EDITORIAL

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Industry 4.0 and Condition Monitoring in Maritime Applications

Proactive and predictive maintenance have become common practices in many industry sectors. In maritime applications, maintenance strategy has also continuously been advanced. It has evolved from a reactive to a predictive maintenance model mainly on the back of Condition Monitoring (CM) developments in the sector.

Condition-based monitoring techniques have gained traction in recent years as scheduled overhauls are significantly more cost-effective than unscheduled repairs. An increasing number of fleet managers, chief engineers and crews trust in Condition Monitoring, where the machine condition is determined based on vibration monitoring and analysis. In addition, vibration monitoring has become an integral part of recognized programs by many classification societies, such as Lloyd's Register and DNV-GL (Det Norske Veritas & Germanischer Lloyd).

Condition Monitoring includes techniques such as vibration monitoring, oil analysis, thermography, and electrical measurements. Compared to other CM techniques, vibration monitoring offers additional advantages: Experts can diagnose wear and damage, and identify the exact root cause.

Vibration-based CM is the most suitable technique to diagnose rotating machinery, as the measurement results can be used to precisely identify where the malfunction is occurring, down to the component level. Based on this data, fleet managers, inspection specialists and engineers can take precise maintenance actions to avoid unnecessary downtime, dangerous situations, and secondary damage.

Two paths, one goal

In general, there are two ways of taking vibration measurements: offline measurement and online monitoring.

Offline monitoring, on the one side, is based on handheld data collectors. With the use of such instrumentation, a crew member can manually take measurements on the machines at regular intervals. To reduce the error rate during data acquisition, a first level of automation has been introduced. Data collectors using a graphical measurement route function together with automatic identification of measurement locations guide the user through the entire measurement procedure. The error rate is reduced noticeably. Even though we are still talking about manual data acquisition, a first step towards Industry 4.0 has been made. However, the networking of the individual components – as it is expected in a full-blown Industry 4.0 environment – is not provided. At this stage, a data upload is necessary for the measurement data to be analytically processed and transferred to a Computerized Maintenance Management System.

Online monitoring systems, on the other side, act as autonomous "black box". It features permanently installed sensors and is usually installed on critical, safety-relevant, or difficult-to-access machines. Such a monitoring system acquires data 24 hours a day, 7 days a week. It can generate large volumes of data – very much in the sense of Big Data. However, this data must be analyzed and sent to the onshore diagnostic specialists. In most cases, it is not possible to send several gigabytes of data via the ship's VSAT system on a daily basis. Reasons are, for example, small bandwidths and high costs.

This is where Industry 4.0 comes into play: Not only can an online system connect to the network of the ship, but it can also communicate with SCADA systems via different bus protocols, allowing data to be exchanged in both directions, to and from the online system. Process parameters, such as output, speed, temperature, or start and stop variables can be transferred. In order to manage the large flow of data, the information can be used by individual or several networked online measurement systems. Based on the process parameters, online Condition Monitoring systems can independently relate the measured vibration signals to certain operating states and use variable alarm thresholds. After each measurement, online monitoring systems use the variables sent to decide whether there has been a significant change, and whether the data should be saved or discarded, or additional measurements initiated (Smart Data).

As the vibration condition of a machine train strongly depends on the surrounding machines and the ship design, the analysis is particularly difficult on ships. Thanks to the networking of all the systems together with the SCADA system, it is possible to make reliable statements about the condition of the machines. Like a gold nugget, only "smart" data is saved. As a result, the much-praised big data lake can be filled with valuable content from the start.

