FIGHTING CORROSION IN SEALING SYSTEMS

Since the first steel structures and implements were created, mother nature has used the relentless power of corrosion to limit the service life of steel components. In this never ending battle of metals against the elements, the National Association of Corrosion Engineers (NACE) estimates that over $200 billion is lost by manufacturers every year to corrosion damage.

Even in high technology stainless steel instrumentation products corrosion can reduce the stability and service life of components much quicker than expected. Stainless steel is of course more resistant than many metals to the ravages of the elements, but damage occurs nevertheless.

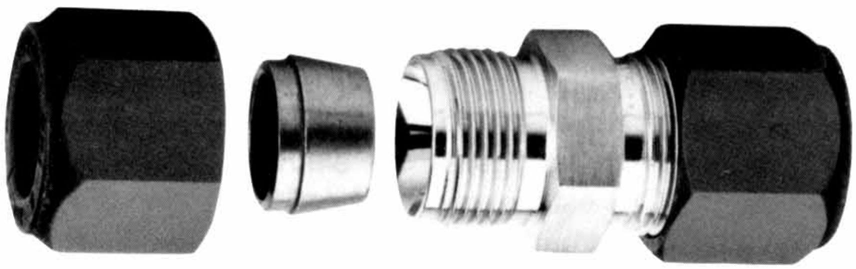
Hardening Stainless Steel Ferrules to Improve Sealing

Ease of installation and reliability caused a rapid growth in the use of stainless steel instrumentation fittings after their introduction. These fittings were initially designed to compress the ferrules onto the tubing, but more demanding applications - higher pressures and temperatures would require a design that gripped the tubing more securely. This modification ensured fitting integrity to the pressure limits of thick wall tubing and improved sealability even on tubing damaged during handling or installation.

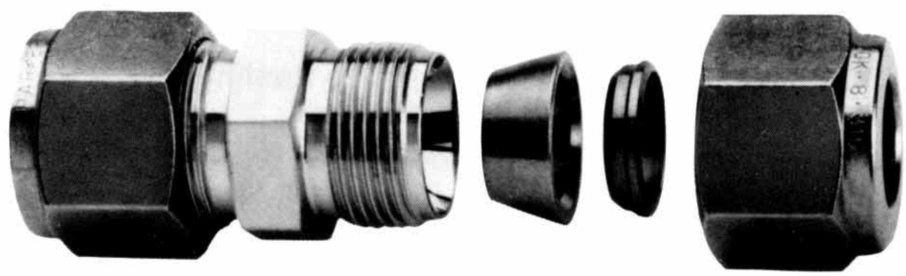
Parker's Instrumentation Connectors Division was not alone in recognizing the potential for improved performance, and soon all fitting manufacturers were chemically hardening the leading edge of ferrules to improve the grip on the tubing. However, all traditional hardening processes for stainless steel reduce its corrosion resistance. So the challenge was to identify a stainless steel hardening process that would provide improved gripping of the tubing and still maintain the corrosion performance of the stainless steel fitting and tubing.

SUPARCASE: THE INVISIBLE BREAKTHROUGH

Over the years, Parker Hannifin took the lead in the development of a metallurgical hardening process that would be better suited for stainless steel ferrules designed to grip and seal tubing. Parker's Research and Development Department, composed of engineers and metallurgists, tested and evaluated hundreds of processes with the following criteria: retain the gripping and sealing ability of the hardened stainless steel ferrule, and resist the corrosion damage caused by harsh media or environment.



Parker CPI Tube Fitting (with Suparcase Ferrule)



Parker A-Lok Tube Fitting (with Suparcase Rear Ferrule)

Now Parker has developed a technological breakthrough which accomplishes these goals. It is called Suparcase.

