BENEFITING FROM THE ADVANCEMENT IN GAS TUNGSTEN ARC WELDING TECHNOLOGY IN A WELDING FABRICATION FACILITY

By

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ABSTRACT

Hammen, Greg J. Master of Science in Industrial Management, University of Southern Indiana, May 2017. Benefiting From The Advancement in Gas Tungsten Arc Welding Technology in a Welding Fabrication Facility. Major Professor: Thomas N. McDonald, Ph.D.

A&B Process Systems is a manufacturing facility of various product lines supporting industries including food, dairy, and pharmaceutical. These fabricated products have a requirement to be high in purity and utilize various grades of stainless steel due to their ability to inhibit corrosion. Historically the business make up has been to customize every order to suit the needs of the buyer. However, times have changed and A&B has recognized that they are in an ever-growing competitive industry. In fact, consultants and employees have been assigned to seek ways to maximize throughput and minimize costs. Practices such as lean six sigma and theory of constraints are being communicated to create a culture that constantly looks for ways to improve the entire fabrication process. From the design to delivery, there are many opportunities to improve upon inefficiencies.

In an effort to reduce lead time and costs, a proposal was made by senior management for standardization implementation. The proposed plan was to have a finite number of tank designs that the company has to offer at a set price. This would ultimately speed up the design process and the ability to batch orders and promote repeatability and consistency through the standardization process. In order to increase productivity and maintain the quality and safety during the fabrication of these tanks, a time study was performed over a period of two weeks to review the current welding practices associated with welding circumferential welds.

On average, A&B produces a quantity of four hundred 10-foot diameter tanks per year. This amounts to 1,275 in. of weld seam per tank. After introducing the new and improved welding process, 3,060 hours of labor have been saved amassing over $275,394.00 and allowing the ability to fulfill additional work orders each year.

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CHAPTER 1: INTRODUCTION

The U.S. manufacturing sector has been hit hard for the past two decades largely in part from policy failures that damaged its international competitiveness, yet it remains a vital part of the U.S. economy. In 2013, the manufacturing sector employed 12 million workers, or about 8.8% of total U.S. employment. Manufacturing employs a higher share of workers without a college degree than the economy overall. On average, non-college educated workers in manufacturing make 10.9% more than similar non-college educated workers across the rest of the economy (Scott, 2015). Manufacturing plays a major role in employment at the local, state and national levels, including the number of jobs manufacturing supports. According to reports, nearly 6 million factory jobs have disappeared since 2000. This makes up almost a third of the entire manufacturing industry.

Welding, one of the most common branches of metal fabrication is highly sought after as a career choice among young adults. Apprenticeships and on the job training is offered for those willing to put in the hours needed to perfect those skills and nurture potential. Historically, welding was seen as a labor-intensive career burdened by heat and filth from burning metals (see Figure 1). However, in the modern industry, welders need not only perfect their manual welding technique, but also become savvy in science and math, in order to be on top of the advancing technological requirements. This opens up new opportunities to the technological generation and further promotes higher quality and production efficiency levels never seen before.

Figure 1. Welders work through the heat and filth on a military structure in the 1940s.

The manufacturing industry must find skilled workers to, not only recognize the quality of work that this new technology should be producing, but to be able to pull together the math and science necessary to fix the technology when it inevitably fails. This transition to implement advanced technology into welding has created a demand for new welders to change an industry that has been relatively unchanged over the past 60 years. As the manual skills tradesman ages and retires from the workforce, the welding industry continues to see a demand epidemic to support manufacturing future growth as well as competitiveness in an uncertain economy. Adam Davidson (2012) at the *New York Times* has been quoted in saying, "The secret behind this skills gap is that it's not a skills gap at all" (para. 6). Companies are looking for intelligent and efficient workers that can, not only mold impressive fabrications, but bring our world into the new age. It is the combination of strength, technique, and mental acuity that will carry the next generation of master welders.

