CONDITION-BASED MAINTENANCE

NEW OPPORTUNITIES FOR THE SHIPPING INDUSTRY

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Due to the increasing complexity of electrical and control systems onboard ships, maintenance of ship electrical installations has become a major issue. Reactive maintenance, i.e. repairing after a failure, is even more critical on ships as maintenance teams onboard are limited in number and at the same time need to be trained and competent on many different systems, products and technologies. In order to ensure correct operation of these systems, it is necessary to follow manufacturer recommendations regarding regular verification, testing and replacement of critical parts when needed.

Preventive maintenance is the common strategy in the shipping industry: according to manufacturer recommendations and classification society requirements, maintenance plans are scheduled in advance so as to reduce downtime. It makes it easier to anticipate and plan resource availability (material, dock, human resources, and so forth).

However this preventive approach is not perfect and cannot guarantee zero failure when shipping. In addition, due to the increasing pressure on costs in a competitive environment, maintenance operations are under scrutiny and reducing the downtime they cause has become a major challenge.

CONDITION-BASED MAINTENANCE FOR SHIPS

Condition-based maintenance (CBM) is a different strategy: while preventive maintenance relies on manufacturer and classification society requirements, condition-based maintenance is adapted according to the actual service conditions the system has to withstand. Ships are generally designed to operate in certain configurations, typically at an average given speed, and all components are sized according to these requirements. In particular, electrical installations are supposed to operate at a rated voltage, with pre-determined load profiles, so as to maximise the efficiency ratio of the equipment. However, the actual use may be different. For example, introduction of a slow steaming operation has modified the operating point of the main engine and propeller, and although this practice aims to reduce fuel consumption, in many cases it does not correspond to the forecasted use of system as it was designed.

In this approach, the technical parameters of the equipment are measured and combined with environmental parameters and information relating to system usage. This information will then be used either to detect early signs of failure or to adjust maintenance plans.

MEASUREMENT AND ANALYSIS

One of the key considerations is how to gather the data needed for monitoring. The shipping industry is starting to take advantage of the global Internet of Things (IoT) trend, and CBM is all about leveraging the fast growing connectivity of devices. Most electrical equipment onboard includes embedded sensors or provides data such as temperature, pressure, current, power - for instance, medium voltage (MV) switchboards are equipped with protection relays, current

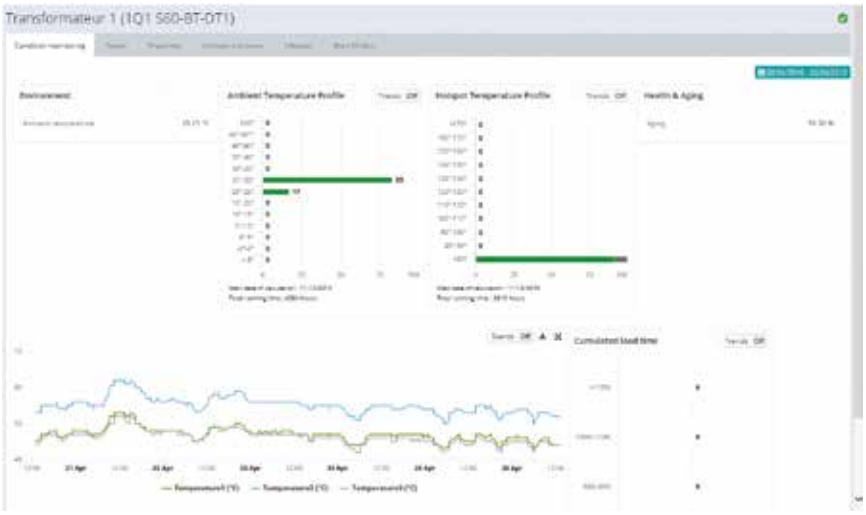
and voltage transformers or power meters providing comprehensive data regarding energy consumption and power quality.

Power transformers can be equipped with embedded temperature sensors. This data is primarily used for ship control and monitoring systems but could easily be made available for external monitoring. The analysis of different parameters combined with environmental data like external temperature or relative humidity can lead to detection of imminent failures or give relevant information relating to the misuse of equipment.