Online Visualization 4.0

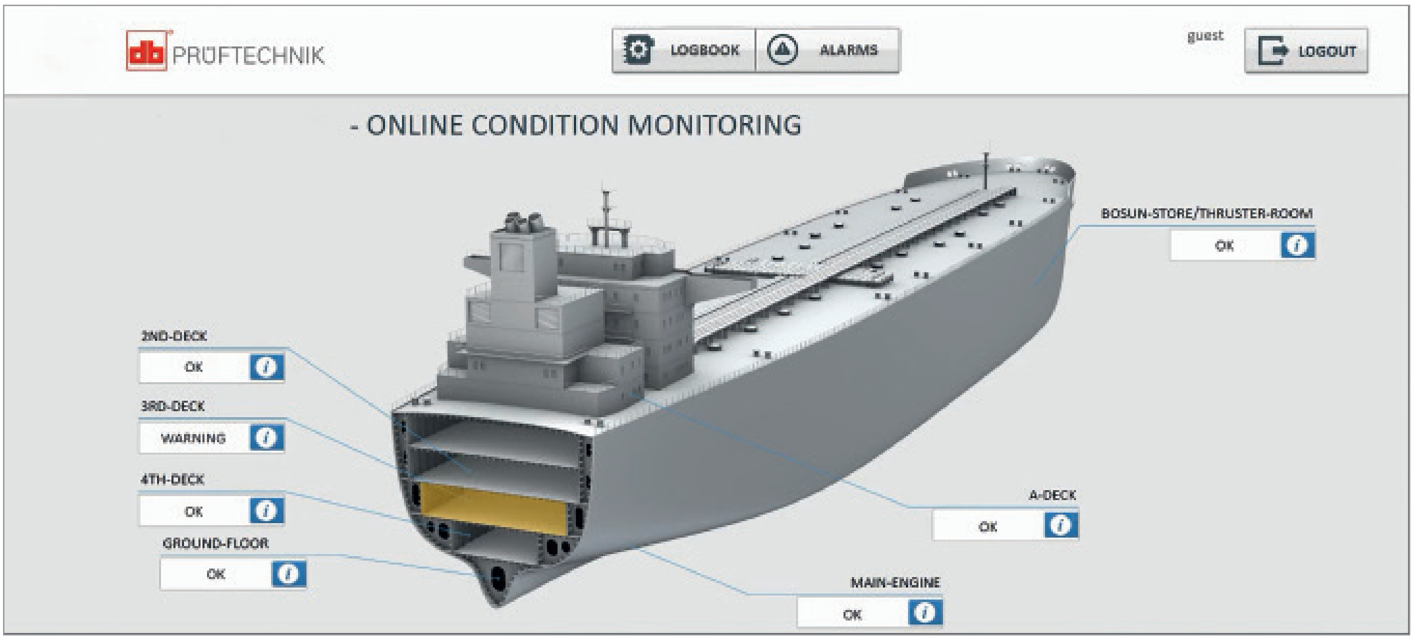

Fig. 1: Online dashboard visualization of a vessel

Thanks to Industry 4.0, data volumes have been reduced to such an extent that they can now easily be sent to onshore diagnostic specialists– compact, but smart!

Now, what about the onboard engineers? How can they benefit from Condition Monitoring in alleged Industry 4.0 environments? Measurement results can be visualized in online dashboards such as the Online View 4.0 by the personnel of the control room, where they can follow up on live data trends. Global warning levels are displayed as traffic lights indicative of a change in the operating condition as opposed to the actual machine condition. Following an in-depth diagnosis, the cause of an increased vibration level as well as the suitable maintenance actions are determined together with the onboard personnel to avoid unnecessary repairs and downtimes.

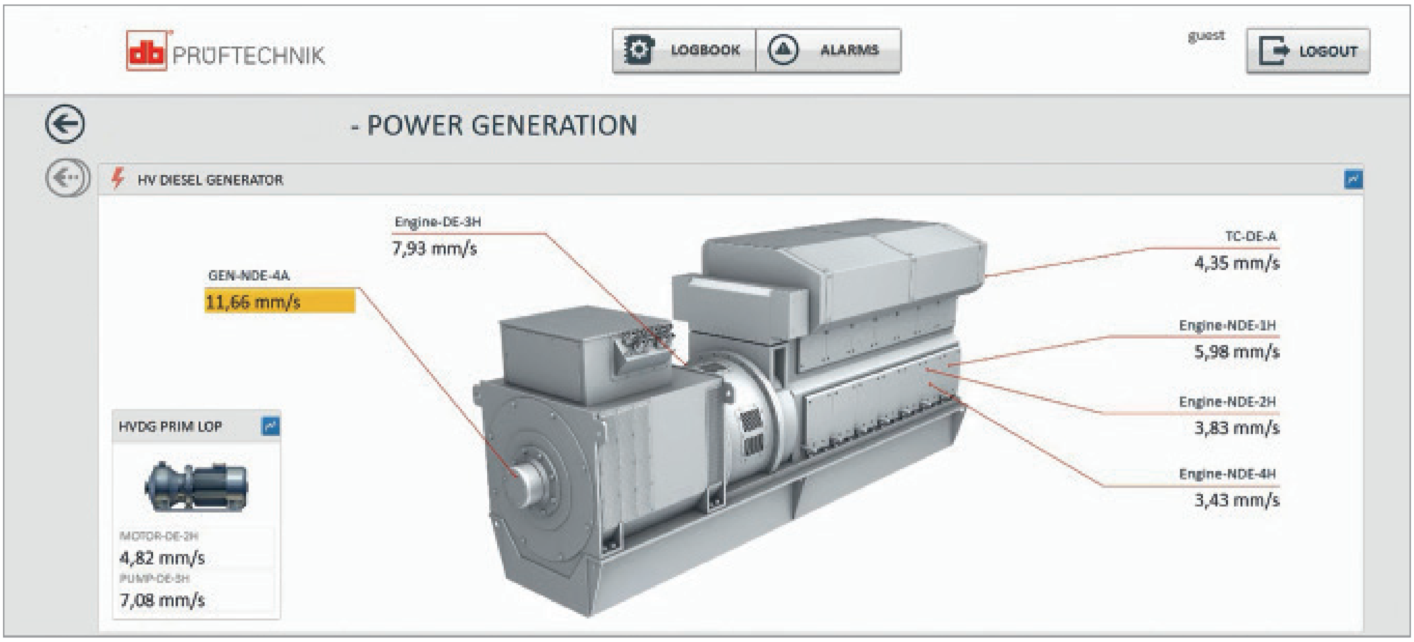

Fig. 2: Drill down to a specific machine train with live data

So far, we have explained both ways of taking machine measurement data using offline and online techniques. Only the online monitoring technique seems suitable for the world of Industry 4.0. Can we accept stereotype thinking and just follow one path? The answer is quite clear: No!

