In the SPOTLIGHT

S³P INCREASES FATIGUE LIFE

ENHANCED ENDURANCE AND STRENGTH

HIGHER LOAD CAPACITY

LONGER SERVICE DURATION

MAINTAINED CORROSION RESISTANCE

Bodycote

SPOTLIGHT

S³P – Specialty Stainless Steel Processes
Fatigue

Almost all components in technical applications experience alternating mechanical stress during their use. This can cause damage to the material, which increases with each load cycle and can ultimately lead to a fracture of the component (Fig. 1).

What is material fatigue?

Material fatigue occurs when cyclic load (pressure, tension, bending or torsion) creates localised, progressive structural damage in a material. This damage results in small cracks that will continue to grow through additional loading cycles until failure occurs. This type of damage arises even when the experienced load range is far below the static material strength. The load level and frequency, material quality (e.g. stress concentrations), structural vulnerabilities (e.g. welding) and environmental factors all affect the service lifetime of a component. With regard to harsh environments, stainless alloys are the material of choice in various industries where corrosion resistance is of utmost importance. However, this highly favourable property is often opposed to relatively modest mechanical properties, particularly fatigue and wear resistance.

Longer product lifetime with S³P

The ideal solution, designed to both maintain outstanding corrosion resistance and provide improved mechanical properties is S³P surface hardening. S³P treatments, featuring Kolsterising® and S³P ADM, are proprietary processes developed by Bodycote to significantly improve the performance of almost all corrosion-resistant Fe-, Ni- and Co-based materials, by increasing the surface hardness. The large compressive residual stresses within the diffusion zone, introduced by supersaturation of C/N interstitials, provide enhanced surface hardness and fatigue life. Due to low process temperatures, the superb corrosion properties of the stainless grades are maintained.

Fatigue strength significantly improved

Rotating bending fatigue tests acc. ISO 1143 with 50 Hz load frequency were performed on austenitic stainless steel AISI 316L (1.4404) to generate a fatigue-life curve, shown in Fig. 2. The tests indicated that low temperature surface hardening by S³P enhances the fatigue strength by more than 40 % (521 MPa) versus untreated material (366 MPa). These results are attributed to the high compressive residual stresses present in the treated layer, which delay crack initiation.

Additional testing conducted in a corrosive environment resulted in an at least 10 times longer fatigue life with S³P treatment, compared to the untreated material, which failed after 1 million cycles. Notice the corrosive attack on the fracture surface of the untreated material, due to crevice conditions created by cracks, whereas the S³P-treated sample shows no signs of corrosion (Fig. 3).

Advantages of S³P

- Increases fatigue strength and service duration
- Durable and safe components
- Improves wear resistance
- Maintains corrosion resistance

Fig. 1 Fatigue fracture of a propeller blade (AISI 304, 1.4301).

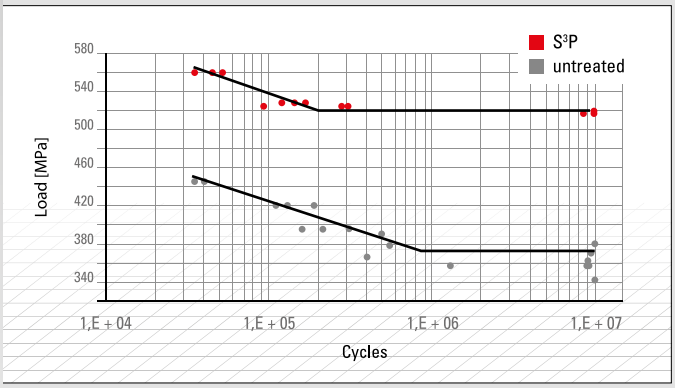

Fig. 2 Fatigue life curves of material AISI 316L in untreated and S³P-treated condition; overall 40 % higher fatigue strength with S³P.

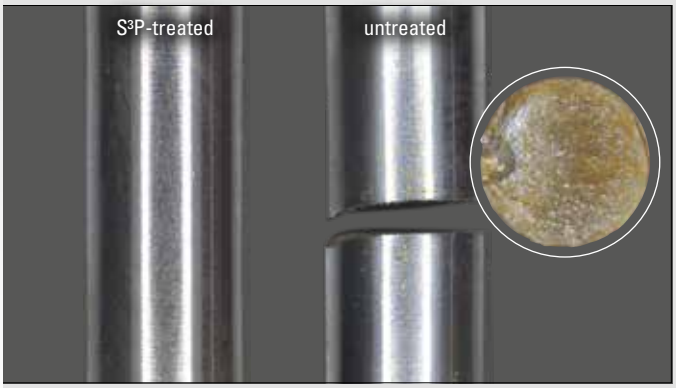

Fig. 3 Ten times improved fatigue life of S³P-treated sample AISI 316L (1.4404), also under corrosive load (5 wt.% NaCl-solution, < 35 °C, 400 MPa bending load, 15 Hz). No failure even after over 10 million cycles.

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