Lean Duplex Repair

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Presentation Overview

- What is Lean Duplex?
- Improper Welding - Consequences
- Welding - Challenges
- Lean Duplex - Identifying
- Welding:
  - Procedures
  - Fillers
  - Gasses
  - Surface Prep
  - Interpass Temperatures
- Finishing and Passivation
What is **Lean Duplex**?

Microstructure ≈ 50% Ferrite/50% Austenite
What is **Lean Duplex**?

The Difference: *physical and mechanical*

<table>
<thead>
<tr>
<th>Alloy</th>
<th>PRE</th>
<th>Chemical Composition %</th>
<th>Mechanical Properties (KSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cr</td>
<td>Ni</td>
</tr>
<tr>
<td>T316(L)</td>
<td>23</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>LDX 2101 (Lean Duplex)</td>
<td>23</td>
<td>21</td>
<td>1.5</td>
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PRE - “Pitting Resistance Equivalent number”  *Higher is better*
Q: What if the Microstructure is not 50/50?

- High Ferrite (>70%):
  - Low Ductility
  - Loss of Corrosion Resistance

- High Austenite (>80%)
  - Low Strength
  - Low “Stress Corrosion Cracking” Resistance
Improper Welding Consequences

- Lack of corrosion resistance
- Weak or brittle welds
Welding **Challenges**

- Appearance of weld gives *no indication of quality*
- Duplex doesn’t melt as readily as 300 series
  - *Weld metal can lay on top*
- **Requires better control of heat**
  - *To preserve dual phase structure*
- **Rapid cooling results in high ferrite**
  - *Very small pipes*
  - *Stud welds*
  - *Spatter*
  - *Welding too cool*
Lean Duplex *Identifying*

**Check the Data Plate**

- Material of construction is on the data plate
Lean Duplex **Identifying**

*Look for Special Permit Marking*

- DOT required markings – *number will vary by manufacturer*
Welding Procedures

Specialized Weld Procedures are Required

• ASME T316 procedures do not qualify you for Lean Duplex
  • Written and qualified procedures are required by DOT regulations

• ASME Qualified Welders
  • Duplex to Duplex
  • Duplex to T316
Welding **Filler Metal**

**Filler Metal is Listed on DOT Plate**
Welding *Filler Metal*

- **LDX 2101 to LDX 2101**
  - 2209 (*high Nickel, for corrosion resistance*)
  - 2101

- **LDX 2101 to 300 Series**
  - 2209
  - 309L
  - 309 MoL

- **LDX 2101 to Carbon Steel**
  - 309L
  - 309 MoL
Welding Gasses

- Argon
- Argon Nitrogen
  - Better Corrosion resistance
- Argon Nitrogen Helium
  - Increased heat, for thicker materials
- NO HYDROGEN!
Welding **Surface Prep**

- Remove surface oxides by grinding, Scotch Brite, Pickling
  - *Do not overgrind shell material*

- Grind oxides off tack welds

- **Bevel, or gap (1/16”)**
  - *Filler doesn’t flow like 300 series*
  - *For full joint penetration*
  - *Minimize heat, large melt pools*

- **Blow off the surface**

- **Wipe with alcohol or acetone**
  - *Use Clean cloth*

- **Sources of contamination**
  - *Grease, oil, water*
  - *Marking crayons, paint*
  - *Backing bars*
  - *Shop dirt*
  - *Dirty gloves*
Welding Interpass Temperatures

• **Critical Temperature!**
  - *Too much time spent above “critical temperature” results in unwanted phase change*
  - *Time is additive (each heating event contributes)*
  - *300 series doesn’t have this trait*

• **Filler metals mandatory**
• **Heat input 15-50 Kj/inch (2101)**
  - *Not hard to achieve*

• **NO Pre-heating**
• **Weld repair adds time to critical temperature**
• **Avoid high heat input**
  - *Beveling helps with this*

• **Multiple-pass welding must cool between passes**
  - *Inter-pass temperature – cool to 200 F*
  - *Applies mostly to nozzles and manhole collars*
Finishing **Grinding and Passivation**

**Grinding**

- Remove heat tint
  - For corrosion resistance

- Grinding
  - Same as other welds
  - Fresh abrasives
  - 180 grit for corrosion resistance

**Passivation**

- Speeds the formation of “passive layer”
  - For corrosion resistance

- Nitric or Citric acid solutions
Welding Recap

- ASME qualified?
- Correct Wire?
- Beveling and Cleaning?
- Correct Gasses?
- Interpass temperatures?
- Finished and passivated?
Questions?