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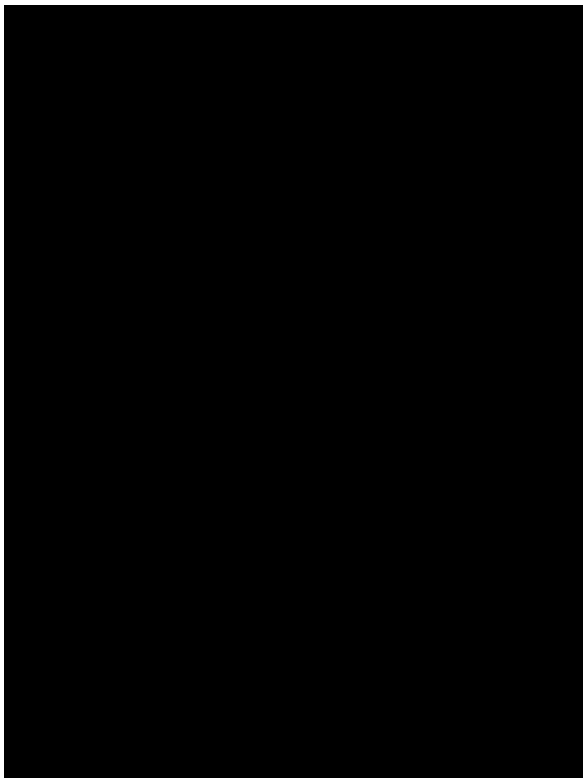
Preventive Maintenance of Centrifuges Using Vibration Analysis



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1. Background and Motivation

Centrifuges are essential components in various industrial sectors, including food processing, pharmaceuticals, and chemical production. Their failure can lead to significant financial losses and production downtime. Traditional maintenance strategies such as time-based maintenance or breakdown maintenance have proven to be insufficient in many cases. Time-based maintenance requires considerable effort and does not allow for early detection of damage, while breakdown maintenance results in unplanned outages and high repair costs.

Online condition monitoring systems, such as ConditionAlert™, offer continuous surveillance and the highest detection rates for potential failures. However, these systems involve substantial investment costs and are often uneconomical for existing installations with low operating hours. This study therefore investigates vibration analysis as a mobile, cost-effective alternative that enables early detection of bearing damage and supports the reduction of Total Cost of Ownership (TCO) for customers.

2. Methodology and Concept

The approach begins with simplified system modeling for different centrifuge types, including belt-driven and gear-driven separators as well as decanter centrifuges. A portable data collector, specifically the SKF Microlog AX CMXA 80 equipped with an acceleration sensor, was used to perform measurements. Measurement points were defined at the motor and drum shaft bearings to capture relevant vibration data.
The measurement parameters were carefully selected to ensure accurate results. The end frequency was set to include up to the fifth harmonic of the inner ring defect frequency, and the sampling rate was determined according to the Nyquist criterion, using four times the end frequency. For data analysis, envelope analysis was applied to detect localized bearing damage. Additional techniques such as band-pass filtering and Fourier transformation were used to identify characteristic defect frequencies.
To validate the concept, a case study was conducted on a BRPX 617 separator installed at a local food company. This real-world application provided insights into the practical feasibility and economic benefits of the proposed method.

3. Case Study Results

Measurements were carried out under three different load conditions, generating frequency spectra up to 4,800 Hz with a sampling rate of 12,800 Hz. The analysis revealed no damage on the six bearings examined, and all operating parameters remained stable throughout the test period.
A cost comparison between different maintenance strategies highlights the economic advantage of on-site vibration analysis. The annual cost for on-site diagnosis was approximately €10,560, compared to €11,600 for time-based maintenance and €13,100 for online condition monitoring using ConditionAlert™. While ConditionAlert™ provides the most comprehensive monitoring and highest detection rate, on-site vibration analysis offers a more economical solution for installations where continuous monitoring is not justified.

4. Benefits and Limitations

The implementation of mobile vibration analysis provides several advantages. It enables early detection of bearing damage months before a potential failure occurs, thereby reducing costs through targeted replacement of defective components. Furthermore, it serves as an entry point for data-driven service concepts and strengthens customer relationships by offering proactive maintenance solutions.
However, the method also has limitations. It does not provide real-time monitoring but rather a snapshot of the machine’s condition at the time of measurement. Diagnostic thresholds must be defined individually for each machine type, and additional research is required to extend the approach to gear damage and complex structural vibrations.

5. Recommendations and Outlook

In the short term, it is recommended to introduce on-site vibration analysis as a dedicated service product and to provide training for customers and technicians. In the medium term, a communication strategy should be developed to promote ConditionAlert™ and to clean up the installed base database for better targeting. In the long term, research should focus on defining diagnostic thresholds, integrating AI-based pattern recognition, and expanding the method to include gear and screw bearing diagnostics.

Key Message:

Mobile vibration analysis represents a cost-effective and practical solution for preventive maintenance of centrifuges. It facilitates the transition from risk-based to condition-based maintenance and supports the industry’s shift toward digital service concepts.