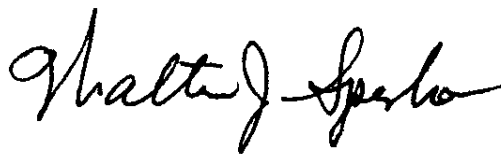


Evaluation of
Wonder Gel[™] Stainless Steel Pickling Gel
and
Derustit SS-3[™] Stainless Steel Cleaner

Prepared for

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Executive Summary

Bradford *Wonder Gel™* and *Derustit SS-3™* are aggressive chemical products that will readily clean and passivate stainless steel welds with moderate levels of oxidation as well as remove ugly red rust stains caused by contamination of stainless steel by contact by ordinary steel. For efficient cleaning, heavy black oxides along welds should be broken up by power wire brushing prior to apply these products. Personnel who use these products must have the proper training to handle them.

Introduction

Many years ago, I published a paper on Sperkoengineering.com, “Rust on Stainless Steel! OMG!!!” That paper points out that red rust on austenitic stainless steel (types 304, 304L, 316, etc.) is normally the result of stainless steel coming into physical contact with carbon steel, trace amounts of the carbon steel rubbing off on the stainless steel surface and, after exposure to moisture in the atmosphere, creating ugly red rust stains. See Figure 1.

Among the products that I recommend for removing such rust are those manufactured by Bradford Derustit Corporation, *Wonder Gel™ Stainless Steel Pickling Gel* and *Derustit SS-3™ Stainless Steel Cleaner*. These products have been around for over 50 years; their active ingredients include aggressive inorganic chemicals that are similar to the chemicals specified in ASTM A380, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*, so surfaces cleaned successfully with these products will not only be free of contamination, but they will also be passivated giving surfaces cleaned with them optimum corrosion resistance in service.

Bradford Derustit was kind enough to send me samples of the above products with a request to evaluate them. Because they are corrosive, Bradford Derustit products should be handled only by trained personnel wearing appropriate personal protective equipment. Go to www.Derustit.com for product safety data sheets, but do not hesitate to contact Bradford Derustit directly for specific guidance for your application.

Testing of *Wonder Gel™*

Over the years I have collected samples of various materials, including several welded stainless steel parts. Depending on the welding process and the thickness of the material, surface oxides created by welding can be shades of yellow, brown, blue and black. These oxides are much more difficult to remove than ugly red rust caused by contamination with free iron. Figure 2 shows a 2 inch schedule 10 stainless steel tube that was welded using automatic GTAW (i.e. orbital TIG welding). The edges of the weld exhibited a narrow band of discoloration which *Wonder Gel™* removed with one application. Figure 3 shows another section of pipe that was welded using SMAW (i.e., stick welding) and GTAW. Those welds were also cleaned readily by *Wonder Gel™* except for some shallow surface porosity and crevices which physically trapped the black oxides making them hard to remove with one application.

A significantly more challenging condition is shown in Figure 4. These samples were prepared courtesy of Don Ellington, Welding Instructor, Guildford Technical Community College in Greensboro, NC. The welding process was SMAW and, since the parts were thin, heavy black oxides developed along the heat-affected zone, and this proved difficult to remove. See Figures 5 and 6. The discoloration on backside of the plates in Figure 4 was partially cleaned using *Wonder Gel™* and the results are shown in Figure 7.

The welder inadvertently touched the welding electrode to the plate surface creating the arc strike shown on the surface of the plate shown in Figure 4. Figure 8 shows what the arc strike looked like before and after applying *Wonder Gel™*. The composition of the arc strike material is not known, but the results after applying

the *Wonder Gel™* indicate that it is not stainless steel. Arc strikes should be removed by grinding before applying *Wonder Gel™*.

Wonder Gel™ was easy to apply, adhering nicely to a soldering brush for application as shown in Figure 12. A moderately thick coating clung to the parts. While not shown, I did apply the *Wonder Gel™* to one of the half-pipe samples in the overhead position, and the gel adhered nicely. *Wonder Gel™* can be removed with a gentle water rinse so that any residual acid drops into a sink or to the ground without splattering on the user. Rinsing the gel onto a concrete floor will etch the floor and damage it unless limestone or similar neutralizer is liberally applied to the floor. Rinsing should be followed by light scrubbing using a non-metallic stiff-bristle laundry brush or similar. I did note that the Gel separated slightly after setting in my hot garage this summer; it should be shaken before use.