Company Background

A&B is a recognized leader in the design, manufacturing and installation of high quality process systems. As a strategic supplier to many Fortune 500 companies, A&B has the experience, the capabilities, and the insight to support the success of projects through every phase—from concept to completion. In 1973, A&B Process Systems was founded by brothers, Ajay and Bill Hilgemann in Stratford, Wisconsin (American Welding Society, n.d.). The initial focus was the installation of stainless steel process systems for the fluid milk and cheese processing industries, although other services were offered to many diverse customers. Many of these relationships are still active and valued today. As A&B grew, so did its reputation. A&B quickly expanded its capabilities to include the manufacturing of high quality stainless steel tanks and process vessels. Today, A&B has over 200 certified welders in five plants producing American Society of Mechanical Engineers-coded vessels for customers across many industries. In addition, A&B has grown its capabilities to include complete in-house process design, engineering, automation controls, quality control/assurance, and modular skidded systems with complete production capacity.

With an uncertain economy, a well established reputation is not enough. Competitiveness amongst many struggling companies has forced A&B to reevaluate how they stream their business from design to shipment. There has been a lot of focus on companies to continually improve and reduce waste by learning cost saving tools such as lean six sigma and theory of constraints. Both of these quality programs have been introduced and ultimately sold to companies to eliminate waste and improve production quality during the life cycle of the manufacturing process. When this initiative was introduced to upper management at A&B, the decision was quickly made that all business units in the company would need to evaluate and look for opportunities for cost savings improvements. With 200 manual laborers welding at A&B with various labor times and quality levels, it was identified as a priority to address immediately. It was evidently known that the welding process being used was very user dependent, even though it had built and sustained the company for 40 years. In order for A&B to remain competitive in their respected business market, they needed to control the entire process from when the initial work order was written through delivery.

Standard Method of Welding Fabrication

Gas tungsten arc welding (GTAW) is the primary welding process at A&B. It is known for its high purity, high mechanical properties, and cosmetic appeal. As the average age of the welder has progressively decreased at A&B as the company grew, it was evident that experience was fading and that a training program would need to be established to create an environment where all of the welders were cross functional and maintaining the scheduled production of a quality product. The GTAW process is a very versatile, all-position welding process. In GTAW, the heat for welding is generated from an electric arc established between a non-consumable tungsten electrode and the workpiece (see Figure 2). GTAW can be performed manually or adapted to automatic equipment, and can be used in production as well as repair welding situations. It is a process that offers precise control of welding heat, and is therefore routinely used for welding thin base metal and other materials that are sensitive to heat controls. GTAW consists of a non-consumable electrode that is composed of primarily tungsten as it has a higher melting temperature than the materials being welded.

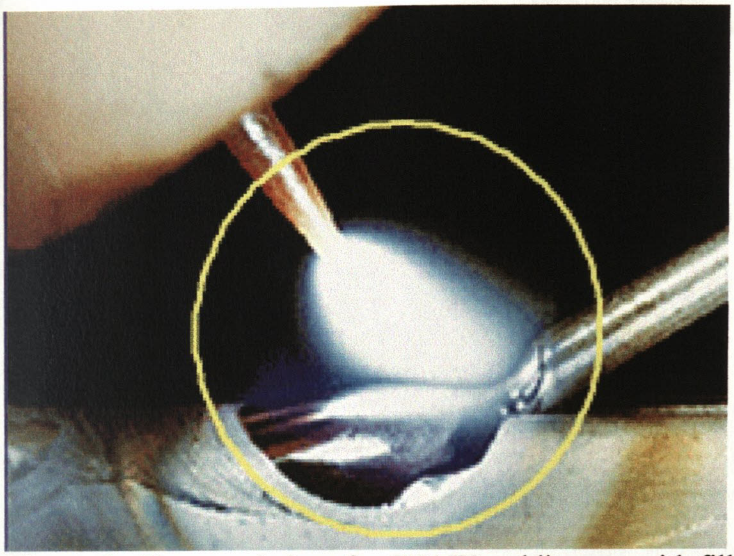

Figure 2. Characteristics of a GTAW welding arc with filler metal addition.

The diameter of the tungsten electrode should be selected according to weld joint thickness and filler wire diameter. It is suggested that the electrode be ground to a cone shape (included angle of 30 to 60°) with a small flat of 0.040 to 0.060 in ground at the point (see Figure 3). This helps the welder control the heat to a constricted area.

