

AI FOR AIR COMPRESSORS



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Condition Monitoring

AI FOR AIR COMPRESSORS

MacGregor, part of Finnish corporation Cargotec, specializes in maritime equipment solutions. For many years, the company has provided remote monitoring solutions for the maritime industry. Together with Bachmann, MacGregor has now developed a platform that goes even further: a system that maximizes air compressor performance by providing operational recommendations to the crew.

Since 2013, MacGregor has offered remote crane equipment checks and technical consultations. But for the company's engineers, this didn't go far enough: their goal was to equip machines with advanced monitoring systems that could predict maintenance requirements. This demanded a system that could recognize patterns in equipment behavior and, through a combination of extensive experience, technical expertise, and AI, identify anomalies indicative of failure. OnWatch Scout is MacGregor's solution.



A Challenging Concept

The creation of clear, understandable action instructions requires continuous status monitoring that can identify current and future failures. This calls for sensor technology able to identify anomalies, wear and tear, and their causes. In addition, the generation of clear performance indicators, as well as maintenance recommendations, places high demands on software. "On-board operators have to be guided through challenging operating and repair processes with concrete, actionable advice and detailed, step-by-step instructions," says Dr. Eng. Jörg Peschke, Director Drives and Controls, Digitalization and Business Transformation at MacGregor Group, describing the concept behind OnWatch Scout.

Limitations of Previous Analytics

During concept development for the air compressor monitoring system, it became apparent that the technical approach of vibration monitoring and spectrum analysis would be unable to generate the necessary unique identifiers for a number of different fault sources. MacGregor, however, was undeterred – together with experts from Bachmann Monitoring, unique attributes for fault detection and wear analysis were finally developed.

In the field of structure-borne noise analysis, many of the diagnostic approaches used to date have been based on

broadband characteristic values, such as the formation of RMS values in specific frequency ranges. The RMS value is associated with the energy value of the signal and is thus a strong indicator of fundamental changes to machine condition. In most cases, however, the value is too ambiguous for accurate fault localization, and can only be used to prevent the most serious accidents and consequential damage.

It is therefore unsuitable for more in-depth diagnosis and early fault detection. Instead, frequency-selective methods have proven successful for early fault detection, for example in rolling bearings and gears. In this case, the fundamental frequency amplitudes of moving components are monitored, as are their harmonics. For certain diagnoses, characteristic values for sidebands can also be generated. To account for variable speeds, which can lead to amplitude value distortion, sensor signals are subjected to order analysis.

There are, however, specific challenges associated with air compressor monitoring. Many air compressors contain plain bearings, which cannot be monitored in the same way as roller bearings. Additional important components, such as inlet and outlet valves, also need to be monitored.

New Methods

The methods of classical vibration analysis were therefore extended through a diagnosis based on shape filters.

At a glance: OnWatch Scout gives on-board users a quick overview of air compressor condition.



»The on-board operator is guided through difficult operational and repair processes with concrete, actionable advice and detailed step-by-step instructions.«



Dr. Eng. Jörg Peschke,

Director Drives and Controls,
Digitalisation and Business Transformation,
MacGregor Group

Building on narrowband frequency analysis, and using a vector concept for parallel filtering and scale-free vibration characteristic calculation, shape parameters are used to obtain information on both amplitude and phase. "The results are robust, largely interference-insensitive scalar values for 'anomaly detection' in the function of machine and plant components," explains Holger Fritsch, Managing Director of Bachmann Monitoring GmbH. With the moments method, all data and signals (pressure, temperature, speed, structure-borne noise and others) can also be used to detect anomalies in operating behavior.

Security by Design

"This is where the strength of Bachmann's solution becomes clear," says Dr. Peschke. "Condition Monitoring technology is an integral component of the M1 automation solution for our compressors. Essentially, this means that all relevant process variables are immediately available for diagnostics." As various computer processes are integrated into the M1 solution, no additional hardware is required to separate operating functions, such as control of the air compressor, and information functions such as Condition Monitoring and data transmissions.

Online and Offline

Data transmission from on-board compressors to Bachmann's certified diagnostic center is not always possible whilst vessels are at sea. In this scenario, the on-board controller aggregates data, where it can be used for visualizations. MacGregor uses the results of such analyses to generate action instructions on-board.

Huge Benefits

OnWatch Scout is vital tool for crew: it reduces unplanned equipment failures and the associated costs and inefficiencies, and it is also effective in preventing serious damage. To mitigate damage impact, companies have previously stock-piled materials and deployed personnel to minimize the effects and prevent

further outages. "The OnWatch Scout system optimizes traditional processes by preserving function and operability, and by extending performance and asset life in a cost-effective manner," explains Dr. Peschke. For him, the platform holds enormous potential. For MacGregor, it is the foundation of a symbiotic business model where company and customer succeed through effective collaboration.

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- Achieved sales of 642 million Euros in 2020
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