Weld Defects in Gas Tungsten Arc Hot Wire CRA Overlaid Parts

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Most defects I see in nickel overlay (stainless and Inconel) welds are either bead shape issues due to procedure or shield gas issues. Bead shape is influenced by technique and skill. The list below addresses causes of shield gas and contamination issues.

1. Drafts. This is a common problem. GTA does not tolerate any drafts. No fans, no ac vents pointing at the part, no open winds. Don't underestimate this issue.

2. Chimney effect. Not a problem with groove welds, but a real issue on valves where the heat from the arc will induce flow "up the chimney" if you don't plug the bottom and the side ports.

3. Excessive tungsten stickout. Run the minimum possible stickout, this is critical.

4. Wrong Gas cup. The biggest cup is the best cup.

5. Excessive travel speed. 8 ipm is conservative, 12 is harder to shield. Err to the conservative side when possible.

6. Excessive hot wire voltage. I recommend 50% of the voltage which is needed to cause the wire to start to short circuit and establish an arc. I can't specify a specific voltage and amperage because it is very dependent on stickout. But too much heat in the wire will cause it to oxidize before it hits the puddle.

7. Dirty parts. GTA does not tolerate oxides, dirt or grease. And if you don't have a shiny first layer you should grind to bright metal. Of course it is better to not make a oxidized weld to begin with.

8. Dirty wire (surface contamination or poor preparation before drawing). I've run tests in our lab welding different heats of wire and have been shocked by differences in weldability. Trace elements, drawing compound and surface preparation of the rod before drawing into wire are critical variables. I don't see this too often with quality wire suppliers, but don't assume that the wire is always good. I keep a proven spool on the shelf for testing, just to eliminate this variable when we are debugging a system.

9. Contaminated gas, bad gas in cylinder, or gas lines, or torch. Normal gas purity is <30ppm oxygen, I have found that >20ppm can cause oxide induced LOF (lack of

fusion) defects in overlay welds between beads. Some of the Inconel gurus agree with me that oxides are one of the biggest causes of LP indications.

So what to do? Stop the drafts, shorten the stickout, use a large cup, check the travel speed, reduce hot wire heat input below the point where the wire oxidizes, only weld clean parts this includes cleaning between layers, make sure you have good wire, check the gas purity at the torch. I always carry a ppm oxygen analyzer with me when I debug systems. Finally consider using 25%He 75%Ar, this helps minimize oxidation.

Don't cut any corners. Just because you once made a good weld with long tungsten stickout and no cup does NOT mean that you should do it. My analogy is you want to be in the center of the solution set of variables not on the edge. Optimize everything so when something goes wrong as it inevitably does you still make a good part. If you start out with marginal conditions, any little problem will cause you to make scrap.

If you welds are not bright and shiny then conditions are not optimized.