Engine safety enhanced with wireless temperature monitoring

AUTHOR: Lenardon Lorella, Special Projects, Services, Wärtsilä in Italy

Recently developed technology has enabled Wärtsilä to introduce wireless temperature-sensing capabilities that can significantly lower maintenance and repair costs.

Compared to the indirect measurements of a conventional oil mist detector, direct continuous monitoring of the crankpin bearing temperature permits earlier detection of crankshaft malfunctioning. This prevents major failures to these critical, high cost engine parts, protects against direct consequences on the operational availability of the engine, and avoids extra costs related to unplanned expensive maintenance operations. To be able to continuously detect and monitor the temperature of rotating crankpin bearings in an accurate and reliable manner, special technologies that had not been previously developed satisfactorily for diesel engines, are required.

Wärtsilä has recently developed such technology, and an innovative wireless temperature-sensing device is currently being promoted and installed by the company. The operating principle of this system is to directly measure the temperature of the connecting rod big end bearing using a temperature sensor fitted as close as possible (within a few mm) to the bearing surface.

This temperature monitoring system is based on patented, Surface Acoustic Wave (SAW) radar technology, which has been proven to be the most reliable technology for real-time wireless temperature monitoring. The Signal Processing Unit (SPU) generates a radio wave pulse, which is picked up by the stationary antenna. This then converts the radio wave into an acoustic wave, and sends it to the rotating sensor. This acoustic wave propagates along the surface of a SAW chip fitted with multiple reflectors, thus permitting the sensor to reflect a pulse train; the time delay between echoes depends on the temperature of the SAW chip.

The wireless temperature sensors are installed in the rotating connecting rod big end. The stationary antennas are screwed to a custom designed bracket fixed inside the engine block in such a way, that the sensors and antennas pass within a fixed distance of each other at each rotation of the engine crankshaft.

The signal is then transmitted via a thin cable passing through the engine block, to the SPU fixed to the engine, and from there to the control room cabinet placed in the engine room.

■ Fig. 1 – Wireless temperature monitoring enables continuous measuring of the crankpin bearing temperature.

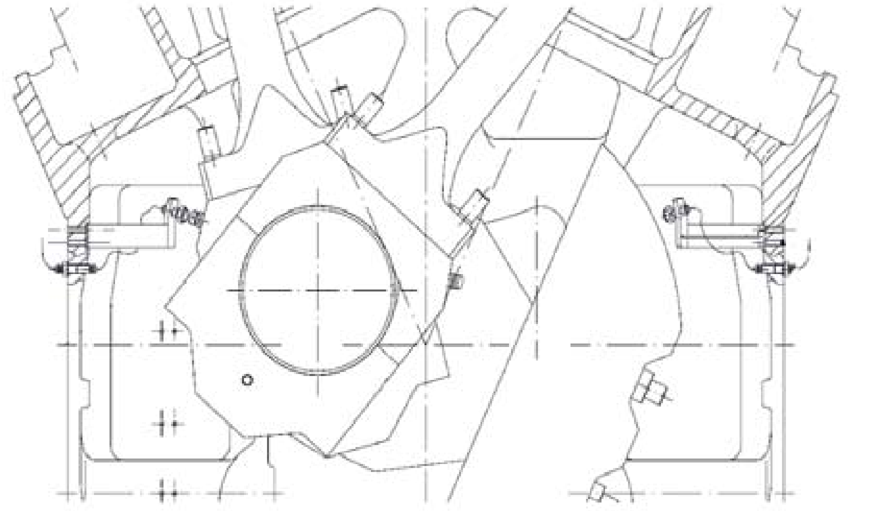

Fig. 2 – Installation drawing showing wireless sensors fitted within the crankcase.

Alternatively, it can also be connected to the main automation system.

Under normal operating conditions, the temperatures of the crankpins and connecting rod big end bearings vary within a specific value range, which is determined for each installation. A temperature increase is therefore signalling the beginning of a malfunction.

Thanks to the wireless temperature monitoring system, it is now possible to measure in real time the temperatures with high precision. This allows any temperature increase of specific bearings to be monitored, and for the alarm to be raised so that the engine can be slowed or shut down before the deviation from predefined values leads to failure or breakdown.

