

PHORGOTTEN PHENOMENA

HEAT TINTS ON STAINLESS STEELS CAN CAUSE CORROSION PROBLEMS

ARTHUR H. TUTHILL, TUTHILL ASSOCIATES, INC.

RICHARD E. AVERY, AVERY CONSULTING ASSOCIATES, INC.

The dark heat tint formed alongside welds during welding of stainless steel (SS)—the heat-affected zone (HAZ)—is a thicker chromium oxide scale with a mixture of iron, nickel, and other oxides. When heat tint scale forms, chromium diffuses outward from the base metal in the heated zone. The zone extends as far as elevated temperatures allow chromium diffusion to occur. The diffusion of chromium into the scale leaves a thin chromium-reduced layer just beneath the heat tint scale. This thin layer is lower in chromium, the primary constituent that gives SS its good corrosion resistance. Corrosion that would not occur elsewhere can initiate in the HAZ unless the heat tint scale and the thin chromium-depleted layer just beneath are removed. Removal by rotating fiber brush, pickling, or electropolishing readily restores this area to base-metal resistance.

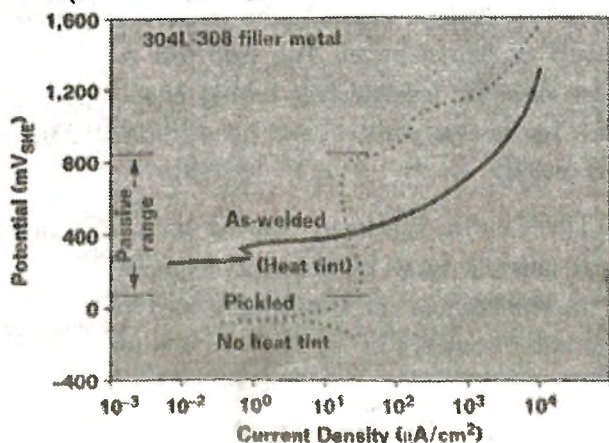
University of Tennessee laboratory investigations using polarized techniques showed base metal to be passive and resistant when clean and free of heat tint scale, as is the normal behavior for SS (Figure 1).¹ The

vertical section of the dotted curve shows the normal passive range typical of SS. The solid line for the HAZ as-welded (*i.e.*, with the heat tint scale intact and a chromium-reduced layer just beneath) has no significant vertical section, or no significant passive range.

The November 1998 *MP* article, "Effect of Chlorine on Common Materials in Fresh Water"², explained that, in potable water treatment, chlorine is added to precipitate iron and, to a lesser extent, manganese. Precipitation allows these elements to be filtered out. Potassium permanganate often is added in addition to chlorine to precipitate manganese more effectively.

Ferric hydroxide ($\text{Fe}(\text{OH})_3$) and manganic hydroxide ($\text{Mn}(\text{OH})_2$) precipitates form a black deposit on the pipe walls. The deposit is not harmful to SS or to the weld itself. However, it has led to corrosion in the HAZ of welds covered by heat-tint scale in fresh waters of low chloride ion content, where HAZ underdeposit corrosion would otherwise be unlikely to occur.³ Removal of the heat tint scale will restore the HAZ to its original corrosion resistance, which is equivalent to that of the base metal.

**POLARIZATION CURVES FOR TYPE 304L
(UNS S30403 AS-WELDED AND PICKLED)**



ACKNOWLEDGMENT

The authors thank the Nickel Development Institute for its support in the preparation of this information.

REFERENCES

1. P. Li, *et al.*, "Effects of Weldments in Microbial Fresh Waters", Corrosion/95, paper no. 151 (Houston, TX: NACE, 1995).
2. A.H. Tuthill, *et al.*, *MP* 37, 11 (1998), p. 52.
3. R.E. Avery, *et al.*, *MP* 35, 9 (1996), p. 59.

Note: Excerpted from NIDI reprint series.