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Rouge Control Options for Stainless Steel Bio-Pharmaceutical Process Equipment

Part 4 of 4 Electropolish for Optimum Rouge Control

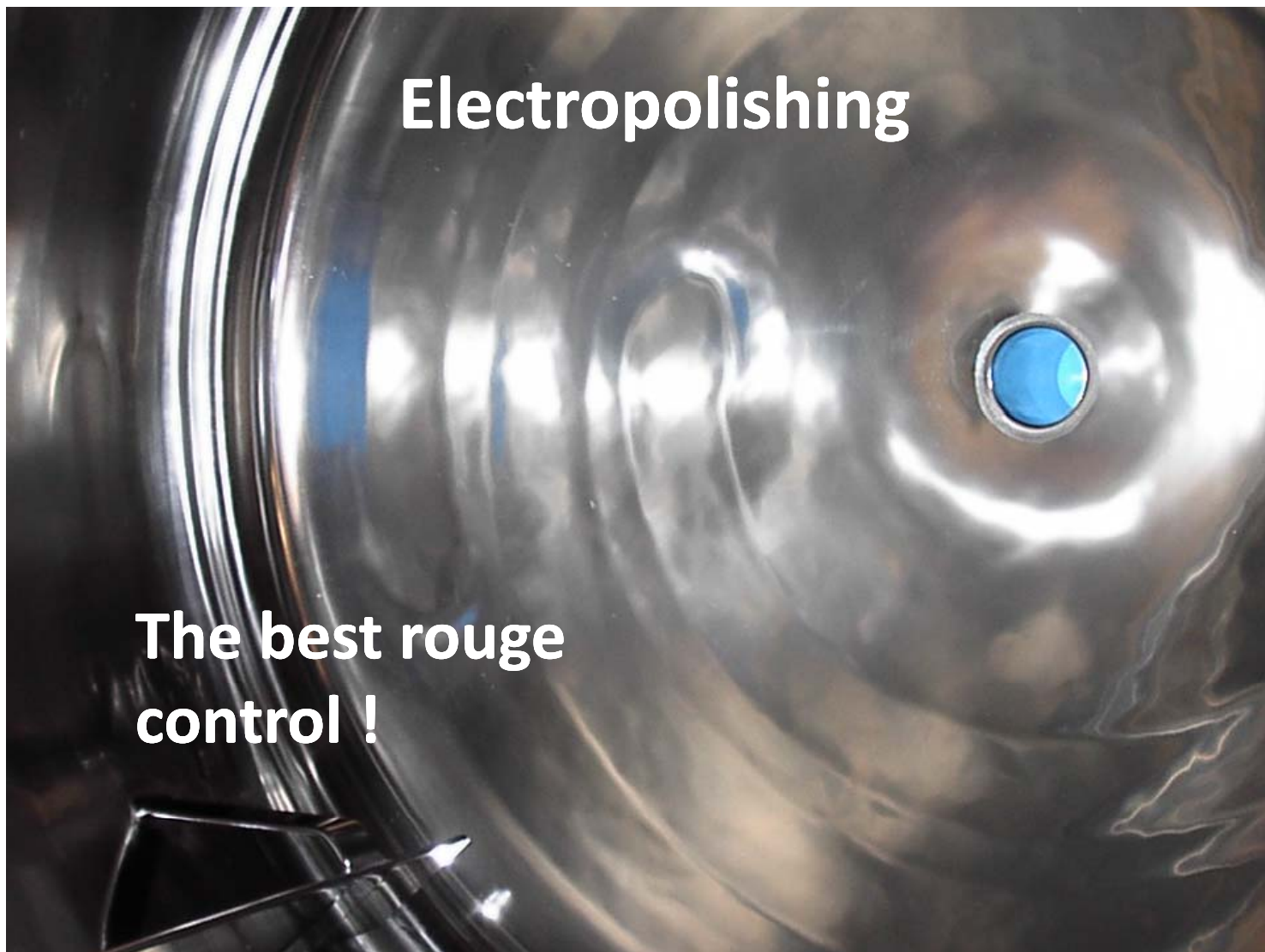


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Electropolishing

The best rouge
control !