Advantage

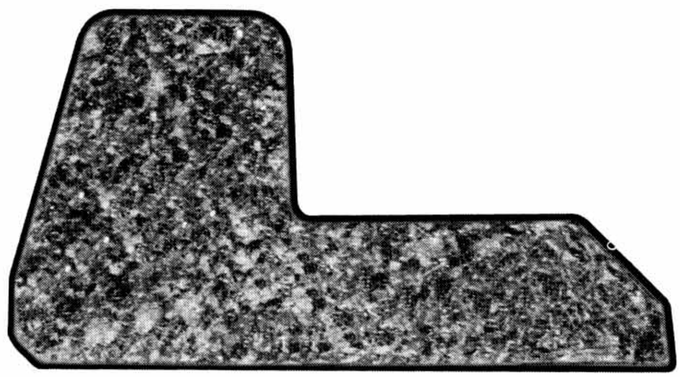
Suparcase is a proprietary metallurgical process for the treatment of stainless steel that imparts a unique combination of characteristics: high hardness and exceptional corrosion resistance. The Parker Suparcase ferrules offer important advantage over ferrules hardened by conventional process: sustained fitting integrity in demanding applications and corrosive environments.

SUPARCASE RESEARCH DATA

Considerable information about the mechanical properties and corrosion resistance of Parker Suparcase was developed during the investigations and research programs that culminated in the Parker Suparcase ferrules.

Metallurgical Structure

The Parker Suparcase process forms a uniform, hard continuous case on the treated ferrule, as shown below. Suparcase is not a coating.

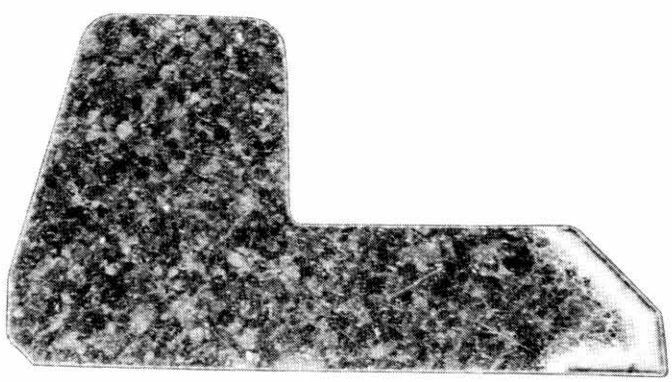


Parker A-Lok Rear Ferrule "Suparcase"

The grain structure of the base metal continues through the Parker Suparcase. The microstructure of the interior is typical austenitic stainless steel.

The Parker Suparcase is even resistant to the etchant used to study the microstructure of 316 stainless steel.

The microstructure of the leading edge of a competitor's ferrule hardened by a traditional process is shown below.



Competitor's Rear Ferrule "Traditional Hardening"

Note the strong reaction of the hardened area to the etchant, indicating its reduced corrosion resistance. The structure under the hardened area has significant carbide precipitation at the grain boundaries.

The structure shown in the figure is not the only hardening process used by competitors, however all traditional hardening processes increase the susceptibility to corrosion.

Corrosion Resistance

The corrosion resistance of Parker Suparcase has been investigated extensively. Measurements of weight loss with time of exposure to corrosive solutions yielded these results:

Corrosive Solution	Suparcase Ferrule Weight Loss
10% Acetic Acid	Not measurable
10% Nitric Acid	Not measurable
10% Sulfuric Acid	Not measurable
5% Sodium Hypochlorite	Not measurable
5% Sodium Thiosulfate	Not measurable

