Fatigue and Stress Relaxation

Fatigue

Fatigue is the main failure mechanism in a material that is subjected to fluctuating loads. Under cyclic loading, localized slip bands can form in regions of high localized stresses. As fluctuating loading continues, these bands increase in number and small microscopic cracks form. Given enough time and stress amplitude, the cracks will grow and propagate through the wall of the seal resulting in a fatigue failure and leakage.

Stress Relaxation

Any highly stressed component, held at high temperatures, is subject to a form of permanent deformation known as stress relaxation. Unlike creep, stress relaxation occurs in a relatively short period of time, typically in as little as 100 hours of exposure time. This is an important design consideration in any critical sealing application at elevated temperature. Stress relaxation compromises both the sealing load and springback properties of the seal, impacting its ability to maintain sealing integrity under both static and dynamic conditions.

Seals designed for greater springback are more resistant to fatigue due to a combination of cross sectional geometry and material properties including temper.

Parker Hannifin has extensive experience designing and testing seals to combat the negative effects of stress relaxation. Our seals are designed to optimize resistance to stress relaxation through careful consideration of geometry, materials and appropriate heat treatment.