20Ra

**Mechanically Polished to
80 grit and Electropolished**

100 μm ×150 15kV

20RA EP

ELECTROPOLISH

The Ultimate Product Contact Surface!

- Electropolishing provides optimum micro-surface finish!
- Electropolishing provides the minimum total surface area!
- Electropolishing provides pure alloy without contamination or damage at the materials surface (product contact interface)!

ELECTROPOLISH

The Cleanest Surface Possible

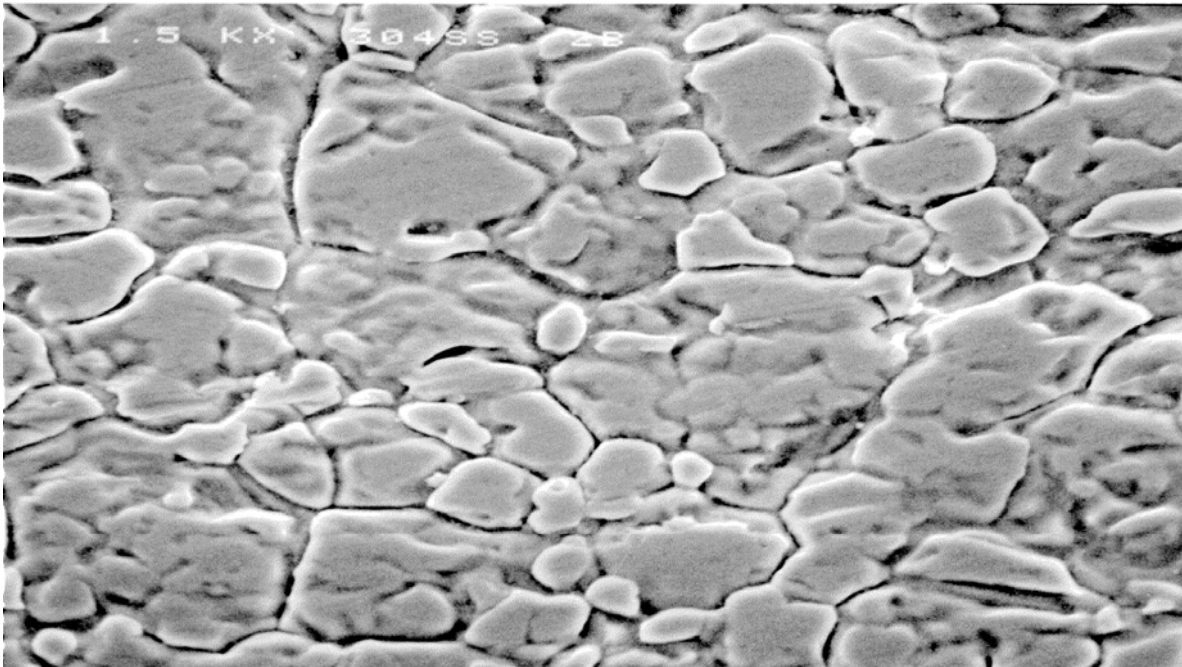
- Electropolished alloy surfaces offer optimum cleanability!
- Electropolished alloy surfaces offer optimum sterility!
- Electropolished surface offers optimum resistance to corrosion for any given alloy!
- Electropolished surface offers rouge formation resistance when base material condition is the cause!

Optimized Micro Surface & Surface Area Reduction

- Electropolishing offers a microscopic featureless surface.
- Electropolishing offers a total surface area that has been dramatically reduced.
- The only comparable surface finish on metal is produced by “lapping” as on metallurgical samples, and gage blocks.

2B Stainless Sheet Metal

SEM 1500X – 304 Stainless Steel



Note the cross section in the following slide to see illustration of surface roughness