Testing of Derustit SS-3

Several years ago, I wrote a paper that was published in *Welding Design and Fabrication* magazine where I compared the behavior of backing fluxes (i.e., Solar Flux, flux-coated wire, etc.) for putting in the root pass of stainless steel weld metal without using an inert backing gas; the article is posted on my web site. Figure 9 shows one piece from that work before immersing it in *Derustit SS-3™*, Figure 10 shows it in the *Derustit SS-3* and Figure 11 shows the pipe section after 4 hours in *Derustit SS-3™*. *Derustit SS-3™* is very aggressive, and, as the photographs show, readily removed welding oxides. The only exception was where the weld metal was ragged and the oxides were trapped in crevices of weld metal.

Derustit SS-3™ is a liquid, and cleaning with it has to be done by immersion or by forced circulation through a closed-loop system. Standard practices for working with strong chemicals must be followed for use and disposal once the work is done. See www.derustit.com or call Bradford Derustit for guidance.

Caution

Those using Bradford Derustit products should be trained in using it safely and should be provided with appropriate personal protective equipment. See www.derustit.com for Safety Data Sheets.

Summary and Conclusions

Bradford *Wonder Gel™* and *Derustit SS-3™* are aggressive products that will readily clean and passivate stainless steel welds with moderate levels of oxidation. Since these products readily remove moderately thick oxides and discoloration caused by welding, ugly red rust stains caused by contamination of stainless steel by contact with ordinary steel will be easily removed with these products. Welds in sheet metal should be power wire brushed before applying *Wonder Gel™* since thin sections tend to have more difficult-to-remove heavy, black oxides than thicker sections do. Surfaces that are rough or have arc strikes or porosity should be smoothed by grinding prior to application of *Wonder Gel™* or when using *Derustit SS-3™*. Personnel who use these products must have the proper training to handle them and waste washed from cleaned surfaces should be neutralized to prevent damage to other materials.

Figure 1



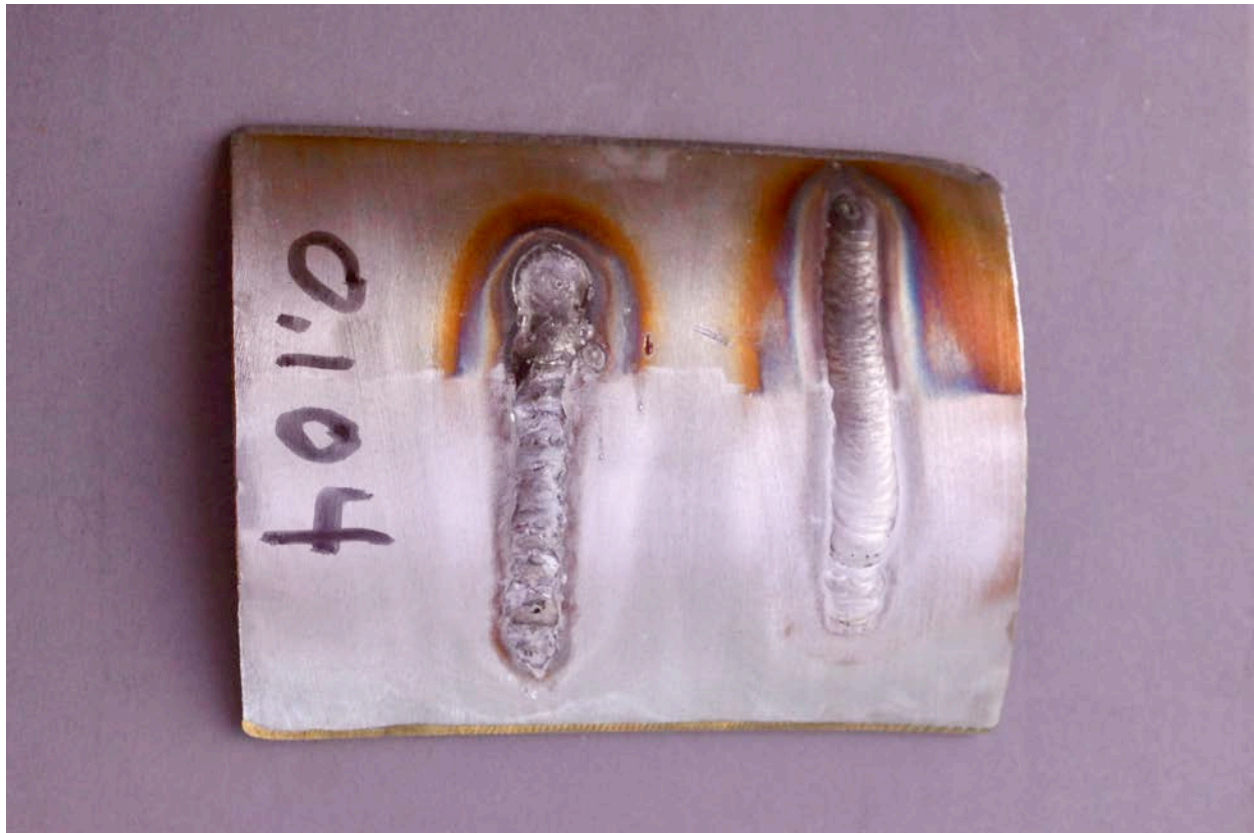
The photograph shows rust on the surface of stainless steel piping caused by contact with carbon steel during handling. This rust, while ugly, will not lead to failure of the pipe under ordinary atmospheric conditions. The proper tools must be used to remove this rust since some cleaning method such as power wire brushing will simply spread the rust further over the surface.