Grimaldi Group in Naples goes for Wärtsilä

The Grimaldi Group in Naples, one of Italy's most important ship owners, has for the past five years, been operating a management and maintenance strategy policy of prevention and safety as regards the propulsion systems of its fleet.

In spring 2006, the Grimaldi Group decided to install a Crankpin Wireless Temperature Monitoring System to one of the 12-cylinder, in V-configuration Sulzer ZA40S main engines powering its "Eurostar Roma" ferry. The purpose was to test this prevention device and its ability to detect in advance possible failures of the engine crankshaft bearings and related components. Following successful completion of these tests in summer 2006, the Grimaldi Group made the decision to install the wireless system to "Eurostar Roma's" other three Sulzer ZA40S main engines. The system was also installed on the two 8-cylinder, in-line Sulzer ZA40S engines on the company's "Fides" and "Spes" vessels.

The preparatory work for the installation of the wireless system includes drilling the engine block, installing the antenna support, and drilling the connecting rod big end upper part in order to install the sensors. Wärtsilä's knowledge of the design and vibration behaviour is critical for the determination of the position and characteristics of the hole.

The best time to perform work on the connecting rod big end is during a major overhaul when the dismantled →

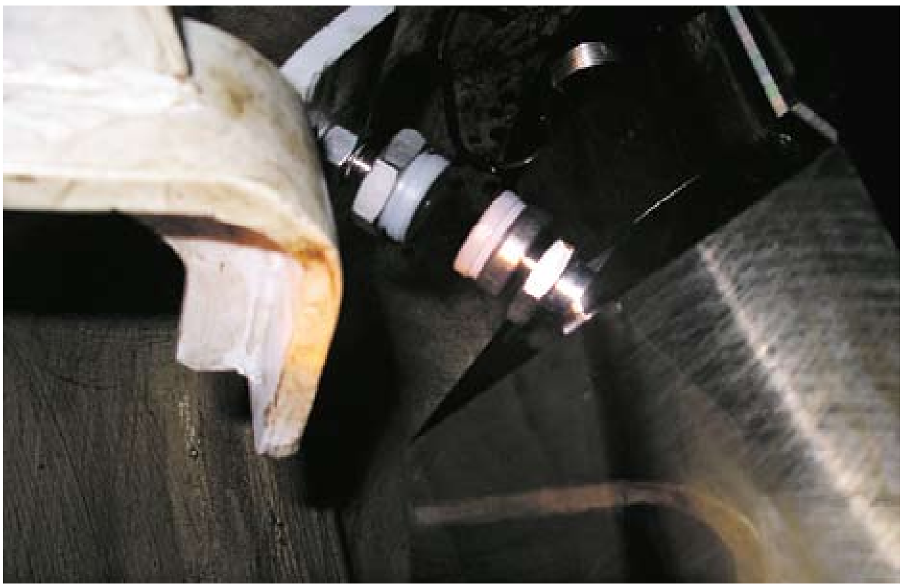

Fig. 3 – Big end bearing wireless sensors and their fixture bracket.

connecting rod big ends can be drilled or replaced with ready-drilled new ones. The installation of the wireless system on the Grimaldi Group vessels was planned and executed during scheduled overhauls, and according to the specific needs and schedules suitable for each vessel.

For Grimaldi's M/V Spes, the work was executed in two phases. The drilling of the connecting rod big end upper part and the engine block was completed during dry-docking, while the installation and commissioning of the wireless system was carried out at sea.

Taking advantage of Wärtsilä's large service network, the first phase was carried out by Wärtsilä in Greece. The drilling of the connecting rod was done in the workshop, while the drilling of the engine block was carried out onboard during the ship's overhaul.

The dry-docking was carried out as planned, and Grimaldi's M/V Spes was again ready for sailing as scheduled by the customer.

On the engine of Grimaldi's "Eurostar Roma", the connecting rod big ends were replaced with new ones already drilled. The remaining part of the job was carried out at sea or during operative calls. Other installations of wireless temperature monitoring systems are planned by Wärtsilä in Italy during this current year. Some will be carried out using an exchange set of connecting rod big ends during fast stops.

