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”COMO2#2 - Bearing degradation indicator using characteristic frequencies applied on non-stationary vibration signals”

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Rolling-element bearings are wear components in rotating machinery. Usually, their condition is monitored with signal-processing tools tailored for vibration-based surveillance. From cyclostationary theory, angle-time analysis, or sparsity-based approaches, numerous methods have been developed relying on the properties of incipient fault signals. The scalar indicators coming from these techniques are well-suited for detection and localisation, but face difficulties in prognosis. The main issue is that the released vibration energy may not correlate with the severity of the fault. There is a need to develop scalar indicators dedicated to gravity estimation. Our belief is that the geometry modification of the fault will induce a change in the kinematics of the rolling-element bearing. Far from the ideal perfect-rolling assumption, the relationship between the races' rotation and that of the fundamental train is the fruit of complex interactions. What is usually summarized in the contact angle in the traditional fault frequency equations conceals various effects of axial-radial load ratio, skidding between the elements, and imperfect transmission. As the fault extends, these interactions may change with a direct impact on the fault characteristic frequencies. Bertoni and Andre [1] proposed to monitor these characteristic frequencies with the BeaFEM method to estimate the most probable contact angle. They showed on an academic test-bench run-to-failure experiment that monitoring the fault frequencies could be a valuable degradation indicator. The validation was done on stationary conditions with a main focus on instantaneous angular speed measurements. However, under non-stationary conditions, the equivalent contact angle is sensitive to various factors such as loading, angular acceleration, or lubrication. An extension of the method is presented to prove the relevance of the concept on an industrial case with non-stationary conditions. The role of apparent contact angle as a scalar accounting for the kinematics is clarified. The effect of load and rotation speed is assessed and the method adjusted to emphasize only the contribution of the fault. The method is applied to industrial vibration signals from a damaged wind turbine operating over a wide spectrum of speed and load conditions. This original approach provides a tailored tool for optimal maintenance decisions. [1]https://doi.org/10.1016/j.ymssp.2022.109891

Presenter(s) : MARSICK ADRIEN

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