

FATIGUE LIFE EXTENSION OF STEAM TURBINE ALLOYS USING LOW PLASTICITY BURNISHING (LPB)

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ABSTRACT

Low Plasticity Burnishing (LPB) dramatically improves the damage tolerance of titanium alloy blades, mitigating blade-disk dovetail fretting and blade edge damage in gas turbines. LPB surface treatment of martensitic stainless steels Alloy 450 and 17-4PH subject to corrosion fatigue and pitting in the low-pressure sections of steam turbines has now been investigated. Condensation in the low-pressure steam turbine environment supports corrosion pitting and corrosion fatigue in martensitic stainless steels, primary failure mechanisms driving steam turbine repair and operational expense.

Chloride corrosion fatigue results with and without high k_f surface damage are compared for LPB, shot peened, and machined 17-4PH; and for ground and LPB treated Alloy 450. The depth and magnitude of compression achieved by the surface treatments are documented. LPB increased the undamaged fatigue strength of 17-4PH by 30% in neutral salt solution, and of Alloy 450 in acidic salt by 50%. In both alloys LPB mitigated damage to the 1 mm depth of compression. The cyclic stress corrosion component of corrosion fatigue was eliminated by the deep LPB compression, effectively restoring the endurance limit lost in active corrosion fatigue in both alloys. LPB offers a cost effective means of improving corrosion fatigue performance and damage tolerance of martensitic stainless steel components in steam turbine service.

Keywords: Residual Stresses, Surface Enhancement, Corrosion Fatigue, High Cycle Fatigue (HCF), Low Plasticity Burnishing (LPB), Shot Peening (SP), Foreign Object Damage (FOD)