Ultrasonic Statistical Prediction of Material Outliers in the Raceway of Railroad Bearing Components

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Abstract

According to the Federal Railroad Administration, many derailments in the United States are directly attributed to bearing defects and their corresponding failure. In particular, the material characteristics of the near surface raceway is especially important with respect to rolling contact fatigue resistance. Traditionally, the industry analyzes these important components using destructive means and attributes the statistical characteristics of a small sample to the entire group. A nondestructive measurement approach could have a major impact on rail safety because specific parts that may be susceptible to near-term spalling could be identified and removed from service. In this presentation, the relationship between ultrasonic scattering and the material state of railroad bearing races will first be described. Diffuse ultrasonic backscatter of shear waves has shown a clear correlation between the material state within the loading zone of parts. That research approach was then applied to several railroad bearing outer rings, also known as cups, that had various states of service life. In these parts, the majority of the raceway, which included visible spalls and pitting in some cases, was investigated. Oblique incidence measurements were performed to collect 45° shear backscatter signals at both 10 and 15 MHz with 1 mm x 1 mm spatial resolution. The data obtained from the C-scans were then analyzed using spatial variance curves which were smoothed and evaluated in terms of the peak variance amplitude and peak arrival time. Differences in the variance of entire raceways were clearly apparent. More importantly, the baseline variance from a new component can be used to identify the spatial position of backscatter signals that represent statistical outliers. These preliminary findings suggest that it may be possible to detect areas in the raceway that have material changes that could be more susceptible to spalling. Further research is needed to determine if these outliers indeed pose a higher risk of spalling using simulated service life testing. From this research, railroad safety can be improved because bearing failure could be mitigated through more quantitative inspections.