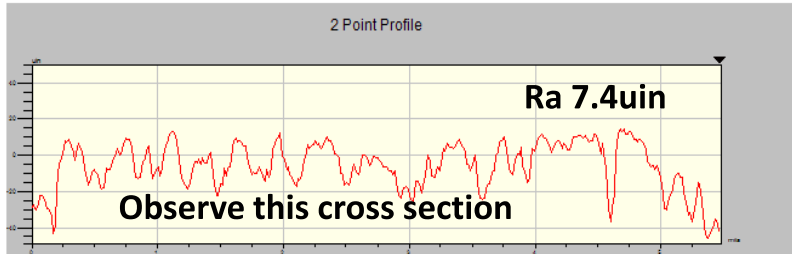
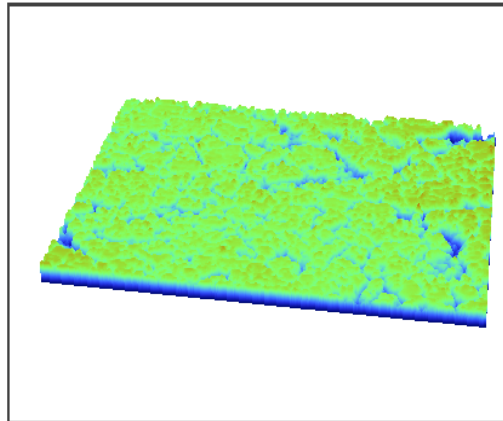
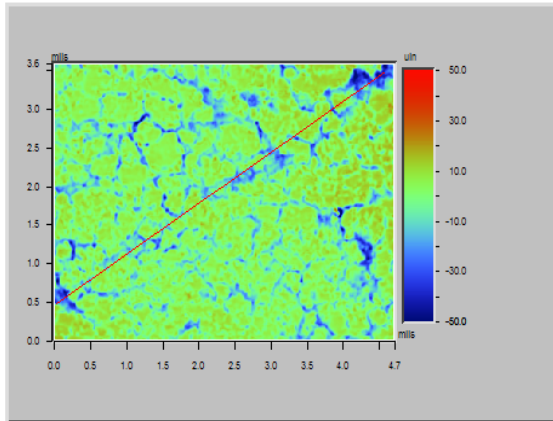


2B Stainless Sheet Metal

White Light Interferometric Surface Analysis

Title: Area 1 (2B) 03

Note: 3/16 Stainless Steel Sheet Metal



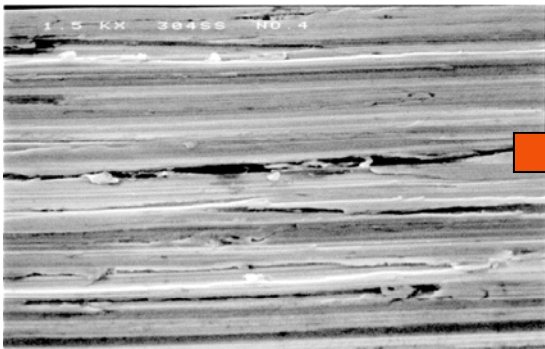
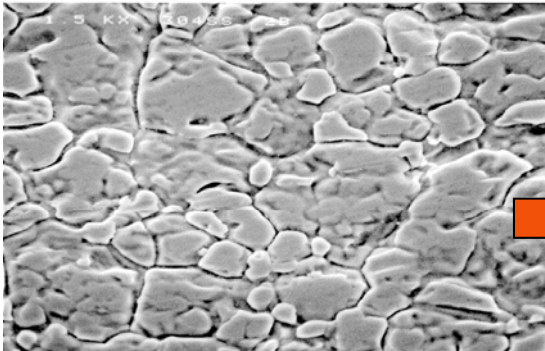
Surface Parameters

