2015 UTSR Fellowship

Dean Sage
July 25th, 2015

Industrial Turbomachinery Systems
Background

School: University of Florida  
Materials Science and Engineering  
Agricultural and Biological Engineering

Department: NPI Engineering

Supervisor: Mark Dieringer
Where I’m From

• If you go far enough south, you get back to the North
It’s not like the South.
Main Projects

• Weld Issues
• Igniter Failures
• Greenbelt Projects
Weld Issues
Derek P.

• Undercut in 316 SS bar-tube welds
• Tail off cracks in 304-HastX welds
Undercut

0.0024 in

0.0952 in

0.0435 in

BAR

TUBE

603P134_1
0-Deg
Undercut Cont.

• Geometric and microstructural differences in tube and bar stock, among other factors, cause undercut with this material combination.

• Solution: Change weld parameters
  
  **Weld Pass:**
  - Decrease amperage and travel speed by ~35%

  **Cap Pass:**
  - Defocus beam ~15%
  - Change beam figure
  - Increase beam width ~10%
  - Decrease travel speed ~35%
Undercut Cont.

BEFORE

AFTER

TUBE  BAR

TUBE  BAR
Tail off Cracks in 304-HastX Welds

25X
Cracking in the tail-out of the weld...
Tail off Cracks Cont.

• Weld puddle carries impurities, causing for a higher concentration where the weld ends.
• Higher concentration of impurities causes cracking.
• Solution (1): Shorten tail off area
• Solution (2): Guide “contaminated” weld puddle away from joint, machine off impurities.
Mark B.

- “Black stripe” issue in qualification of weld joint
Black Stripe

• “Black stripe” appears in weld qualification with no precedent.
Black Stripe Cont.

**Solutions:**
- Change part geometry
- Modify weld parameters
- Work with XRI to further interpret x-ray images
- Let Derek deal with it
Black Stripe cont.

- Before:
Black Stripe cont.

• After:

![Image of measurement data]

- 0.0773 in
- 0.0358 in
- 0.0348 in
- 0.0597 in
Igniter Failures
Mike H.

• Igniter Shell Failure
• Igniter Glass Flow Issue
Igniter Shell Failure

Materials:
- Tube (light green): 304 ss
- Shell (red): 430 ss
- Collar (pink): 304 ss
Igniter Shell Failure Cont.
Igniter Shell Failure Cont.

- 304L SS
- Weld Bead
- Underlying member is 304L SS
- 430 SS
Igniter Shell Failure Cont.

• Failure of 430 SS shell near 304L-430 weld joint.
• 430 SS failed, not the weld.
• Igniters had been subjected to 12,000 hours of operation with 400 starts.
• High temperatures for prolonged periods of time.
• Failure analysis conducted by Tripti Jain in Rockford facility.
Igniter Shell Failure Cont.

304L SS Tube
94 HRB

304L SS Body
26 HRC

39 HRC

430 SS Shell

0.02 in
Igniter Shell Failure Cont.

• Polishing the fractured area revealed enlarged grains and thick boundaries
Igniter Shell Failure Cont.

- SEM (Scanning Electron Microscope) and EDS (Energy Dispersive x-ray Spectroscopy) analysis revealed chromium deposits between grains, effectively making the material more brittle.

- Conclusion: 430ss should not be used in this application.
Igniter Glass Flow Issue

- Glass seals in igniters are softening in service, flowing away from designated areas, and allowing other internal fixtures of the igniter to break.
**Igniter Glass Flow Issue Cont.**

Igniter Preliminary Results Showing Potential from Ceramic Fracture

- Finite analysis investigation of thermal stresses seen in igniters
- Glass seal to be replaced with higher temperature resistant glass
Greenbelt Projects
• Outer bellows weld porosity
Outer Bellows Porosity

- Porosity and lack of penetration causing weld to fail in XRI.
- Objective of project is to reduce number of failed parts.
Outer Bellows Porosity Cont.

• **Proposed solutions (project still in progress):**
  
  - Automate weld prep/ pre weld cleaning processes
  - Change weld schedule
Used Processes

- Optical Microscopy
- TIG/ GTAW Welding
- EB Welding
- CMM
- Visual Measurement System
- Perthometry
- Lathes
- Saws
- Laser Marker
- Vibrapene
- X-Ray Inspection
- FPI
- Flow Testing (Air & Calibration Fluid)
- Resistance/ Spot tacking
- Mounting
- Polishing
- Etching
- Laser Tacking
- Drop Testing
- Six Sigma Statistical Analysis
Questions?