One of the most critical examples relates to busbar joints and cable connections. Poor connections can result in serious damage - from over-heating to fire, causing large losses. It is estimated that about 25% of all major electrical failures are due to loose or faulty connections[1]. To prevent such events, a preventive approach would typically consist of regularly checking tightening torque on every single power connection point, which can take a lot of time on a large ship. In the predictive approach, one solution is to monitor the conductor temperature next to the connection point and to detect abnormal values, either individually or by comparing other values (temperature on other phases). In these conditions, it is possible to point out connections that need to be verified instead of having to check all of them individually. This saves time and avoids unnecessary work.

Other applications related to condition-based monitoring on electrical installations include circuit-breaker monitoring (low and high voltage), environmental monitoring, high circuit-breaker partial discharge and vacuum monitoring. Of course condition-based maintenance is not limited to electrical equipment. Methods such as vibration analysis are used to detect component failures such as defective bearings or misalignment of equipment such as gearboxes, fans, shafts, motors and so forth.

Such monitoring demands well-adapted IT infrastructure onboard vessels. While data has to be collected locally, it should be made available for analysis preferably on shore, for example in ship operators' service offices. Different solutions exist, but cloud-based architectures are suitable. Data loggers are installed onboard to collect data and send it to a remote server through an Internet connection, most likely using satellite communication; the configuration of this communication system will be very much dependant on the number of assets to be monitored as well as on the frequency of data exchange, keeping in mind that the available bandwidth is expected to be limited to approximately 200kbytes/second (megabyte size communication lines are very unlikely to be used for such purposes, for cost reasons). Finally, all this data should be securely stored so as to be analysed and saved for future reference. Implementation



of this infrastructure should be made taking appropriate measures regarding cybersecurity and use of dedicated IT solutions and data loggers.

KEY BENEFITS AND CHALLENGES

The benefits of CBM for ship operators are multiple. First it will improve the overall system reliability and significantly reduce downtime. It will also make it possible to adjust and optimise the maintenance plan frequency based on actual figures, thus leading to significant cost reductions. Data analysis can also be used to compare similar vessels inside a fleet or to examine trends over longer periods, typically energy consumption on critical loads and efficiency levels. This data and related reports may be used to determine areas for optimisation in the ship's design or usage and drive retrofit requests. Spare parts management is also simplified, especially because the need for emergency spare parts is reduced.

On the other hand, some challenges should be taken into account. Although CBM can lead to modifications in the frequency of maintenance operations, ship operators should manage these unpredictable maintenance periods from a logistical point of view and justify these changes towards classification societies. In any case, there will always be a need for preventive maintenance simply because some operations need to be performed on a regular basis or because certain ageing components cannot be easily monitored. Another point worth noting is that the initial cost of the installation needed to perform condition-based monitoring can be quite high. The best approach is to include the technical requirements linked to condition-based monitoring as early as possible in the design of the vessel. When it is not feasible during the retrofitting of a ship, the best solution is to maximise the use of non-invasive technologies embedded in easy-to-install devices, such as wireless, battery-free sensors.

The shipping industry is facing challenges regarding energy efficiency and cost optimisation. In order to optimise the investments made in this field, condition-based maintenance is taking on a greater significance in terms of key implementation strategies to consider in the coming years.

1: Source: NETA (InterNational Electrical Testing Association)

ABOUT THE AUTHOR

Matthieu Dessaux holds a Master of Science Degree in Electrical Engineering from the Grenoble Institute of Technology, France. With more than 10 years' experience in the development of products and systems for electrical distribution, he is currently Technical Manager for Shore Connection and Marine Automation at Schneider Electric. In this role, he is responsible for the development and deployment of new technical solutions as well as technical support for customer project execution.

ABOUT THE ORGANISATION

Schneider Electric is a global specialist in energy management, providing expertise in smartgrid development, turnkey solutions and end-to-end services that help establish a best-in-class green port operation. With its Shore Connection solution, ShoreBoX™, Schneider Electric enables ports, terminal operators and ship owners to meet environmental regulations in the most efficient way, all while they optimize their costs with a full range of support. With more than 90 years' experience and over 20,000 ships equipped with our solutions, Schneider Electric is a key global partner for the marine industry as well.

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