Ra: 7.4 µin
Surface Area: 1.79e+007 µin²
Sdr: 6.312 %

Mitigen Metrology

Electropolished Stainless Coupon

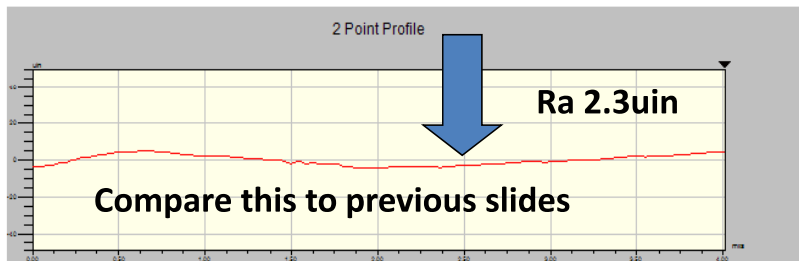
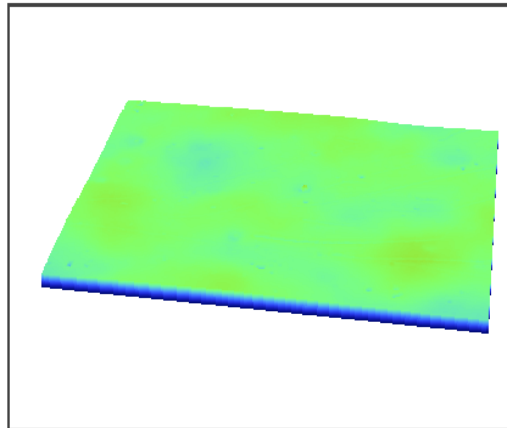
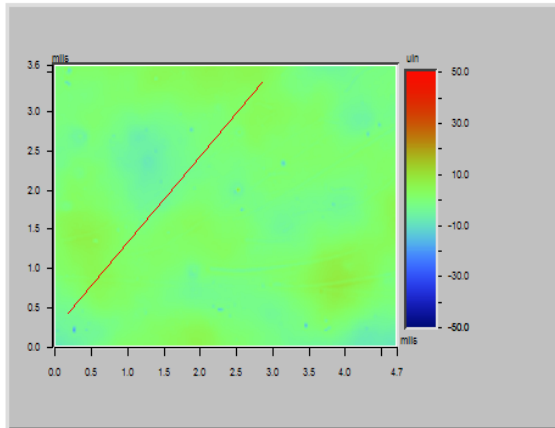
SEM 1500X - 304 Stainless Steel



Electropolished Stainless Sheet Metal

Title: Area 2 (2B EP) 02

Note: 3/16 Stainless Steel Sheet Metal

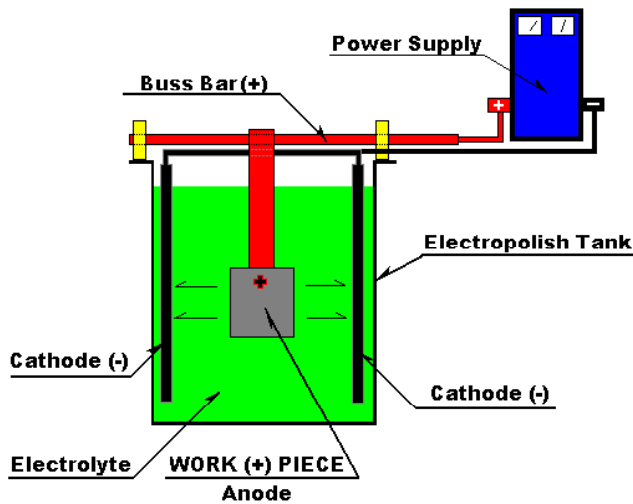


Surface Parameters

Ra: 2.3 uin
Surface Area: 1.68e+007 uin²
Sdr: 0.043 %

Michigan Metrology

Electropolishing - How it Works

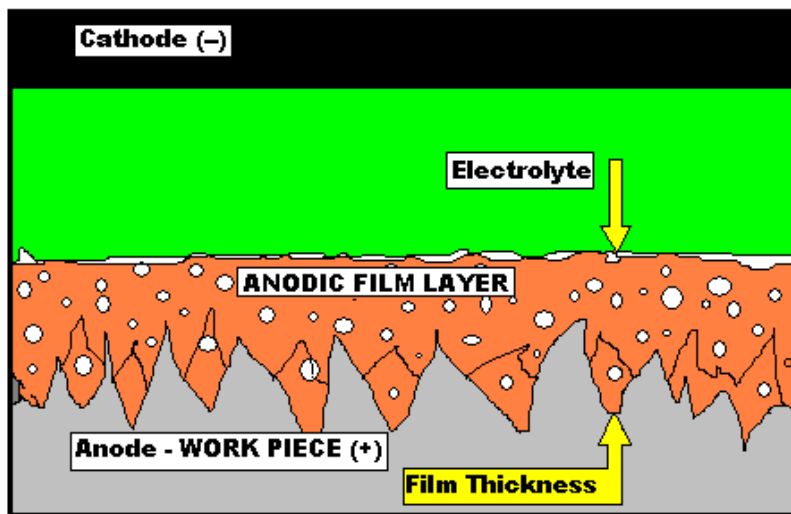


- A surface to be electropolished is made anodic (+) in a DC power circuit
- The work is then exposed to an acid electrolyte (dipped or wetted)
- A cathode (-) is present adjacent to the portion of the work that requires electropolishing