A combined implementation of offline and online systems is often the most economical approach to reliable Condition Monitoring. In this context, the machines to be monitored must be differentiated according to the following criteria:

- Criticality of the machine to the overall operation
- Accessibility of measurement locations
- Measurement duration (equipment cycle time, frequency range)
- Workload involved
- Health, safety, and environmental aspects

Using this combined approach, critical machines are monitored around the clock using online systems. Less critical machines are monitored monthly using offline measurements. The result is a reliable and cost-efficient condition monitoring program and a general reduction of the workload for the onboard crew.

The last missing piece of the puzzle is the integration of the offline systems into the Industry 4.0 environment. The good news is that some solutions already exist. Data can be compressed and sent onshore via e-mail, where it finds its way into a common database. Data will be prepared and analyzed. This way, the networking of information is now happening at a global level, connecting the information to the entire fleet of vessels. The results generated can be made available jointly in a web-based dashboard.

Fleet managers, chief engineers, and analysts communicate through the dashboard and gain access to performance indicators, machine conditions and measurement results of the entire fleet down to the individual machine trains.

There is no doubt that industry 4.0 makes life easier in maritime environments, both at the local and global levels. The costs associated with the presence of specialists onboard are significantly reduced as monitoring data is sent back and forth – for faster and more precise measurement results – according to the claim: "Move the Data, not the People".

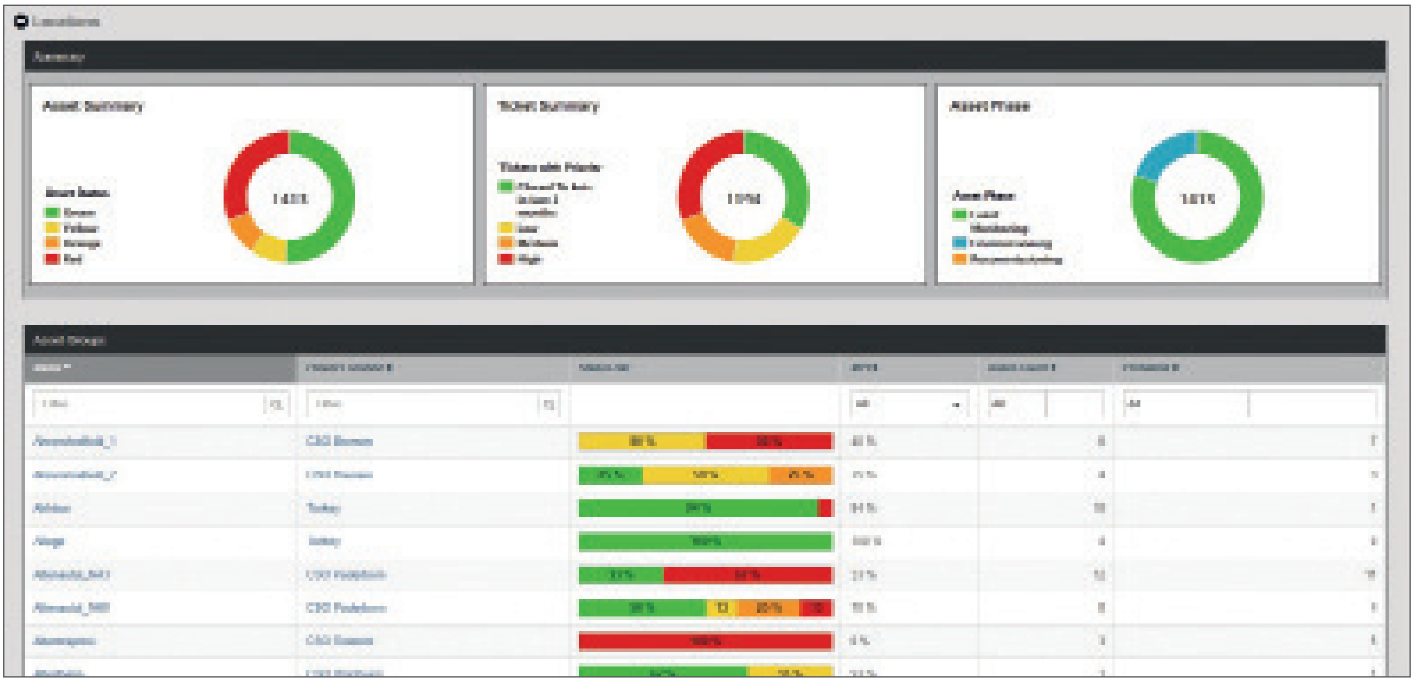

Fig. 3: Online dashboard with traffic light warning system

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About PRUFTECHNIK:
The PRUFTECHNIK Group, with its subsidiaries and partners in more than 70 countries worldwide, continues to set new standards with innovative technological advancements in the field of machine alignment and vibration measurement technology in order to maximize and optimize the availability of machines and plants.

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