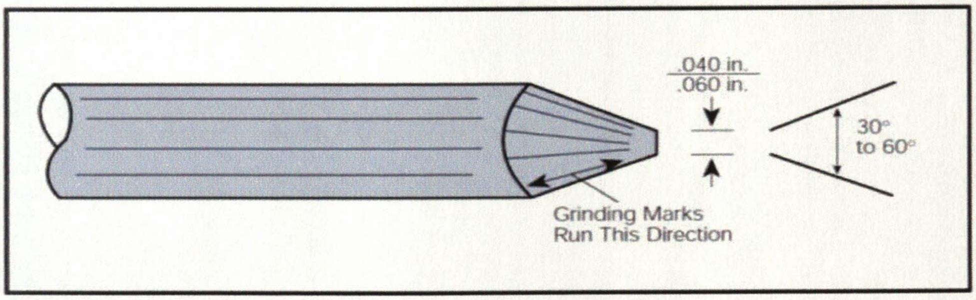

Figure 3. Typical geometry of a tungsten electrode for GTAW.

It is important to protect the molten weld pool and base materials being welded from atmospheric elements such as oxygen, nitrogen, and hydrogen. These elements are easily dissolved in molten metal and will result in gas pockets in the weld metal as it cools. To prevent this, an inert gas must be used to shield the welding process as it will not cause a reaction with the weld metal. One of the most common weld-shielding gasses is argon. Argon is an inert gas, and is also dense which allows it to settle or blanket the weld area nicely. Welding grade argon shielding gas with a 99.996% minimum purity is suggested for most welding situations. It is of equal importance to also have the flow of the shielding gas set to an optimal level. Too low of a rate will not provide adequate protection of the weld pool, while too high of a rate can increase turbulence and aspirate air. Typically, flow rates for argon shielding gas are in the 20 to 30 cubic feet per hour. Generally, the shielding gas cup should be as large as practical so that the shielding gas can be delivered at lower velocity. It is also recommended that the welding torch be equipped with a gas lens in order to stabilize the gas flow and provide optimum shielding gas coverage. While welding-grade shielding gases are of a very high purity, even a small amount of air can compromise the protective shielding and cause weld metal oxidation/discoloration and porosity. This can be caused by air movement from fans, cooling systems, drafts, and so on. When proper shielding is achieved, the deposited weld metal should typically have a bright shiny appearance and require only minor wire brushing between weld passes.

It is recommended that the welding torch be held essentially perpendicular to the work-piece and only a slight travel angle of 0 to 5°. If a large drag angle is utilized, air may be drawn into the shielding gas and contaminate the weld. The arc length (distance from tungsten electrode to workpiece) should be maintained as short as possible. Stringer bead techniques, or narrow weave techniques, using only enough current to melt the base material and allow proper fusion of the filler, are recommended. Filler metal is then manually added carefully at the leading edge of the weld pool to avoid contact with the tungsten electrode. An example of this technique is illustrated in Figure 4.

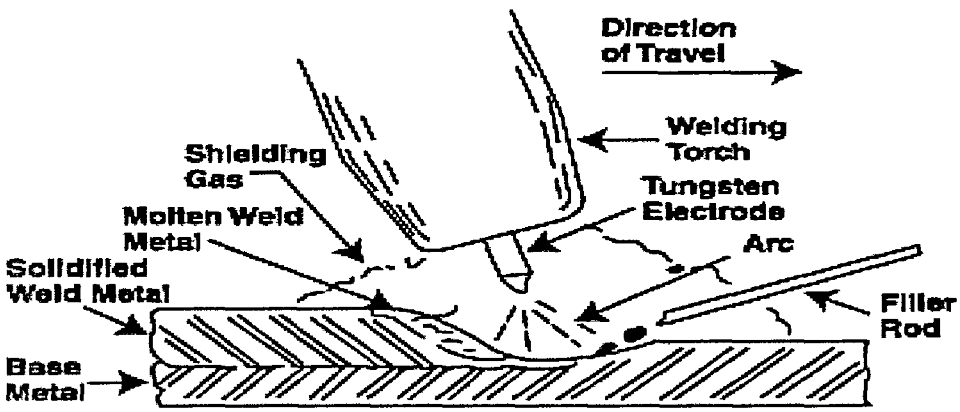

Figure 4. GTAW torch parts and technique.