Figure 2



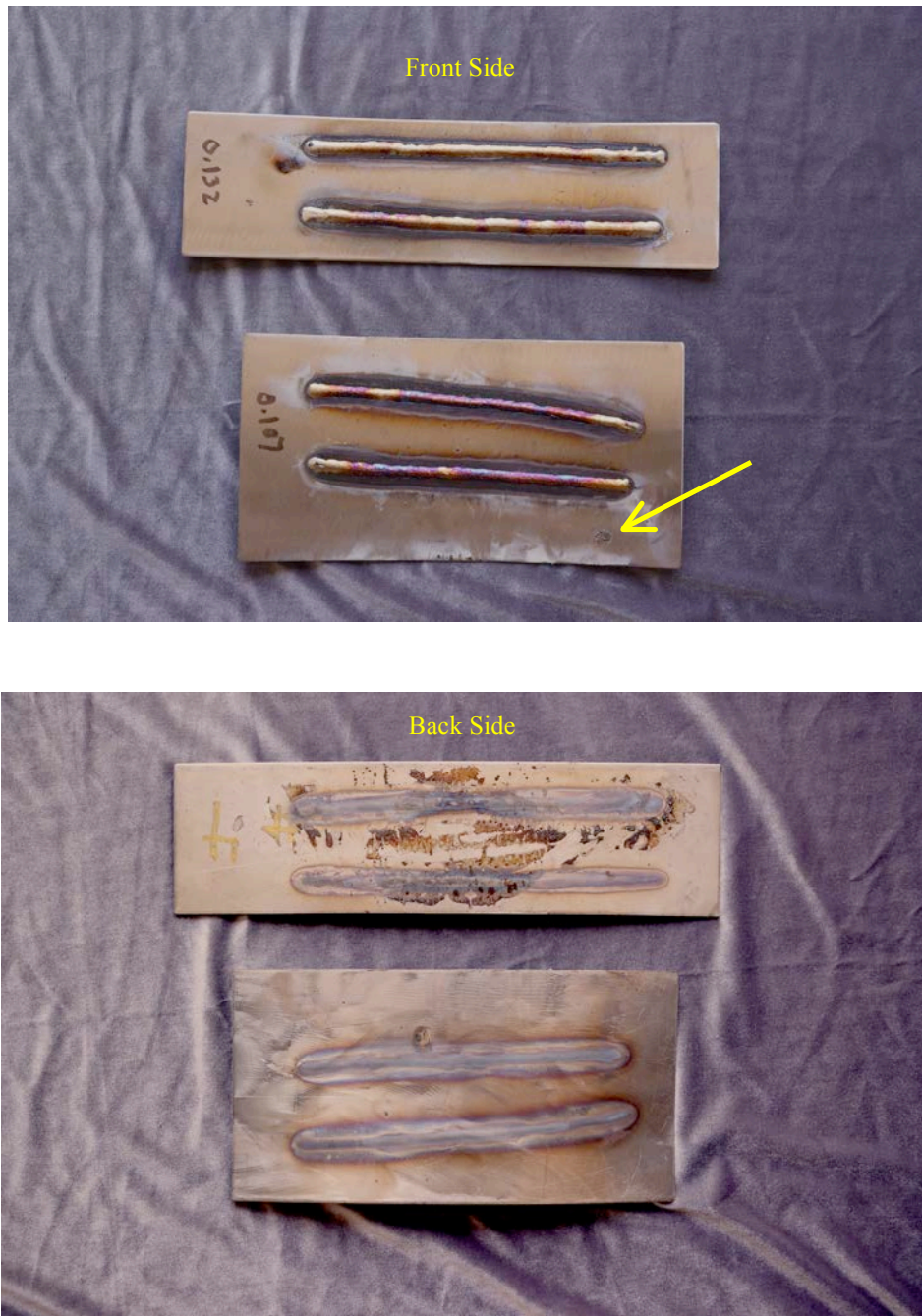
The photograph shows a 2 inch schedule 10 pipe butt weld made using automatic GTAW (i.e., Orbital TIG) before and after cleaning with *Wonder Gel™*. The cleaned surface is lightly etched where the oxides were present leaving a light shadow, but the surfaces are free of any oxides.

