Hansford Sensors
Excellence in Vibration Monitoring

A white paper from Hansford Sensors

Marine Monitoring

Considering the cost of putting to sea, it is well worth investing in vibration monitoring equipment that can help engineers to protect and maximise the performance of marine machinery.

Here, we discuss the challenges facing engineers and offers advice on how to successfully install and use vibration sensing equipment on marine vessels.

As machinery has become more complex and mankind has demanded greater productivity from each mechanical system, there has been a corresponding growth in the need for sophisticated vibration sensors that can help maximise the performance of many engineering processes. This is especially true at sea, where vibration monitoring is a key tool used by marine engineers to manage the availability and maintenance of a wide range of equipment with rotating shafts, including pumps, motors, fans, gearboxes and engine systems.

The cost of putting an oil tanker or a cruise ship to sea has always justified the cost of monitoring it but in recent times pressure has grown on ship owners to ensure that they meet deadlines. Add to this the fact that much bad publicity can be generated by severe failures, whether caused by the unscheduled docking for repairs of a container ship or the malfunction of ventilation fans in hotels on cruise ships, and the need to apply reliable preventative maintenance techniques becomes ever-more pressing.

'...vibration is one of the main causes of failure in marine propulsion systems and auxiliary equipment.'

Thankfully, today's designers and engineers have succeeded in developing a range of tools and practices to prevent vibration and its consequences, such as alignment tools and automatic lubricators that can be applied during system construction, while components themselves are continually being refined and upgraded to offer greater resistance to vibration.

However, vibration can never be entirely banished from rotating machinery and so there has been much development in vibration monitoring technology; in particular, vibration sensors increasingly offer exceptional reliability packaged in a variety of resilient enclosures to enable their use within a wide rangeof applications.

The adoption of vibration monitoring equipment is vital in marine applications because vibration is one of the main causes of failure in marine propulsion systems and auxiliary equipment. The development of vibration monitoring equipment has naturally involved examining the key causes of vibration, such as poor alignment of rotating shafts in, for example, propulsion systems and turbochargers for main or auxiliary engines.

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Vibration monitoring offers a vital early warning, enabling engineers to take action before any substantial damage is caused. When machinery such as fans and motors run out of alignment, the resulting vibration leads to excessive wear and premature failure of parts and, ultimately, a resulting reduction in efficiency. Gaining access to motors and fan units can be difficult and time consuming and without a strong condition monitoring regime engineers will find themselves continually reacting to problems that have already been created.

A good illustration of this is to consider how vessels have coped in recent years without condition monitoring. Take, for example, a tanker that is subject to inspection by a class surveyor, who makes an annual check on the equipment. Without condition monitoring, the only way to analyse equipment is for on-board engineers to take it apart and show the pieces to the surveyor, which naturally consumes much valuable time and manpower and can only be done when the vessel is in dock. On large vessels, the surveyor may not be able to inspect more than, say, 20% of equipment every year, meaning that it might be five years between examinations for some machine parts. That leaves many machine parts unexamined for long periods of time and even those parts that are examined can suffer because taking machinery apart and reassembling can cause its own problems.

Many marine engineers have observed that a large percentage of defects are maintenance induced, so the less they have to take things apart and put them back together, the better.

In contrast, condition monitoring, such as vibration monitoring on pumps, motors, fans, gearboxes and engine systems, allows marine engineers to maintain equipment far more efficiently with less manpower and maintenance.

The above example explains why vibration monitoring of marine machinery, especially propulsion and manoeuvring systems, engines and turbochargers, is becoming a more widely adopted facet of condition monitoring that, alongside other powerful tool such as oil monitoring and thermal imaging, is protecting profits and enhancing performance. To appreciate how vibration monitoring is bringing these benefits to marine applications, let's look at the current technology.

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The current array of sensors or accelerometers for vibration monitoring offered by market leaders such as Hansford Sensors can operate over a wide temperature range, measuring both high and low frequencies with low hysteresis characteristics and excellent levels of accuracy. These devices also offer robust and reliable service, thanks to stainless steel sensor housings that can prevent the ingress of moisture, dust, oils and other contaminants.

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Sensors should be mounted on a flat, smooth, unpainted surface, larger than the base of the accelerometer itself.

There are two main categories: AC accelerometers, which are used with a data collector for monitoring the condition of higher value assets, and 4-20mA accelerometers, which are used with a PLC to measure lower value assets. Both are capable of detecting imbalance, bearing condition and misalignment but AC accelerometers can also identify cavitation, looseness, gear defects and belt problems.

Hansford Sensors offers AC and 4-20mA versions of the HS-100 and HS-420 Series, which are intrinsically safe being ATEX and IEC Ex certified.

These industrial vibration sensors can be used to monitor vibration levels on pumps, motors, fans and all other types of rotating machinery found in marine applications.

Accelerometers contain a piezoelectric crystal element bonded to a mass. When the sensor is subject to an accelerative force, the mass compresses the crystal, causing it to produce an electrical signal that is proportional to the level of force applied. The signal is then amplified and conditioned using inbuilt electronics that create an output signal, which is suitable for use by higher level data acquisition or control systems.

Output data from accelerometers mounted in key locations can either be read periodically using sophisticated hand-held data collectors for immediate analysis or subsequent downloading to a PC, or routed via switch boxes to a centralised or higher level system for continuous monitoring.

The challenges of condition monitoring at sea are great - for example, readings taken in port will almost certainly be different from those taken when the vessel is at sea, and heavy weather will only amplify any such differences - so it is in everyone's interest to specify the best accelerometers and apply the best practice in managing their performance.

To correctly specify an accelerometer, engineers need to consider the vibration level and frequency range that is to be measured, as well as environmental conditions, such as the temperature and whether there are any corrosive chemicals present.

A series of further considerations follow on from there; for example, is the atmosphere combustible? Are there weight constraints? In marine applications, there is no earth, which presents a further challenge but this and other difficulties have been addressed by the designers and

engineers of accelerometers and the right research and training, or consultation with a market leader that has experience in a wide range of sectors, can swiftly enable the right decisions to be made.

Once the most appropriate sensors have been selected it is important that advice is followed and care is taken during installation to ensure the maximum level of performance. For example, accelerometers should be located as close as possible to the source of vibration.

'With an efficient vibration monitoring system in place, marine engineers find they have progressed to a new level of efficiency...'

Also, devices should be mounted onto a flat, smooth, unpainted surface, larger than the base of the accelerometer itself and this surface should be made free from grease and oil. Condition monitoring depends on stability and readings from a poorly mounted accelerometer may relate not only to a change in conditions but also to the instability of the sensor itself. Once data has been collected in the most appropriate and efficient manner, machine reliability data must be analysed and interpreted, either by on-board engineers or by a remote monitoring centre, building a picture of machine condition and helping to create a future maintenance schedule.

With an efficient vibration monitoring system now in place, marine engineers find they have progressed to a new level of efficiency and, with systems well protected by accelerometers and associated machinery to monitor vibration, can move on to identify areas for further improvement in terms of machine performance, energy efficiency or output.

AC accelerometers can be used to identify gear defects.

Vibration monitoring thus becomes an increasingly powerful tool and a vital one at a time when the effects of vibration in marine propulsion and auxiliary systems are potentially more costly than ever.

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