During welding, the tip of the welding filler metal should be held under the shielding gas to prevent oxidation. If the filler metal oxidizes, this will be deposited in the weld resulting in a void within the weld material.

The major drawback of the GTAW process is productivity, as weld metal deposition rates during manual welding are low. Another pitfall to GTAW is that it is arguably the most user dependent welding process and requires a special and skillful technique. The welder must manually manipulate the molten weld puddle and must control the heat and amperage of the welding current to ensure proper fusion while not burning through the materials. It is also a very slow welding process. The operator travels approximately 3 to 5 in. per minute while adding filler material to the joint to be fused manually as shown in Figure 5. This technique requires superb hand-eye coordination as well a steady execution. Welder fatigue is inevitable and ultimately many unpredicted and non-value added rest stops occur. These stops in production vary from each individual and add to the uncertainty of planned working hours.

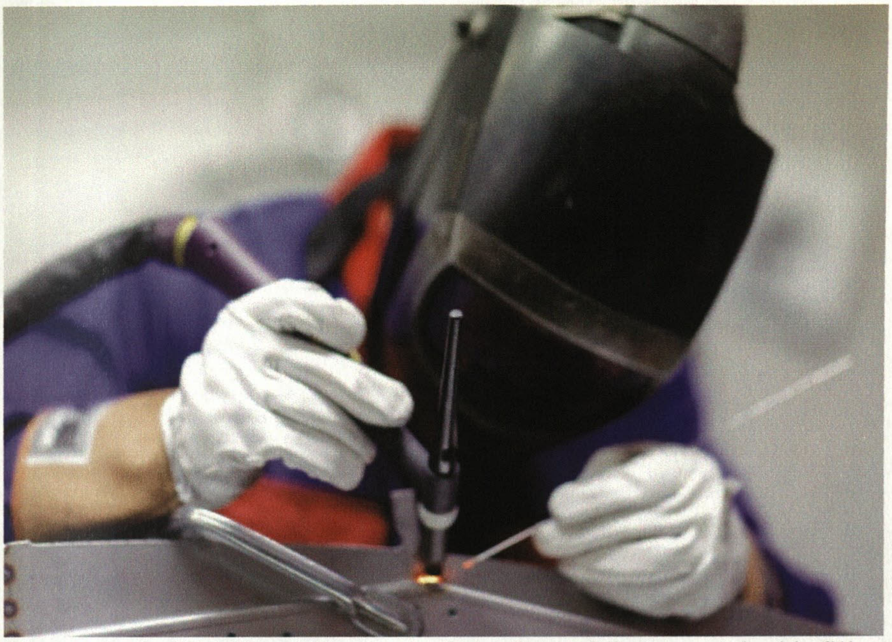

Figure 5. A GTAW welder manipulates the welding arc and adds filler metal simultaneously.

Given a 10-foot diameter tank built by A&B has an average of 1,275 in. of weld seam, the welding process for one welder would take 4 to 6 hours if the welder never takes a break. Not only do the welders require cool down periods from strenuous work, but so does some of the welding equipment. Welding power supplies are rated on their duty cycle and typically run an 80% duty cycle on average. This means that the power supply can supply amperage to the welding torch for 8 out of 10 minutes at maximum amperage output before it would need 2 minutes to cool down. This adds to the amount of downtime during the welding process, especially if the welding operator is waiting for the equipment cool down period. Even amongst the most efficient welders, the fabrication times vary significantly and the amount of time that can accrue due to operator or machinery stops can accrue very fast. With the current company goal of growing the business by 50% in 5 years, fabrication costs must be grasped and estimated accurately while competitive with the competition remaining in the market.