Figure 3



The photograph left side shows a section of pipe 0.104 inches thick that was welded using SMAW (i.e., ordinary stick welding); the right side was welded with GTAW before and after cleaning one time with *Wonder Gel*. The SMAW weld has some small flecks of oxide associated with surface irregularities and small porosity on the surface, and the GTAW weld is almost perfectly clean except for some small dots that are trapped in some shallow surface porosity.

Figure 4



The top photograph shows plates approximately 14 and 10 inches long that were welded using SMAW with E308L-16 electrode. The upper plate is 0.132 inches thick and the lower one 0.107 inches thick. There is an arc strike at the red arrow. While this difference in thickness would not seem to make much difference in welding, the surface oxides along the heat-affected zone were thicker and wider on the thinner plate than those on the thicker plate due to slower cooling of the thin plate. The thicker oxides of the thinner plate were found to be more challenging to remove. The lower photograph shows the backside of the plates. Note the heavy oxidation of these surfaces.

Figure 5



The photograph shows the 0.132 inch thick plate in Figure 3 after cleaning a short length of weld with *Wonder Gel*. The heavy oxides did not come off with one cleaning. The lower photograph shows the weld after a second cleaning with *Wonder Gel*. Some flecks of oxide remained along the edge of the weld after removing the *Wonder Gel* and brushing the weld with a stiff bristle brush.



Figure 6



The upper photograph shows the 0.107 inch thick plate welds after a short length of the weld was cleaned with *Wonder Gel*. These welds had a thicker oxide due to the slower cooling rate caused by the comparative thinness of the material, and that made it more difficult for the *Wonder Gel* to remove in one application. The lower photograph shows the weld after a second application with *Wonder Gel*.



Figure 7



The photograph shows the lower photograph in Figure 3 after cleaning most of the weld lengths one time with Wonder Gel. The material was 0.107 inches thick. The lower weld was made after the upper weld, so the plate was hotter when making the lower weld than it was when making the upper weld. As a result, the weld pushed through a little starting at the arrow and going rightward. That portion of the weld was near the melting point of the metal, about 2600°F while the weld was being made.

Figure 8



The photo shows the arc strike shown in Figure 4 and partially visible in the lower photo of Figure 5. The lower photograph shows what it looked like after being cleaned with *Wonder Gel*. Not unexpectedly, arc strikes were not removed by *Wonder Gel*; they should be removed by grinding before cleaning with *Wonder Gel*.



Figure 9



The top photograph shows the OD surface of a weld that was made using Solar Flux in lieu of inert gas backing of the root side. The lower photograph shows the root side. Note the roughness of the root weld metal. Figure 11 shows these surfaces after cleaning with Derustit SS-3.

