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Do corrosion pits eliminate the benefit of shot-peening?

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Abstract

The impact of corrosion pits on the beneficial effect of shot-peening of 12Cr steam turbine blade steel has been evaluated under fatigue loading conditions in air. The fatigue limit was measured for pits of depth in the range 50 μm to 300 μm , typical of depths to be expected in a reasonably well-managed operating plant but with occasional transient excursions in water chemistry. X-ray diffraction (XRD) measurements indicated that the compressive residual stress approached zero at a depth of about 250 μm , yet a significant benefit of this residual stress on the fatigue limit was still retained with the pit of depth 300 μm . An explanation could be found in finite element analysis, which predicted a reduced net tensile stress range and mean stress at the base of the pit in the shot-peened specimen. The fatigue crack growth rate from a corrosion pit was also reduced by the residual stress, until the crack attained a depth of 0.9 mm, well beyond the depth of compressive residual stress. An explanation based on constraint to lateral crack propagation near the surface and its impact on stress intensity factor at the crack base is proposed.

Keywords: shot-peening, pitting, fatigue, finite element analysis

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