Materials

A&B works exclusively with stainless steel materials. *Stainless steels* are defined as iron-based alloys which contain at least 10.5% chromium. The thin but dense chromium oxide film which forms on the surface of a stainless steel provides corrosion resistance and prevents further oxidation. There are five types of stainless steels depending on the other alloying additions present. The most common material that is required on most projects at A&B is a 12 gauge (0.109 in.) thick, 316 austenitic grade stainless steel bulk tank. This material adds to the complexity of welding as it has a chromium rich chemistry which is essential for inhibiting corrosion, but if too much heat is applied to the base material during welding, the chromium will segregate away from the weld and corrosion will occur in this welded area. *Corrosion* occurs when an electrochemical cell establishes electrical reactions on a metal surface, with one of the reactions being at a weak point. Corrosion can be caused by a range of conditions, including using steel that isn't sufficiently corrosion-resistant for the environment or the material's protective outer chromium oxide surface is compromised or exposed to damaging conditions. Pitting and crevice attacks are the two most common corrosion types. *Pitting* occurs when a cell is formed between two nearby points on a metal surface. *Adjacent anodes* (negative charge) and *cathodes* (positive charge) are created, and, in the presence of chloride ions, metal oxide breakdown begins. While the dimensions of tanks vary in height and diameter, they are almost always cylindrical (see Figure 6). It is common for tanks to be greater than 10 feet in diameter and have over three circumferential weld seams.

Figure 6. Typical stainless steel tank design at A&B.

Two problems are associated with welds in the austenitic stainless steels. Sensitization of the weld heat affected zone, and hot cracking of weld metal. Sensitization leads to intergranular corrosion in the heat-affected zone of the weld. The heat affected zone is the area of base material nearest the weld which is impacted the most by the heat of the molten weld puddle. Sensitization is caused by chromium carbide formation and precipitation at grain boundaries in the heat affected zone when heated in the 800 to 1600°F temperature range. Because most carbon is found near grain boundaries, chromium carbide formation removes some chromium from solution near the grain boundaries which reduces the corrosion resistance of these local areas. This problem can be avoided by using low carbon base material and filler material to reduce the amount of carbon available to combine with the chromium. These welds should be made without preheat and with minimum heat input to shorten the time in the sensitization temperature range. Hot cracks can occur immediately after welds are completed and sometimes while the welds are in progress as the weld metal tends to solidify from the corners of the base metal to which it is joined (see Figure 7). Hot cracking occurs when the available supply of liquid weld metal is insufficient to fill the spaces between solidifying weld metal, which are opened by shrinkage strains. As the solidification proceeds, the low melting alloys within the solution of the liquid weld puddle concentrate in the center of the weld and remain liquid. This is then torn apart by the stress associated with the welding, resulting in a center line crack.

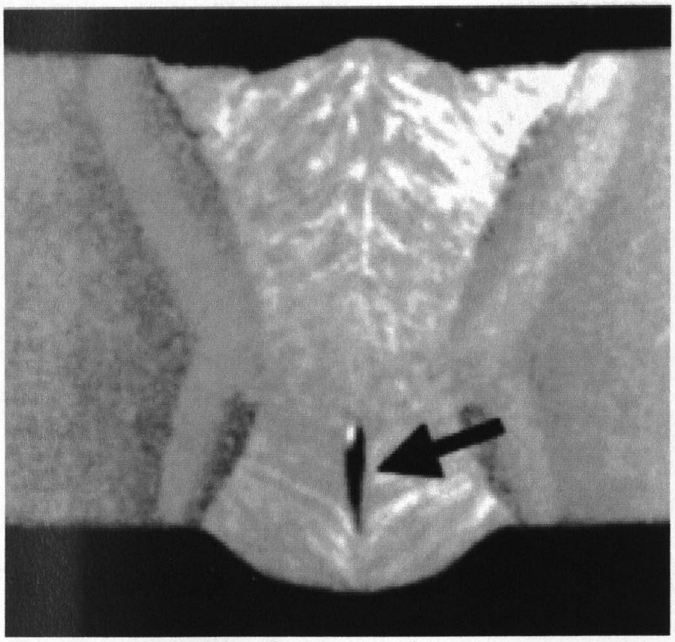

Figure 7. Example of a Hot crack.