Electropolishing; How it Works

When the power is applied an anodic film forms on the surface of the work and the material begins to be removed ion by ion

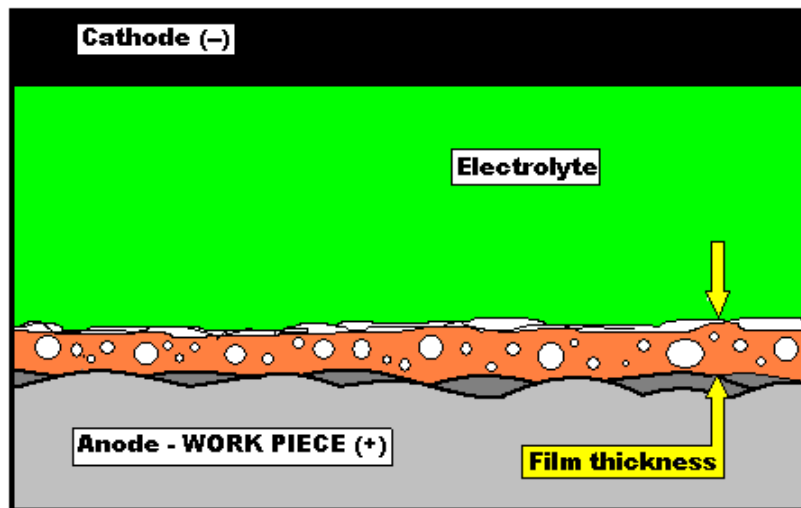
The effect on the microscopic surface is to smooth and level as the microscopic "peaks" dissolve more rapidly than the microscopic "valleys" due to the increase in resistance to current flow as the film get thicker in the valleys



Electropolishing; How it Works

When the process is allowed to continue for an adequate amount of time the surface becomes microscopically smooth and virtually featureless

As the anodic film becomes uniform in thickness the benefits of electropolishing have been accomplished and material will continue to be removed uniformly until the process is stopped



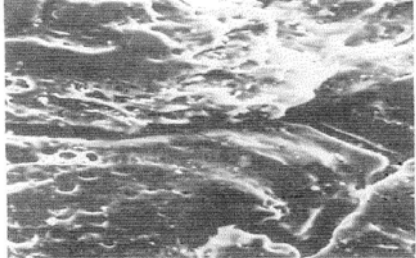
Electropolishing; How it Works

MILL FINISH - Hot Rolled Annealed 316 Plate Material

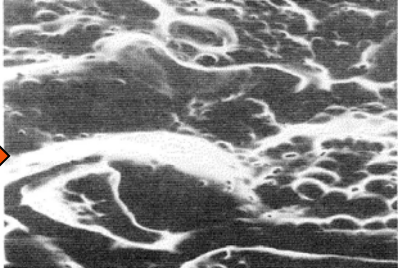


Electropolishing; How it Works

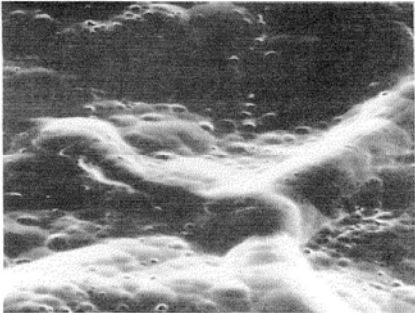
As Electropolishing Exposure Increases Microscopic Smoothing Continues Until Optimum Improvement is Achieved