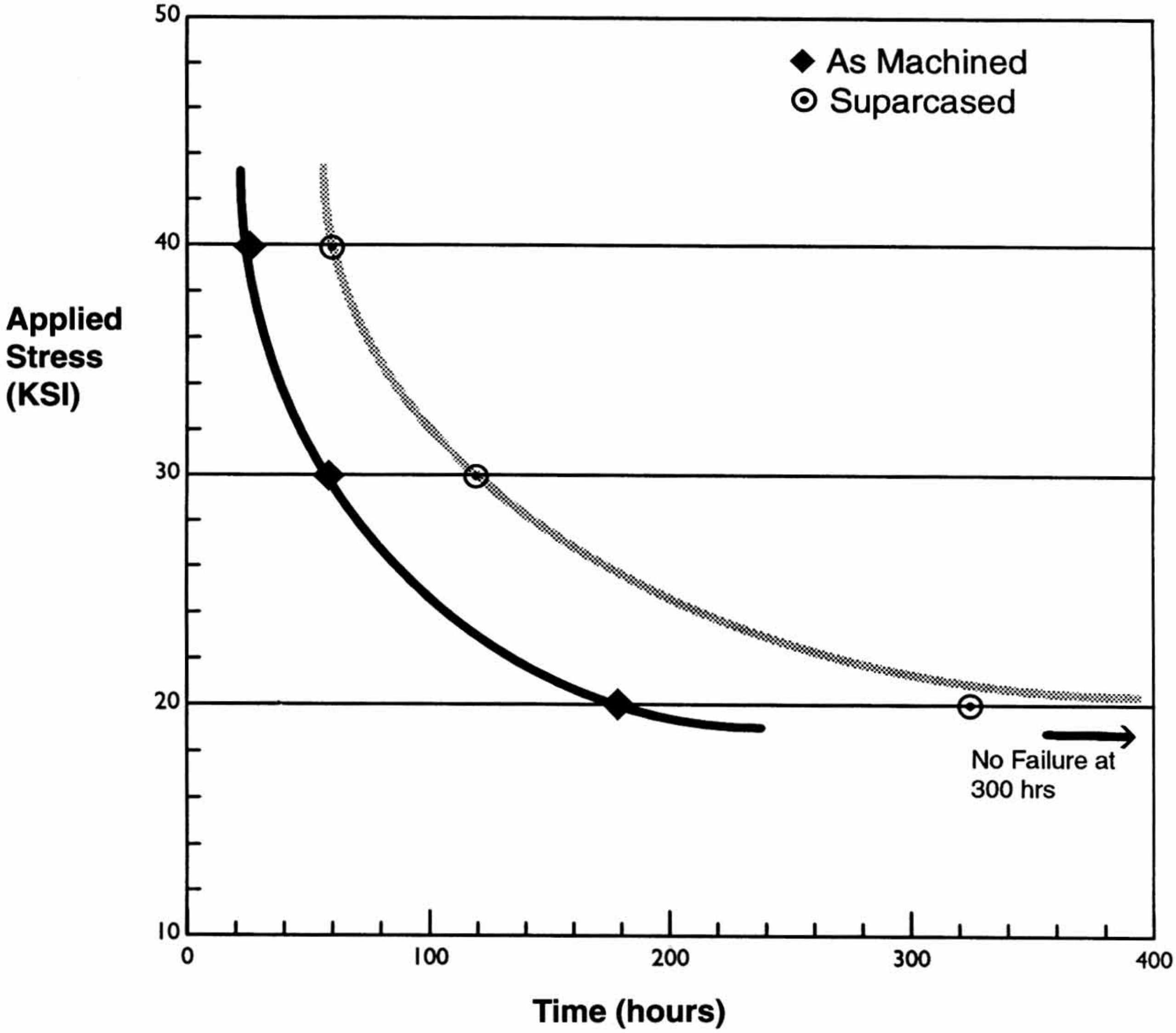
Total time of exposure - 54 hours
Temperature of exposure - 22 degrees C

Stress Corrosion Resistance

Since an instrumentation tube fitting ferrule is under stress in use, tests for stress corrosion cracking (SCC) resistance were run in chloride, sulfide and caustic environments. These tests were performed with ASTM 0.125 inch diameter miniature round tensile bar specimens in the as-machined Suparcase condition.

The chloride SCC test was performed per ASTM G 36: "Std. Practice for evaluating Stress-Corrosion-Cracking Resistance of Metals and Alloys in a Boiling Magnesium Chloride Solution" (Streicher Test). The results indicate that Suparcase 316 stainless steel is significantly superior to untreated 316 stainless steel, as seen in the following graph.

STRESS CORROSION TEST RESULTS
42% $MgCl_2$ BOILING 152° C



When stressed at 20,000 psi, the untreated sample fractured after 160 hours, whereas the Parker Suparcase sample had not failed at the termination of the test (300 hours).