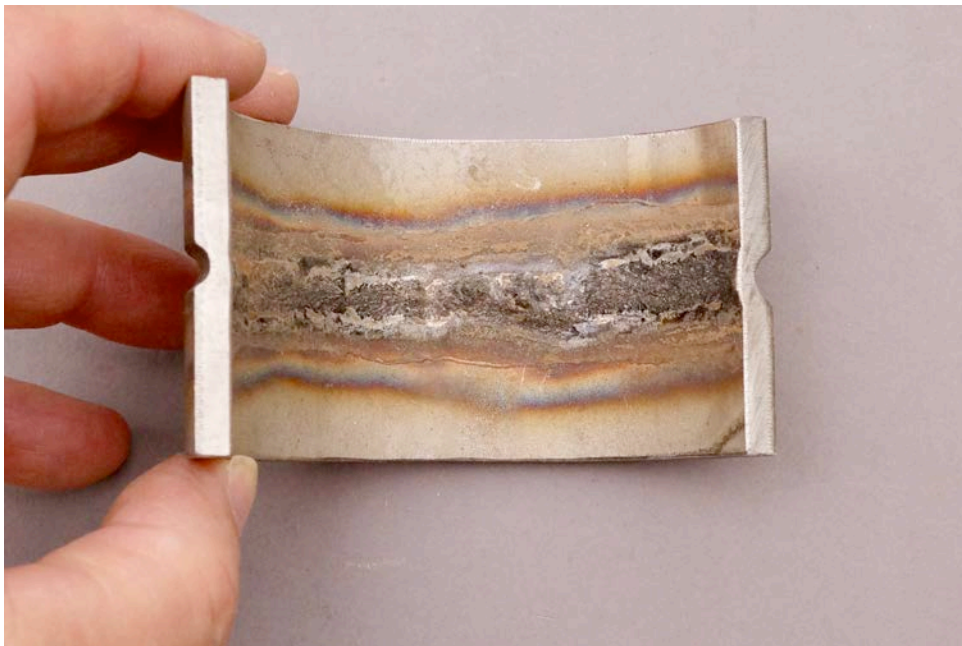


Figure 10



The photograph shows Wonder Gel attacking cutting slag. As the oxides are dissolved, the gel forms bubbles. When parts are immersed in Derustit SS-3, the bath bubbles, giving off acid fumes.

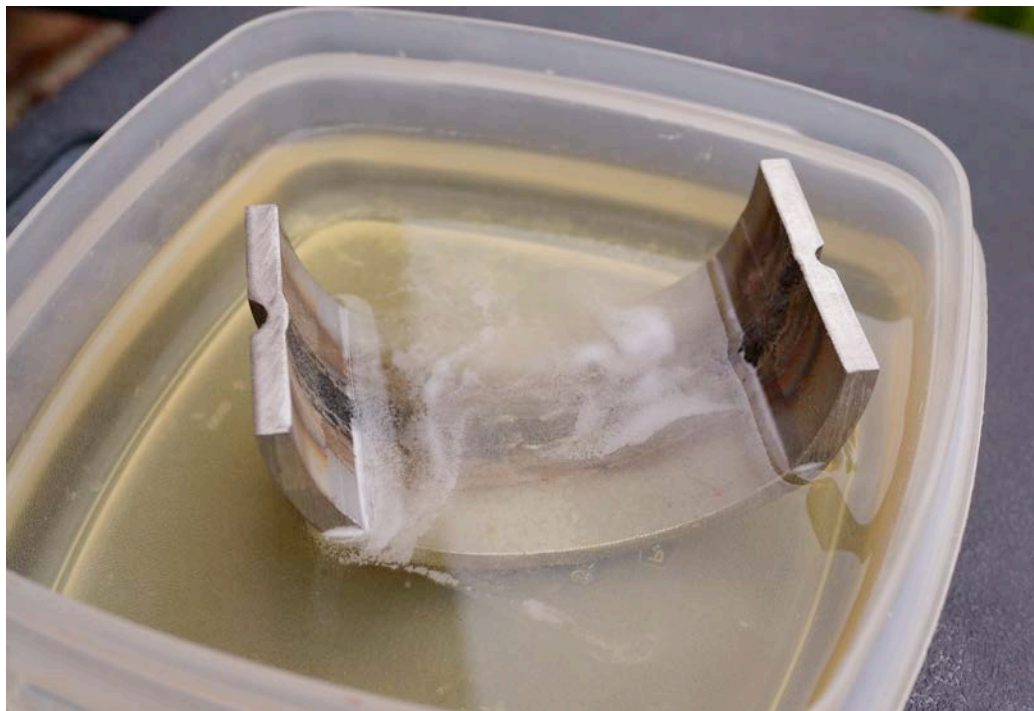


Figure 11



The photograph shows the pipe section shown in Figure 9 after immersion in Derustit SS-3 for 4 hours. On the face side photo, the weld is clean except for some residual oxides trapped in shallow undercut. In the root side photo, oxides are trapped in the surface roughness crevices.