CHAPTER 2: A NEW WELDING CHARTER

In pursuit of a solution to reducing costs, welding consultants were contacted for ideas to improve the conventional GTAW process. While the welding industry has been very reluctant to change proven methods, it is crucial to explore options to continue growth and remain competitive. Even if the equipment is operable and is producing good results, the initiative to improve prevails. For A&B that day came following a visit from a sales representative from the welding company known as Tip Tig. This sales representative knew the A&B business model and felt strong that this new product would benefit both parties. A demonstration for a new welding system was shared with several individuals from management at A&B with a message that it would increase welding speeds by 5 times and drastically reduce welder fatigue, which also reduces safety risks. In contrast to regular GTAW where a welder manually adds filler material as needed, the Tip Tig process was an automated wire feeder that consistently feeds wire to the optimal location of the weld puddle (see Figure 8).

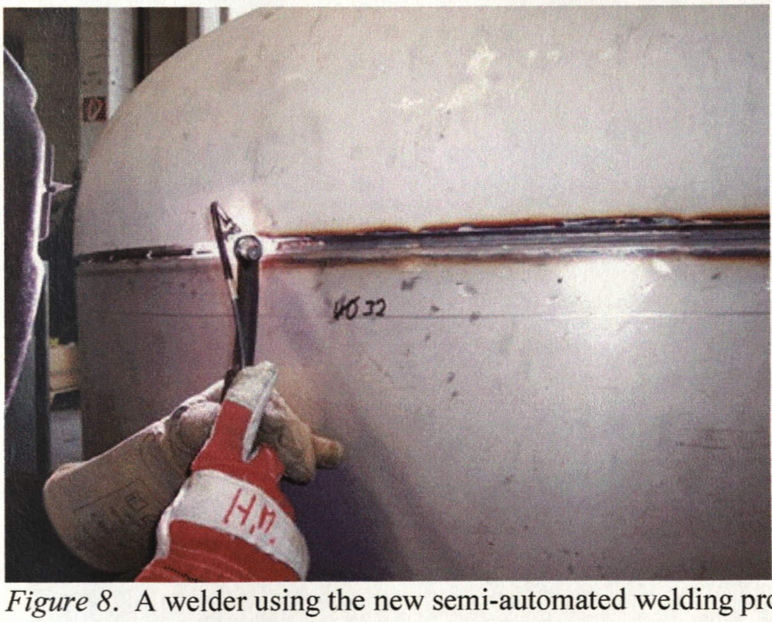

Figure 8. A welder using the new semi-automated welding process, Tip Tig.

In addition to the filler wire being fed automatically, the wire is oscillating at high frequencies which slow the weld solidification. This enables more wire to be fed into the weld pool. This change in the weld solidification dynamics enables much greater weld deposition rates allowing for faster Tip Tig weld speeds. This was a significant sales pitch, but with nothing to lose and an offer to test the machine in production for 2 weeks at no cost, management was supportive.

A&B Process Systems has 37 conventional GTAW welding machines. All of this equipment has been fully depreciated as part of the company's business assets and the frequency of maintenance on them has increasingly grown as they age. In theory, A&B should be buying new equipment just to minimize the total maintenance costs that have grown. A new Tip Tig welding system costs $15,000. Fabrication time savings alone based on welding speed increases can pay for six units in 12 months. In addition to using the new system, the welding torch can be mounted to a manipulator or a fixed arm that will remove the user dependency and fatigue, promoting an increase in value added fabrication time (Tip Tig Welding Systems, n.d.).

Current State

In order to grasp a better estimation of savings, a time study was performed on the current state process while in production. For 2 weeks, a group of five welders who represent the diverse spectrum of experience, were asked to record and report the travel speed of their welds. All material thickness combinations expressed in gauge thickness were covered for the seam welds on production tanks. Seven-gauge material welded to 7-gauge material requires two welding passes to fill the weld joint. The first pass is called the root, and the second pass is called the cover. It had been evident for a long time that each welder operates at various skill levels and at various cycle times. The solution to this was a decision to standardize the welding process and create a document that would capture the best welding practices. Ultimately this would then be used as a training tool to bring all of the welders together and perform in a consistent fashion. In order to do this, a time study was proposed on the most popular welding joints and positions that require the most time to perform. Welding in a flat position versus a vertical progression was also observed as vertical welding requires a different technique that may impact welding speeds. GTAW is dependent on the amperage that is supplied to the welding torch. Thicker materials require more heat to melt and ultimately more amperage. This was also captured in the pursuit of a standard setting.

