]. The cooling fans in the engine room and the seawater and technical water pumps are oversized and always operate at maximum power, resulting in energy losses. Limiting the operation to maximum power for very short periods allows us to reduce emissions, to comply with ISO50001 regulations and to achieve "safer, more secure and efficient transportation on cleaner oceans" [6,7].

Power distribution solutions allow the connection and integration of control systems, alarms, monitoring and energy management on board. Surveillance can be performed at the deck level, by a SCADA system, based on redundant Vijeo Citect and Magelis tactile panels, a solution that maximizes the reliability of the ships and the efficiency of the crew in order to increase

DOI: 10.2478/kbo-2020-0109

availability and for faster response times. The Central Command Point (CCP) and the Compact Local Points(CLP) achieve an efficient and optimized system of electricity for generators and allow a 20% energy saving [8,9].

The EcoStruxure Power system is built in three architectures that can be combined, is easy to install, configure and use, allows the complete monitoring of the electrical consumption of the ship and is based on three directions [13]: Measurement - a complete range of energy meters, MT protection networks and circuit breakers connected to measure the electrical parameters of the electrical installations; Data collection - with the Enerlin'X communication system, the data is taken from the metering devices and displayed and stored; Display, analysis and access to data - it is done, locally and remotely, in real time allowing the estimation of the power supply, consumption and energy saving potential [1,10,11].

The quality and availability of electricity supply are essential in the maritime and offshore fields, where any interruption of electricity endangers the safety of processes [12,13]. The use of Uninterruptible Power Supplies (UPS), tailored to marine standards, are designed to provide a safe, secure power supply for the maritime industry. There are standardized products, ranging from 1 to 200 kVA [12,14].

An innovative solution for the transport and distribution of energy are the collector bars placed in a protective housing, a system that is flexible and compact, offers space saving, installs quickly, without interrupting the supply. This solution allows the determination of the flammable load of an insulation material or its resistance to wear during installation, saving on materials costs, installation and maintenance, while maintaining low energy consumption costs. This system meets industry standards, can be disassembled, reused and recycled, has an extended service life, has superior mechanical strength, low resistance to contact and voltage drop, simple installation and maintenance, quick implementation and is safe, reliable, durable, no emissions of smoke or toxic gases in case of fire [8,12].

The distribution of medium voltage electrical energy can be achieved through one or two ring loops instead of the low voltage radial distribution. This generates a reduction of up to 30% of the costs with investments, a reduction of up to 35% of the losses of electricity, a reduction of the mass by 47% with regard to the design of low voltage, optimized imprint of the main control panel of medium voltage, easy separation of the feeder, quick installation, including fast cable connections.

As the utilization of the installed power increases, the distribution of electricity requires the switch to the medium voltage design, which allows a much higher installed power, limiting the high short-circuit current and the related power fuses, reducing the peak current of the circuit up to 30% - 40%, achieving guaranteed and complete coordination of the circuit breaker.

The new structure of reliable energy management and electrical distribution includes electric current transformers, low and medium voltage control units, low voltage circuit breakers, bypass protection relays, isolation monitoring devices, electricity management systems [13, 15,16]. The large number of electronic components on board ships can create harmonic distortions, and this affects the components of the system but provides many benefits for the control related to processes and energy savings.

There are active harmonic filters that provide a 3% reduction in harmonic distortion - AccuSine PCS + is a flexible, high performance, cost effective solution for stabilizing electrical networks, offering harmonic reduction, power factor correction

and load balancing. Harmonic reduction, power factor correction and the balance of the network current allow a cascade operation of units arranged in parallel for temporal equalization of units arranged in parallel for longer service life, complete control, parameter adjustments and diagnostics.

2. Equipment used in the navigation bridge

An integrated navigation system is designed to perform navigation functions (planning and monitoring the voyage / route of the ship; conning the ship; performing internal and external communications; (avoiding collision at sea), controlling and managing (controlling navigation information and displaying data; management of alerts on board; monitoring of equipment; loading and unloading of the ship) [17,18,19].

The navigation information control module ensures the presentation of information for manual and automatic control of the ship on the planned route, with the presentation and use of external safety messages.

An integrated navigation bridge consists of the following components: ECDIS monitors (ensures the display of electronic maps on which navigation is monitored and navigation information is presented); conning monitor (summing up the functions needed to govern the ship - the connection block of the ship's driving data - time, position of the ship, longitude, latitude, true path, road above the bottom, speed through water, speed above the bottom, depth of water under the keel, distance traveled, drift, wind, water current, tide, rudder angle, number of propeller rotations, bearing; receivers, satellite navigation systems; the AIS monitor (ensures the presentation of static and dynamic information regarding the targets within the radius of visibility); the GMDSS console (provides communications within the global maritime safety system in case of danger); VHF radio link console; ship's lights console; radar monitors (provides radar surveillance and the necessary information for avoiding collision; ultrasound probe indicators, Doppler lock; number indicator) propeller rotations; rudder angle indicator; gyro repeater; the navigation stopwatch and the clock.

3. Improving the energy efficiency of ships

In order to reduce gas emissions on board ships, and to obtain the Green Passport, the Energy Efficiency Design Index (EEDI)was made mandatory for all new ships.Several measures have already been taken in the form of new technologies, which are also reflected in the projects of new ships, so that ship owners can ensure from the beginning that the energy efficiency design index, is fulfilled .[20].

