

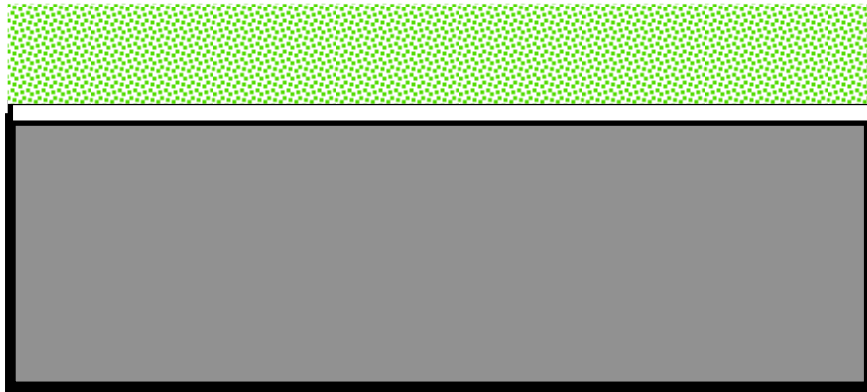


Passivation of Stainless Steels

2011 NTTC CTM Seminar

James D. Fritz
Outokumpu

Corrosion Resistance of Stainless Steels



Stainless steel is protected from corrosion by a thin layer (passive layer) consisting primarily of chromium oxide

Definitions – Passivation

1. Mechanism by which stainless steel will spontaneously form a protective film.
 - With stainless steels passivation occurs naturally in the presence of oxygen in the atmosphere or dissolved oxygen in aqueous environments.
2. Chemical treatment with an acid solution for the purpose of enhancing the formation of a protective film.

Chemical Passivation Treatments

- Removes free iron, sulfides, and other foreign matter
- Assist in the formation of a passive film with superior corrosion resistance
- Typically performed with nitric or citric acid solutions
- Will not remove oxide scale, heat tint, or accompanying chromium depleted zone

Pickling

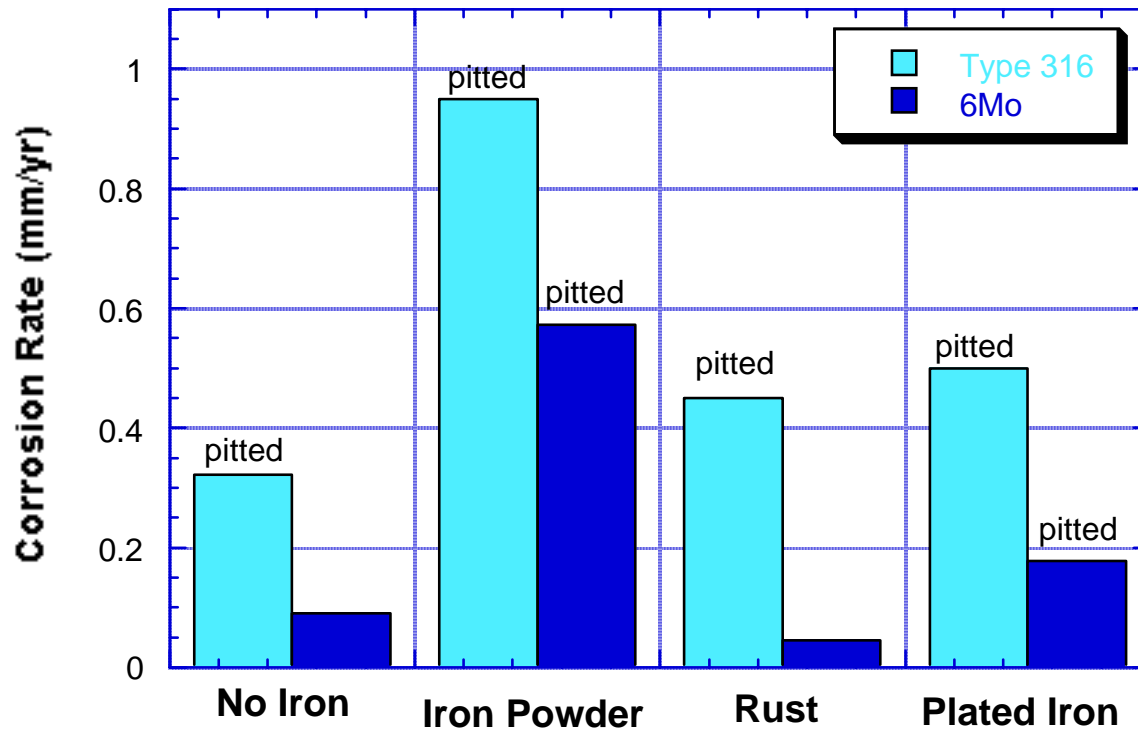
- Aggressive chemical treatment for removing oxides (de-scaling).
 - Removes oxides, chromium depleted areas, and some of the stainless steel surface.
 - With stainless steels nitric-hydrofluoric acid solutions are most widely used.
 - Pickling treatments result in a passive surface and subsequent passivation treatments are not necessary.

