International Journal of Advanced Manufacturing and Material Processing

Predictive Maintenance of a Centrifugal Pump Using Vibration Analysis

Zambri bin Abdul Halim *, Mohamad Fauzi Bin Abu Bakar , Fakhrul Azman Bin Mohamed and Azizi Bin Mat Shariff

RESEARCH ARTICLE

ARTICLE INFO

Keywords:

Predictive maintenance;
Centrifugal pump;
Vibration analysis;
Bearing fault diagnosis;
Order analysis

Article History

*Received:*24 October 2025
*Revised:*19 February 2026
*Accepted:*28 February 2026
Published:

Centrifugal pumps are critical components in industrial systems where bearing failures may result in significant downtime and economic losses. This study investigates the vibration condition of a 450 kW centrifugal pump using condition-based predictive maintenance techniques. Vibration data were acquired from Pump Bearing #4 (Free End, 6321) under steady-state operation and analyzed using Time Waveform (TWF) and Fast Fourier Transform (FFT) spectrum analysis. The calculated bearing characteristic frequencies—Fundamental Train Frequency (FTF), Ball Pass Frequency Outer Race (BPFO), Ball Pass Frequency Inner Race (BPFI), and Ball Spin Frequency (BSF)—were compared with spectral peaks expressed in order analysis. Results indicate dominant harmonics between 21× and 25× orders corresponding to BPFI, confirming advanced inner race spalling. Sideband modulation and repetitive impact patterns further support the diagnosis. Physical inspection after disassembly validated the presence of localized inner and outer race damage. The findings demonstrate that vibration-based condition monitoring is effective for early fault detection and fault progression assessment in high-power centrifugal pump systems.