Heat Recovery Innovations

Automated Seam Welder White Paper

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Introduction

Heat Recovery Innovations (HRI) designs and manufactures high temperature heat exchangers for a variety of end markets. Heat exchangers are often made up of multiple, smaller segments called cells. The geometry of these cells can be tailored to meet the application requirements and cells can be added or removed to balance cost and performance attributes. Cells can be constructed in many different ways and one of the most cost-effective configurations is to create an elongated tubular shape from a single piece of metal, referred to as a "folded plate". Using the folded plate design requires a seam weld to complete the tube. To meet design requirements the seam weld needs to be flat and leak proof. The original approach was hand welding by experienced welders (Figure 1). These seam welds required 100% post weld grinding to ensure flatness, and 20% of the seams exhibited leaks after cell brazing which required repair to correct. The company needed a way to repeatably seam weld these folded plate cells while reducing or eliminating the post weld grinding and eliminating the leaks and repair. HRI chose to automate the seam weld process.

Methodology

Time studies were conducted for both the hand and the automated seam weld processes including:

1. Setup
2. Welding
3. Grinding
4. Initial Leak Testing
5. Repair
6. Post Repair Leak Testing

Total takt time was calculated for both methods of fabrication.

Execution

The team brainstormed a solution that would remove the human factor from the seam weld operation and improve both takt time and quality. An automated seam weld station was created to fixture the parts in a repeatable manner using pneumatic clamps. With the parts now fixtured, the welding torch was mounted to a ball screw driven linear slide that could be precisely controlled with a small VFD. Limit switches ensured the torch would only travel in the weld zone (Figure 2). An inverter based TIG welding machine was integrated with the station and once tuned, produced perfect welds every time (Figure 3). Today these parts can now be completed with machine operators instead of certified welders, allowing a more flexible workforce. The total budget for the station was $4000.

Results

Manual Process – Test lot size 50 pcs

1. Setup: 5 minutes
2. Weld: 10 minutes
3. Grind: 5 minutes
4. Initial Leak Test: 5 minutes
5. Repair: 5 minutes (20% of total reworked)
6. Post Repair Leak Test: 5 minutes (20% of total reworked)

Total Takt Time: 27 minutes per piece

Automated Process – Test lot size 50 pcs

1. Setup: 2 minutes
2. Weld: 3 minutes
3. Grind: 0 minutes
4. Initial Leak Test: 5 minutes
5. Repair: 0 minutes
6. Post Repair Leak Test: 0 minutes

Total Takt Time: 10 minutes per piece

Calculated Improvements:

Takt time – 63% Improvement

Repair time – 100% Improvement

Conclusions

For manufacturing high performance heat exchanger cells, low-cost automation can reduce takt time and improve quality simultaneously when strategically implemented. In this example, the takt time improved by 63% and the need to repair parts was completed eliminated. The modest investment of $4000 will quickly payback with the faster weld times, leading to more throughput per shift and a reduced part cost. The elimination of grinding and post-braze repair work will provide additional savings per part. Finally, by removing the need for a certified welder to complete the work and instead adding a certified welding process, each part automatically becomes less expensive to produce thanks to the less expensive labor rates we can employ. These benefits add up to a more competitive product when compared to the same parts that are produced with a hand welding process.

Figure 1. Hand Welded Seam Example

Figure 2. Complete Automated Seam Welding Machine

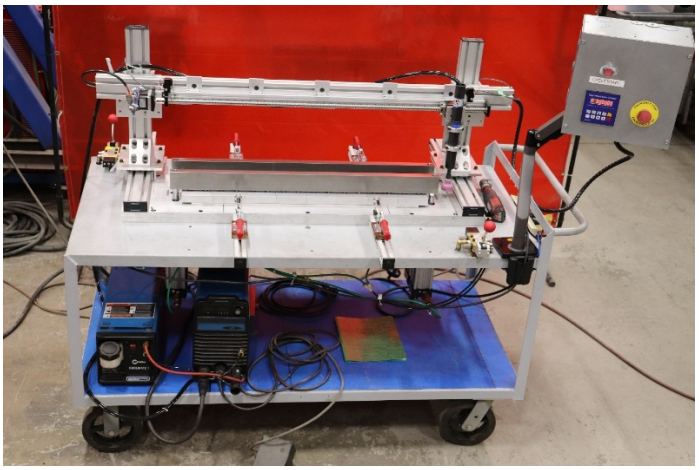

Figure 3. Machine Welded Seam Example