When is Natural Passivation Sufficient?

- The stainless steel surface should be clean and free of contaminants such as free iron, oxides, dirt, grease, and oil.
- The surface must have a smooth finish equivalent to 180 grit or finer.

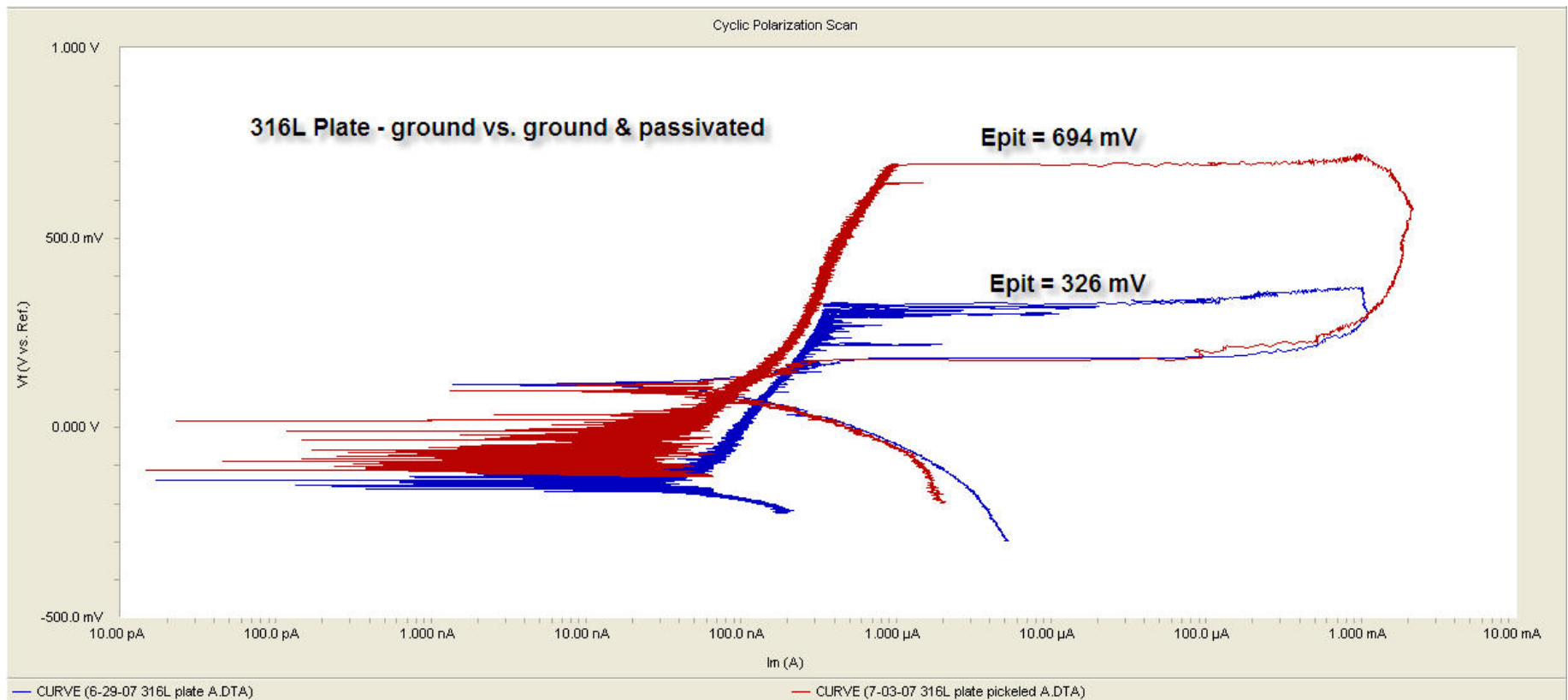
When is Chemical Passivation Recommended

- After fabrication operations such as grinding, cutting, welding, and cold forming
- When contaminants such as free iron are present
- After corrosive attack