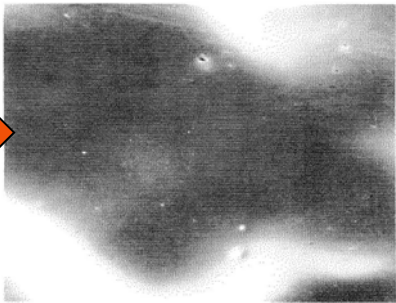
HRAP #1 S.S. Plate As Received



Inadequate Electropolishing



Intermediate Quality Electropolishing

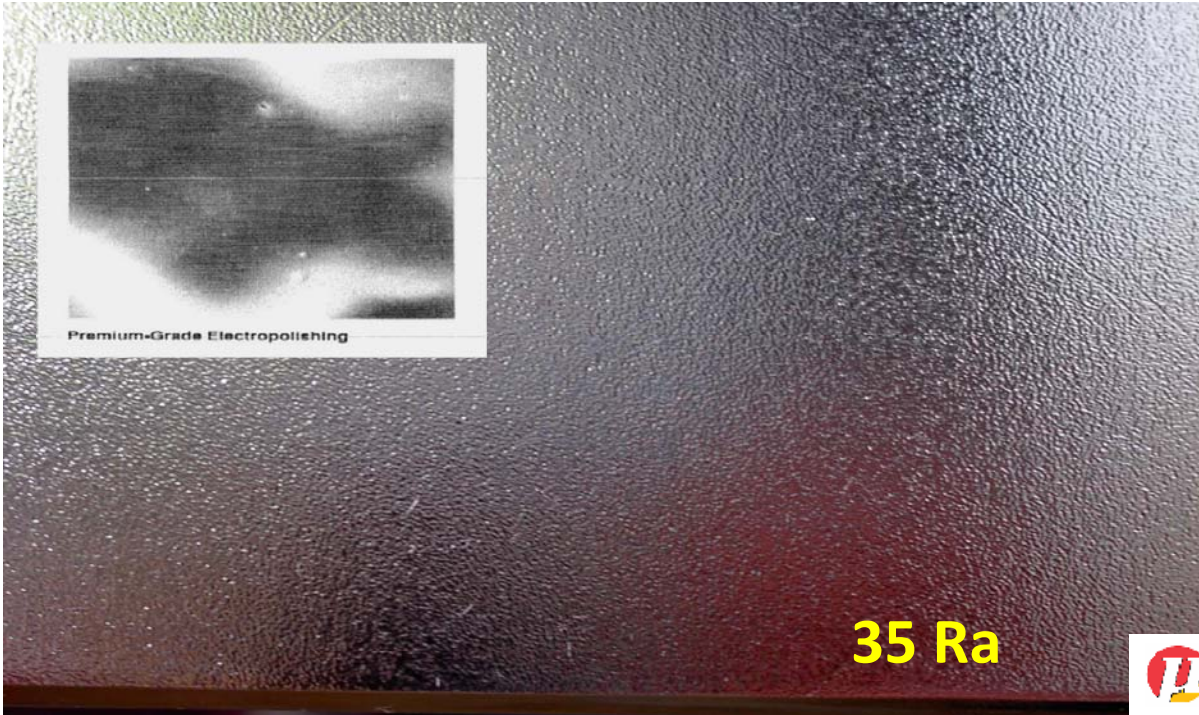


Premium-Grade Electropolishing



Electropolishing; How it Works

ELECTROPOLISHED - Hot Rolled Annealed 316 Plate Material



Conclusions

1. **Diruneutra** offers a **pH neutral, non-hazardous**, derouging alternative that can be used without risk to equipment, personnel, or the environment by equipment owners eliminating the need to hire contractors. Observation of treated systems over time has shown evidence this technology is retarding rouge reformation. Part 1 of 4
2. **Electrochemical Cleaning (ECC)**[™] offers an excellent de-rouging/passivation alternative that has been shown to retard the return of rouge dramatically when compared to aggressive chemical de-rouging/passivation. Part 2 of 4
3. **Mechanical Polished** surfaces offer a contaminated damaged, micro-rough, non-austenitic product contact surface prone to giving off a grey (SS) powder residue throughout service life. Prone to very rapid rouge formation if exposed to DI water or clean steam. Part 3 of 4
4. **Proper Electropolishing** offers the optimum product contact surface as the process can completely remove damaged surface layer present after mechanical polishing. Provides a microscopic featureless surface that offers best resistance to bacterial contamination, corrosion, rouge formation, product residue retention. **Allows for an extremely uniform “passive layer” with no “thin spots” that may cause passive surface failure.** Part 4 of 4