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Monitoring Vibrations and Diagnosing Mechanical Faults in Industrial Equipment

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Introduction:

In mechanical engineering maintenance, vibration monitoring is essential for optimizing performance and extending equipment life. In the case of a centrifugal finisher pump, vibration analysis significantly improved operational availability by enabling timely maintenance and fault detection.

Key issues identified included: Misalignment between motor and turbine shafts , Repeated bearing failures on the turbine shaft

These failures led to frequent replacements and highlighted the need for bearing resizing to meet operational demands. The practical findings will be compared with numerical simulations to validate results and improve maintenance strategies.

Study Objectives: Analyze vibration behavior of the centrifugal pump, identify root causes of vibratory faults, recommend mitigation strategies to improve system stability and efficiency

Rotating machines are vital in industrial operations but are susceptible to mechanical issues like imbalance, misalignment, and bearing failures, leading to excessive vibrations, structural damage, and reduced lifespan. Lubrication problems further accelerate wear. Key vibrational issues include defective balancing, misalignment, poor fastening, and bearing defects. Effective maintenance also requires understanding the types of industrial pumps—primarily centrifugal (dynamic) and piston (positive displacement) pumps—and their typical failure modes.

Results :

This technical analysis focuses on vibratory diagnostics of a centrifugal finisher pump used in a tomato paste production line. The pump encountered major mechanical issues, including misalignment, bearing defects, and imbalance, which resulted in significant vibrations and abnormal noise. Through vibration and acoustic analysis, early fault detection was achieved, allowing for targeted corrective maintenance.

Pump Overview:

- Function: Moves and pressurizes fluid in the final stage of production.

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- Works: A spinning impeller adds energy to the fluid, which the pump casing then converts into pressure.

- Main parts: Impeller, pump casing, pipes for fluid in and out, and a steam system for drying and thickening the tomato paste.

This study confirms the value of vibration diagnostics in predictive maintenance and highlights the importance of integrating numerical analysis (e.g., modal analysis, FEA simulations) to support real-world diagnostics [1, 2,3].

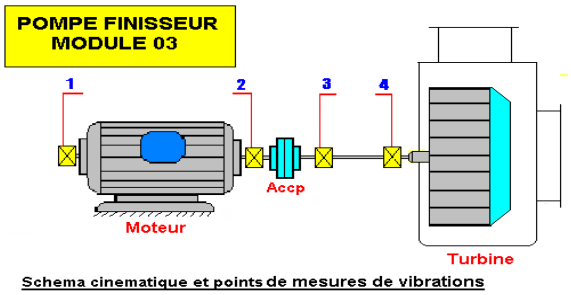

Figure 3-1 Kinematic diagram and vibration measurement points.

Conclusion

This study combined experimental testing, SolidWorks, and ANSYS simulations to analyze the vibratory behavior of a rotor–pump finisher system. Modal analysis revealed bending-dominated vibration modes and potential resonance risks due to natural frequencies aligning with rotor harmonics. The simulations closely matched real-world diagnostics, confirming the role of resonance in recurring mechanical issues.

Corrective recommendations include :

- Elastic shaft couplings, Optimized bearing selection, Vibration-damping supports.

Overall, the study confirms that finite element analysis is a valuable tool for diagnosing faults, improving design, and supporting predictive maintenance in rotating machinery.

References:

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