The versatility of Wärtsilä Services allows customers to easily install the latest technologies without hindrance to operating schedules.

Retrofit packages, for which many customers including the Italian Navy have expressed interest and commitment, will soon be available as well for GMT 420 and 230 engines. Within Wärtsilä, wireless temperature monitoring of big end bearings is available for a wide range of engine types (see Table 1) for both marine and power plant installations. Although the operating principle is the same for all engine types, the sensors and their positioning, the antenna supports inside the engine block, and the vibration stability are specifically designed and checked for each engine type.

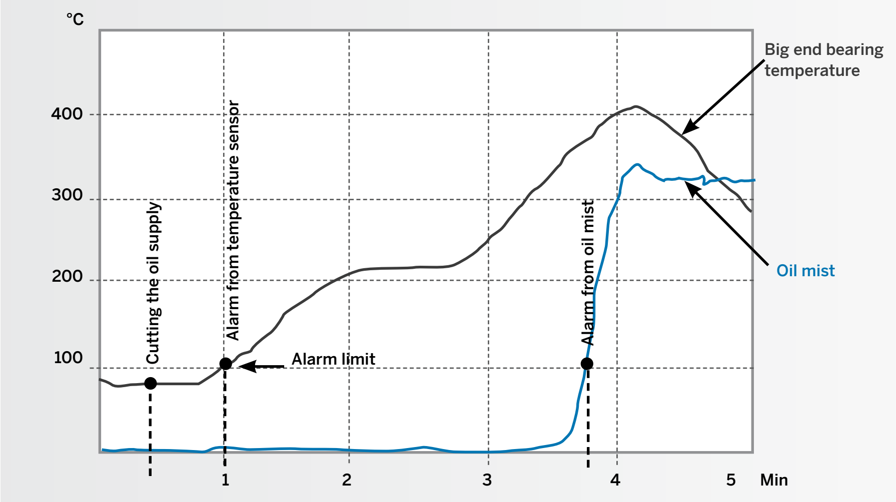

Fig. 4 – Detection times of crankpin failures by temperature monitoring and oil mist detecting.

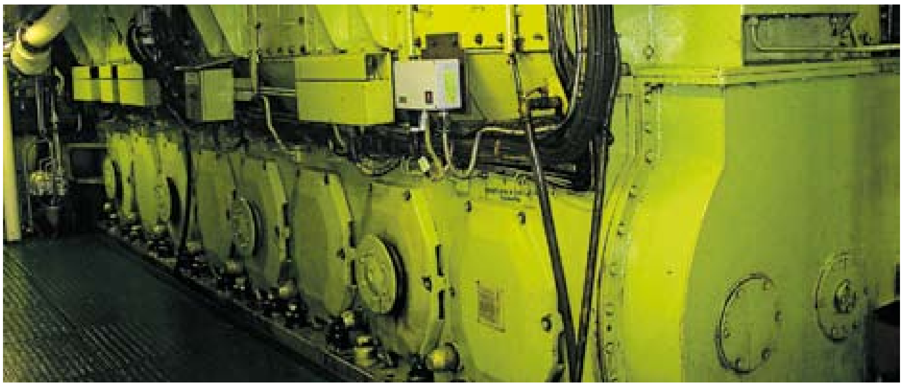

Fig. 5 and 6 – The Grimaldi Group's M/V Spes is equipped with an 8-cylinder, in-line Sulzer ZA40S engine fitted with the wireless temperature monitoring system.

Table 1 - Engine types that can be equipped with the wireless temperature monitoring system.

Wärtsilä 32, 38A, 38B, 46, 50DF
Wärtsilä Sulzer Z, ZA, ZAS
Wärtsilä GMT 230 and 420
Wärtsilä Nohab F20, F30, 25, 25SG
Wärtsilä Stork 240, 280, 410, 620
Wärtsilä Deutz Marine D350, D358, D501, D510, D511, D528, D536, D540, D545, D620, D628, D645, D816,