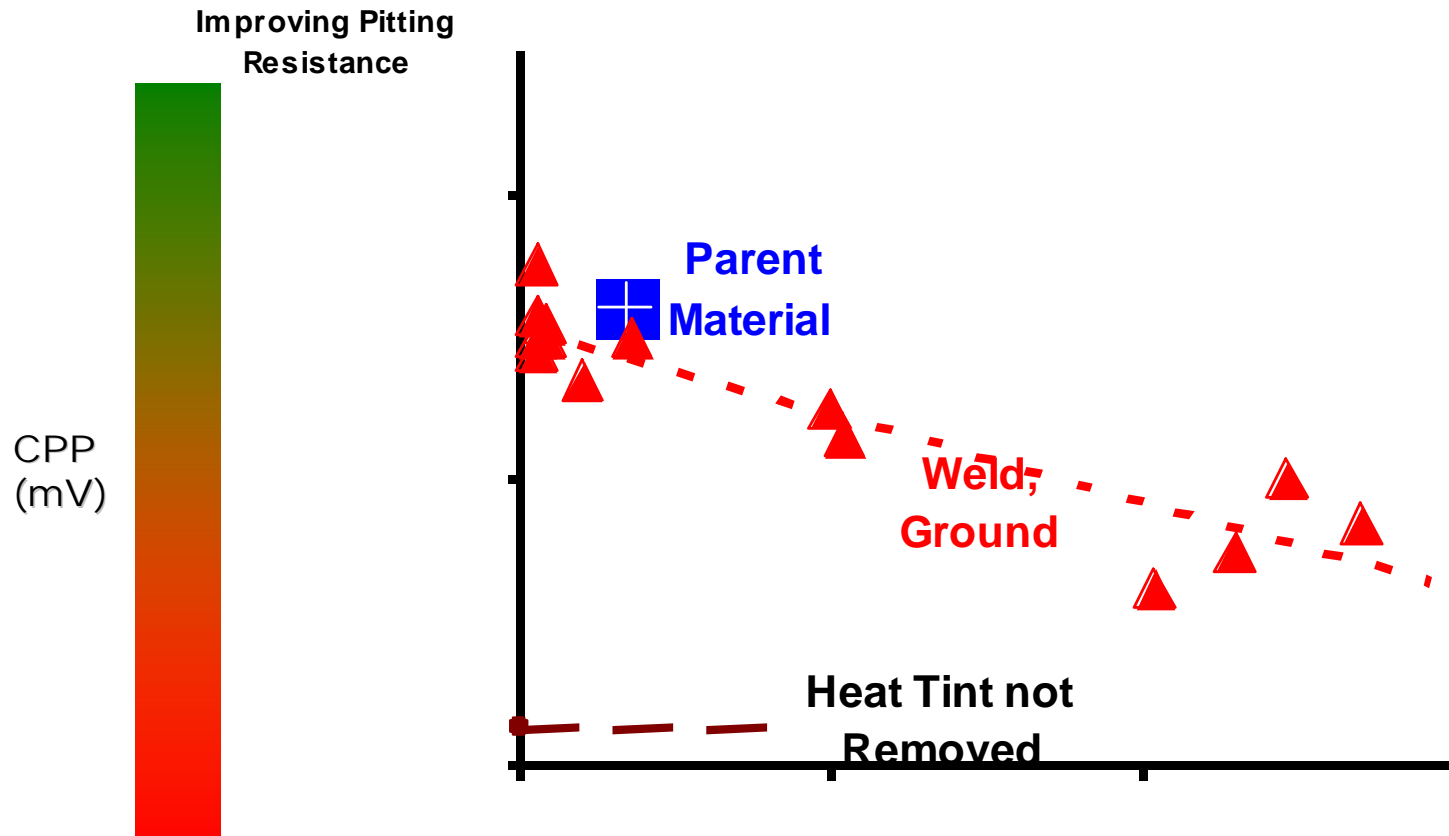
The effects of iron contamination on the pitting resistance. Samples exposed to 3% CaCl_2 + 3% NaCl + 0.5 FeCl_3 with 20% SO_2 and 80% air bubbled through solution. (Paper 482 - NACE Corrosion 98)

Passivation



Sample passivated in 9.5% HNO₃ at 50 C

Weld Corrosion Resistance



Passivation/Pickling Methods

- Dip
 - Composition of the acid, temperature, and dwell time depends on stainless steel grade
- Spray methods
 - Used for large surfaces that cannot be dipped
- Pastes
 - Acid solutions combined with binding agents to form a paste
 - Not very affective at low temperatures (<50 °F)
 - Avoid drying the paste - keep temperatures below 100 °F

Specifications

- ASTM A380 – Standard Practice for Cleaning, De-scaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- ASTM A967 – Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts