mechanical engineering magazine

technologyfocus
FLUID HANDLING AND FLUID POWER

Hard Case of Stainless

A manufacturer of fluid control devices says it has developed a new process for surface hardening stainless steel without compromising corrosion resistance. The treated steel has been used in its products, and now the company wants to treat steel for a fee.

The manufacturer, Swagelok Co. in Solon, Ohio, has patented the process, which it calls SAT12, and describes it as "a method for heat-treating austenitic stainless steels that enables large-scale carbon absorption." The result, the company says, is significantly improved surface hardness without loss of corrosion resistance. The company also claims that the process enhances other performance characteristics of common steels besides surface hardness. Aided by a grant from an Ohio state agency, Swagelok formed a subsidiary, Swagelok Technology Services Co., early this year to harden steel for customers.

The company says the process diffuses carbon atoms into the crystal structure of the stainless steel and avoids the creation of carbides with chromium atoms. It is the formation of chromium carbide that compromises corrosion resistance when carbon is added to harden stainless steel by common methods.

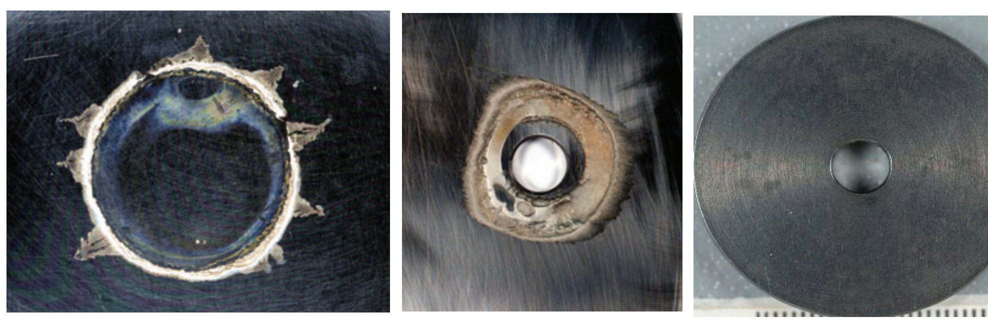
The SAT12 process is described in the company's literature: The stainless steel is placed in an atmosphere of carbon-assisted hydrogen chloride gas to remove the passive oxide layer that forms when stainless is exposed to the atmosphere. If it were not removed, the layer would block carbon diffusion into the surface. (The layer will form again when the steel is reintroduced to air.)

The steel is next heated in a mixture of gases containing carbon at a low temperature for several hours. The temperature is high enough to promote carbon atom diffusion, but too low to start carbide formation.

After additional heating, the processed steel contains carbon atoms in the interstitial space of the unit cell, expanding the crystal lattice and increasing its hardness.

The hardened surface layer is about 25 micrometers thick after treatment in the furnace for two to three days. The company claims that it has measured hardness close to the surface of treated 316L stainless of about HV1200, comparable to 70 Rockwell C, in the range of tool steel, and about four to five times the hardness for bulk 316L. The thickness of the hardened layer can be increased by longer or additional treatments.

The company said that finished components have been treated without distortion or change of dimension, and the technology can be used on other alloys besides austenitic stainless steels.



Samples tested for a week in saltwater under an applied potential of 300 mV. From left: Alloy 625 initiated crevice corrosion after less than 60 hours of exposure; untreated 316L stainless initiated crevice corrosion in less than an hour of exposure; 316L treated with the SAT12 process showed no initiation or signs of etching after more than 160 hours.

U.S. NAVAL RESEARCH LABORATORY

Farrel Martin of the U.S. Naval Research Laboratory in Washington, D.C., is one of nine authors of a paper, "Localized Corrosion Resistance of LTCSS-Carburized Materials to Seawater Immersion," in volume 3 of *ECS Transactions*, published in 2006 by the Electrochemical Society. "LTCSS" abbreviates another name for the surface-hardening process, "low temperature colossal supersaturation."

Besides representatives of the laboratory, the paper's authors include Arthur Heuer and others at Case Western Reserve University in Cleveland.

The paper describes tests of corrosion resistance of treated 316L stainless steel. Samples were placed in ambient-temperature seawater under an applied potential of 300 millivolts. According to Martin, treated 316L showed no signs of etching after more than 160 hours in the water, and performed on a par with titanium 6-4 and wrought Alloy C-22. Untreated 316L began to erode in less than an hour.

Swagelok says testing has also shown improvement in resistance to wear and fatigue. The company is recommending treated steels for uses ranging from pump and circulation systems to fasteners, industrial components, and medical devices. The company's original use for treated steel was in a two-ferrule tube fitting.

One ferrule creates a gas seal and the other works with it to hold tubing across a broad area, isolating it from the stress of vibration. Swagelok says the design relies on the case-hardened rear ferrule to grip the tube effectively.

John Buda, president of Swagelok Technology Services Co., said the company has not ruled out eventual licensing of the technology, but is launching the business by treating parts for customers. Sheet metal can also be treated and the product is ductile enough to be formed. Parts manufactured with cuts or welds, he said, are better treated as finished parts.

He was reluctant to quote prices, but said the process can take 316L and raise its surface properties to the quality of Hastelloy, for example, and the resulting part will still be significantly cheaper than one of Hastelloy.