DEVELOPMENT OF A PREDICTIVE LIFE TOOL FOR TAPERED ROLLER BEARINGS USING MEASURED RESIDUAL STRESS AND RETAINED AUSTENITE DATA

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Case-carburized tapered roller bearings used in the railroad industry are manufactured with a dual-phase microstructure that consists primarily of tempered martensite and retained austenite. As-produced bearing inner races typically contain 20-25% retained austenite, and a compressive residual stress in the martensitic phase of approximately 275.8 MPa (40 ksi). The retained austenite phase is metastable, and will transform to martensite with sufficient thermal or mechanical energy during service. Transformation from an FCC to BCT structure leads to an associated 3-4% volume change, depending on carbon content. The increase in surface volume due to transformation, and the subsequent increase in compressive residual stress could indicate the onset of certain failure modes, including fatigue spalling. In addition, retained austenite transformation can lead to an increase in bore diameter, which could result in a loss of fit on the axle journal. Several bearing inner races with various service histories were measured with a Siemens x-ray diffractometer using chromium radiation. Results indicated that the transformation of retained austenite and resultant increase in compressive residual stress are interrelated with load and rolling cycles. This paper covers the development of a tool called the Service Load Factor (SLF) that relates changes in retained austenite and residual stress to the service history of railway tapered roller bearing components.