From a technical point of view, this approach has created "greener" ships, by adopting measures at the design level as well as at the operational level. This reduction in fuel consumption and carbon dioxide emissions could be achieved through the use of alternative fuels, such as Liquefied Petroleum Gas (LPG), which is one of the methods that can safely lead to the ultimate goal, the achievement of a GREEN SHIP.

Technologies that can be used to obtain a Green Ship of the future [1,8,9,10].

- Without ballast system. The ballast water convention focuses on reducing the transit of sediments and micro-organisms from one marine territory to another.

Figure 1 shows a design for the ship's ballast system that allows the blocking of organisms that are moved from one side to the other and the termination of all requirements for costly ballast equipment, as costs, such as sterilization installations, filters, ultraviolet installations, or other technologies. This system creates a constant flow of seawater through a network of tunnels, which moves from the bow to the stern of the ship, below

the waterline, thus reducing the potential for moving a quantity of water from one place to another. In addition, it could be a huge economic gain by producing capital savings with a net cost of about $ 540,000 per ship.

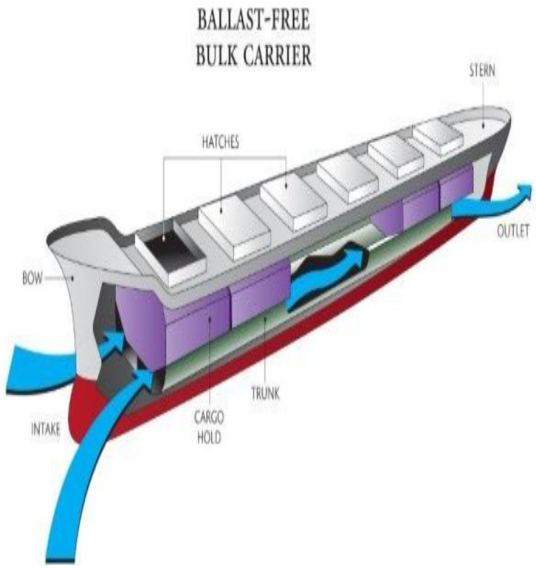

Figure 1: Ship without ballast

-LNG used as propellant fuel and auxiliary engines. Liquefied **P**etroleum **G**as is the fuel of the future in the shipping industry. Gaseous fuel helps reduce air pollution in ships, and a combination of LNG and diesel fuel will lead to outstanding performance in terms of efficiency of the main engine, with direct results in savings regarding the costs generated by the purchase of fuel. Two of the most famous methods are: Q-Flex and TFDE LNG. Advantages: gas-powered ships have many automations; they have two electric propulsion engines that take up little space and are light; almost "zero" maintenance for electric motors compared to main diesel engines.

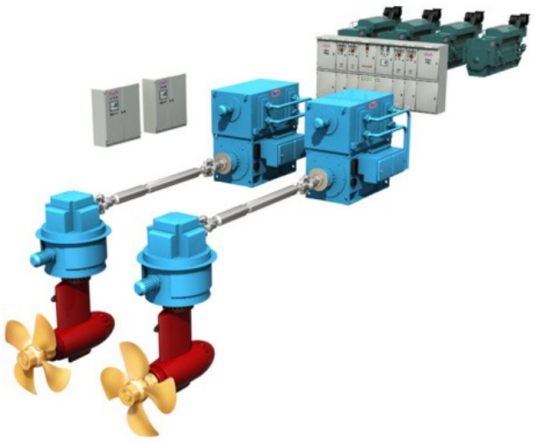

Figure 2: Propulsion engines with LNG fuel

- Sulf Scrubber Sistem. By installing an exhaust gas, exhaust system in which the sulfur emitted by the exhaust from the main engine is washed after leaving the engine exhaust, resulting in a reduction of SOx of up to 98%. At the same time, other harmful particles are reduced.

-Advanced rudder and propeller system with speed nozzle. A well-designed power train and a well-proportioned rudder system can reduce fuel consumption by up to 9%, resulting in a lower emission of pollutants. Advanced propeller and rudder system models have been developed to not only reduce fuel consumption, but also improve the ship's propulsion system.

-Residual heat recovery system. It allows to reduce the fuel consumption of the ship by 14% of the total consumption. The residual heat recovered from the exhaust gases can be used to heat and generate steam which, in turn, can be used to heat the goods or accommodation spaces etc.

-Water in fuel: Adding water to the fuel just before the injection into the combustion chamber can reduce the temperature inside the line cylinder. An efficient system causes this to reduce NOx by up to 30-35%.

3. Conclusions

The creation of the management must be based on the requirement to reduce the

operating and maintenance costs of ships. This reduction of costs implies an increase of the efficiency of the electrical equipment. The Officer intervenes to keep the parameters of the electrical installations within normal limits, and he also executes the connection of the electric machinery in the circuit: charging installations, anchoring, signaling, launching of the boats, ventilation, governance. Understanding the Power Management System (PMS) is a priority for the shipboard management.

Power management on ships comprises two main aspects:

-The use on board of ships of automatic energy management systems, so the use of automation to save energy.

-Use of good practices and decisions taken by the ship's management in order to reduce energy consumption on board.

The automatic Energy Management System (PMS) plays a role, in managing the automatic start and stop of the generators depending on the load required at a given time by the consumers. The system can also coordinate the removal of non-essential consumers from the system.

At the beginning of each voyage, the ship's management together with the Officers discuss the energy management plan for the voyage to be taken, taking into account all factors that may influence the PMS (Power Management System).

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