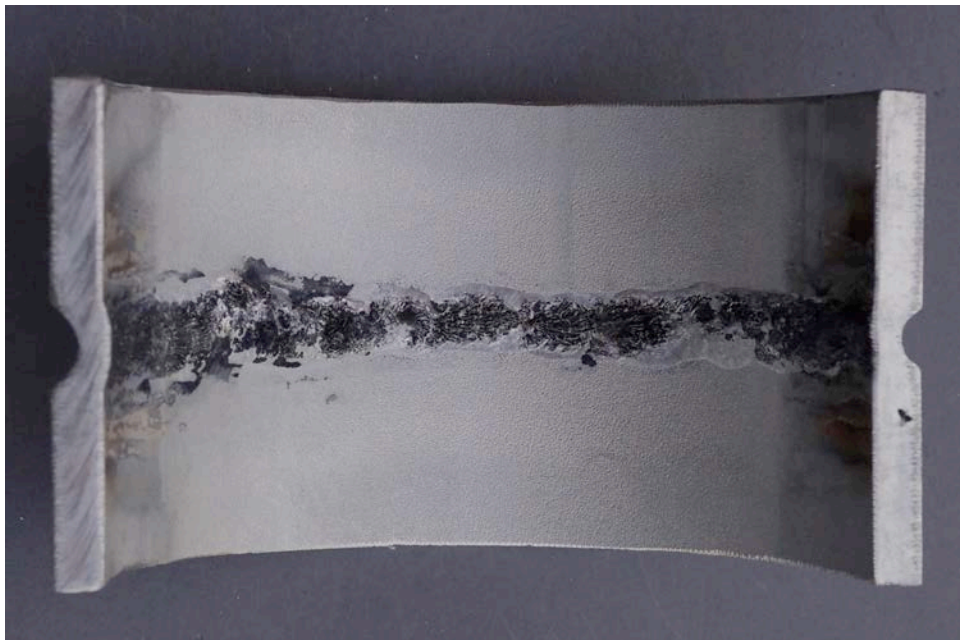
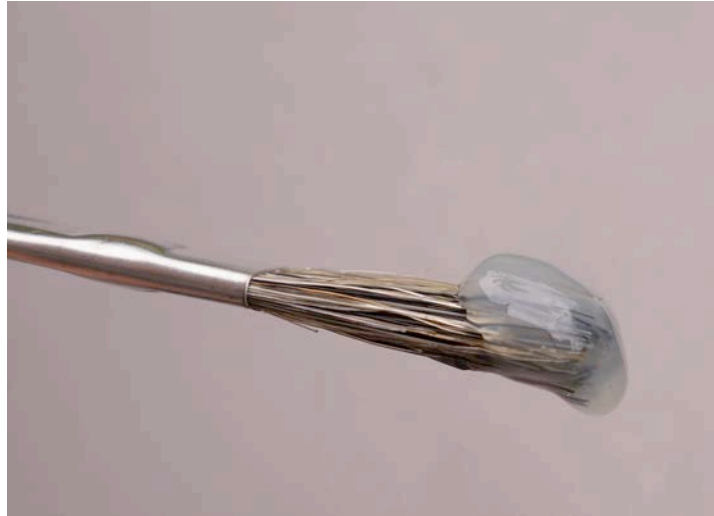


Figure 12



The photograph shows *Wonder Gel* on a brush for application. The Gel clings to the brush and to the surfaces on which it is applied readily. In order for it to clean any oxides off the surface, the Gel should be applied liberally. When the Gel stops bubbling (see Figure 10), rinse it off and brush the surface with a stiff bristle brush if any oxides are still present. If oxides remain trapped in porosity or crevices in the welds, reapply the Gel. If multiple applications are needed, one should consider precleaning with a power wire brush to break up any black oxides. Although the surface will appear clean, some of those oxides are imbedded in the metal surface and will oxidize when exposed to moisture as shown below if wire brush cleaning is not followed by an application of *Wonder Gel*.

