Why and How to Passivate Stainless Steels

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How the Corrosion Resistance of Stainless Steels Works

a passive layer

- SS & some other alloys have an active and passive state
- In active state in sea water, 304 has resistance of low alloy steels
- In passive state in sea water, 304 has resistance similar to silver and nickel-chromium alloys

The Passive Layer

- “Passive State” created by very thin, transparent, chromium-rich oxide layer
- Ideally layer is continuous, non-porous, & self healing in presence of oxygen
- Clean SS will passivate in air/moisture
- Pickled and electropolished surfaces properly rinsed essentially passivated
- SECRET – clean surface

Cleaning for Chemical Passivation

- If needed, flush to remove any debris or extraneous material
- Remove all grease, oil & other organic contamination
  - accomplished with alkaline, emulsion, solvent or detergent cleaners
- Water-Break test to check removal of oil, grease etc.

Heat Tint not removed by Chemical Passivation

- Heat tint caused by welding must be removed by grinding, pickling or electropolishing
- Most heat tint is on ID of tubing where grinding is impossible
- Use AWS D18.1 or D18.2 for acceptable heat tint levels. Chemical passivation of heat tint areas improves corrosion resistance, but not to level of clean surfaces

Checking for Free Iron

- Water-Wetting & Drying test – practical
  - water – preferably distilled or deionized
  - apply by spraying or by immersion
  - 24 hour test with alternate wetting & drying ~ one hour each
- Ferroxyl Test overly sensitive & not useable for food applications (cyanide)

Deposit Free Iron Causing Corrosion at “29”

Common Chemical Passivation Processes

Removes free iron & enhances passive layer

- Nitric acid 10 – 40% &, 30-90 min. @ ambient or higher temperature
- Citric acid 4 – 10%, longer time than nitric
- Chelant systems or with citric acid
- See ASTM A380 or A967 for more details

More about Passive Layer

- High Cr/Fe ratio of layer – higher cor. resistance
  - chemical passivation reduces Fe – resulting in higher Cr/Fe
- Cr/Fe ratio determined by: AES, ESCA/XPS or GD-OES
- Oxide depth ~ 15 angstrom min. desired

Summary of the 316L CPP Measurements

Sample	Unpassivated	Passivated
As Welded (HAZ)	276 mV	525 mV
Color Cleaned (Scotch Brite)	230 mV	475 mV
Ground (120 grit finish)	343 mV	495 mV
Base Metal (2B Finish)	506 mV	494 mV
Weld (120 grit finish)	---	603 mV

Passivation Procedure Qualification

- ASME BPE Standard has non-mandatory method for qualifying 316L
- Similar to Welding Procedure Qual.
  - process description, essential variables, welded & non-welded coupons, coupon testing
- Cr/Fe ratio 1.0 or greater
- Oxide depth 15 angstrom min.

Passivation Chemical Sources

- Bradford Derustit Corp.
  - www.derustit.com
- Avesta Finishing Chemicals|
  - www.avestafinishing.com
- Quality Welding Products Inc.
  - www.qwpinc.net
- Many others including commercial chemical companies

Safety and Regulation Considerations

- Passivation chemicals & particularly pickling solutions must be handled with care to avoid harm to personnel & environment
- Proper disposal of spent chemicals varies with the chemical and with local regulations

Outsourcing Passivation Work

- Biotech & pharmaceutical industry often use specialty companies for cleaning/passivation/deroughing
- These companies handle the complete job including disposal of spent solutions
- Less used by dairy/food plants but might be considered for start-ups and large projects

Thank you

Any questions?