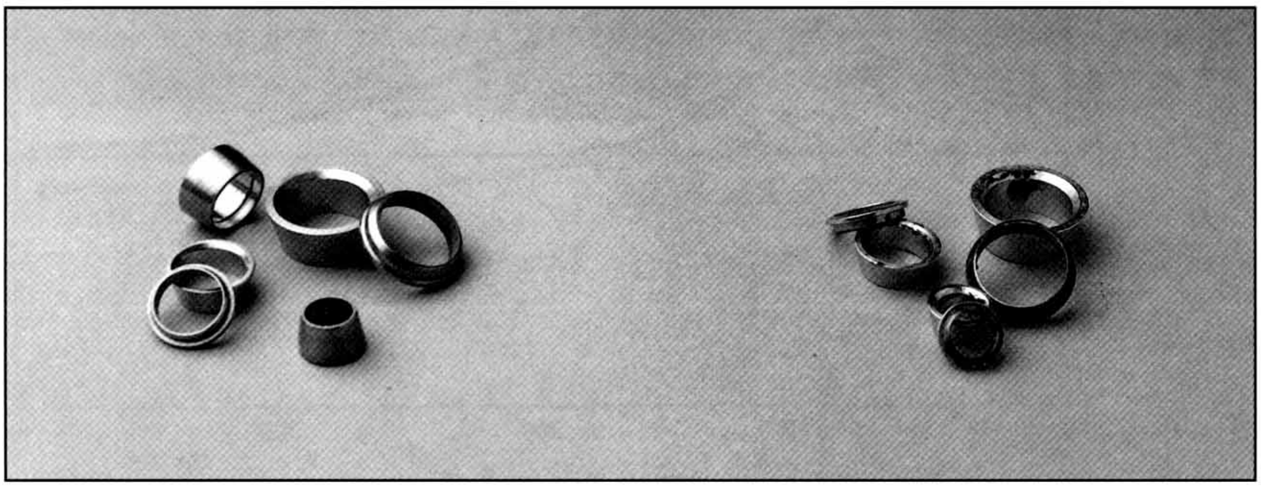
Metallographic examination of the fractured samples showed very different characteristics, with fewer crack initiation sites and much less crack branching in the Parker Suparcase sample.

Sulfide SCC testing was performed in an H_2S + NaCL + acetic acid environment per the NACE (National Association of Corrosion Engineers) Test Method TM-01-77, and caustic SCC testing was performed in 35% NaOH boiling at 125 degrees C. No significant differences were found between the untreated and Parker Suparcase samples in the sulfide and caustic SCC tests. This indicates that the Parker Suparcase ferrule performs similarly to the other 316 stainless steel components of a Parker instrumentation fitting in these environments.

Salt Spray Corrosion Resistance

Salt spray corrosion testing was performed on Parker Suparcase ferrules per ASTM B 117: "Std Method of Salt Spray (Fog) Testing." No evidence of corrosion was found on the Suparcased ferrule even after 30 days exposure.

The photos below show the lack of corrosion damage demonstrated by a Parker Suparcase ferrule versus a ferrule hardened by a traditional process and exposed to salt spray for only 72 hours.



Parker A-Lok/CPI Ferrules **Competitor's Ferrules**

TEMPERATURE LIMITATIONS

The temperature limit for Type 316 stainless steel is determined by the temperature at which segregated carbide precipitation (sensitization) substantially decreases corrosion resistance. Parker Suparcase ferrules are fully functional up to the temperature limits described in ANSI/ASME B31.1 Chemical Plant and Petroleum Refinery Piping and similar standards. Ferrules hardened by many traditional hardening processes are already susceptible to corrosion in some areas prior to use.

PARKER SUPARCASE APPLICATIONS AND ADVANTAGES

Parker Suparcase is available on CPI single ferrule and the rear ferrule of A-lok double ferrule fittings. They are ideal in demanding applications with corrosive environments. Examples:

Offshore Oil Production

Refinery Instrumentation

Co-generation Operations

Environmental Operations

Black Liquor Controls in Paper Mills

Semiconductor Manufacturing

SUMMARY OF ADVANTAGES

The Parker Suparcase ferrule offers the following features and advantages to the user:

1. Superior or equal to Type 316 stainless steel in a broad range of corrosive applications.
2. Not affected by normal working temperatures of Type 316 stainless steel.
3. Superior resistance to pitting compared to Type 316.
4. Superior to Type 316 in stress corrosion tests.
5. A high surface hardness to prevent galling and increase remakes.
6. Proven in field applications throughout the world.
7. Improved shelf life in corrosive environments.

Over the past several years, the Instrumentation Connectors Division of Parker has made continuous product improvements in forging quality, body seat and tube finish, pipe threads, I.D. surface finish, tighter tolerances and now ferrule hardening. Parker Suparcase, the ultimate product advantage.