The findings from the welding time study shown in Table 1 were that most welding at A&B was being performed at a rate of 3 to 5 in. per minute. This average range considered the low end and high end travel speeds based on the low and high amperage values used during welding. On average, A&B produces a quantity of four hundred 10-foot diameter tanks per year.

Table 1. Conventional GTAW welding data.

		Conventional Tig-Flat						
Material		Low Amps	Low Amps Travel	High Amps	High Amps Travel	Notes		
7 to 7	Root	138	3.3	155	3.86	1/16 wire	Travel Speed Averages	3.58
	Cover	135	3.8	135	3.9	3/32 wire		3.85
7 to 10		120	3	135	4.1			3.55
7 to 12		105	3.4	125	4.78			4.09
10 to 10		100	3.12	125	4.8			3.96
10 to 12		90	3.25	120	4.86			4.055
12 to 12		80	3	105	5			4

		Conventional Tig-Vertical (45°)						
Material		Low Amps	Low Amps Travel	High Amps	High Amps Travel	Notes		
7 to 7	Root	135	3.2	155	3.8	1/16 wire	Travel Speed Averages	3.5
	Cover	135	3.88	135	3.88	3/32 wire		3.88
7 to 10		120	3.2	135	3.6			3.4
7 to 12		105	3.5-4	125	4.3			4.3
10 to 10		100	3.12	120	3.7			3.41
10 to 12		90	3.5	115	5.6			4.55
12 to 12		80	3.12	95	4.9			4.01

With a shop rate of $100 per hour, this welding time alone is costing A&B $170,000 to $283,000 per year. A separate time study was observed to measure the amount of time the welder is actually welding on a weld seam. From taking breaks to readjusting and replenishing the filler wire, a welder averages 25% efficiency. This skyrockets the total welding time and costs approaching one million dollars.

Future State

Tip Tig production rates that have been verified within A&B are up to 2 to 3 times higher in comparison to the traditional GTAW process after applying a similar time study to the new welding process. This number will become more rigid with time and once all employees are trained to the new standard. While the speed of welding in not as high as what was originally advertised, the downtime savings are large. Higher welding speeds can be achieved by mounting the welding torch to a rigid arm or manipulator and further rotating the cylindrical part on top of mechanized rolls. Conventional manual GTAW speeds average about 3 to 5 in. per min.

Due to the much higher deposition rates, automated Tip Tig welding can achieve travel speeds of up to 7 in./min as seen on Tables 2 and 3, along with superior quality and far more consistent results. Higher travel speed also means less welding time and lower weld gas consumption. The comparison between conventional GTAW welding and the Tip Tig process in travel speed is well represented with the Tip Tig process leading in Figure 9.

There are other supplementary benefits that had been advertised and observed in our cost savings charter. These were categorized by the following: (a) quality, (b) lower heat input, (c) cost, (d) labor, and (e) consumables.

Table 2. New Tip Tig welding data, flat.

Tip Tig-Flat-Run 1

Material		Low Amps	Low Amps WFS	Low Amps Travel	High Amps	High Amps WFS	High Amps Travel	Notes
7 to 7	Root	170	27	6.5	200	27	5.9	Bevel 45° w/ 1/16 land
	Cover	170	72	7.8	200	72	8.4	
7 to 10		160	48	6	182	51	6.5	
7 to 12		120	36	4.29	160	45	7.5	
10 to 10		110	12	4.64	165	24	8.5	
10 to 12		100	15	4.75	146	24	8.5	
12 to 12		85	12	4.75	120	21	9	

Travel Speed Averages
5.8
7.875
6.3
5.97
6.36
6.555
6.5675

Tip Tig-Flat-Run 2

Material		Low Amps	Low Amps WFS	Low Amps Travel	High Amps	High Amps WFS	High Amps Travel	Notes
7 to 7 Root	Root	170	27	5	200	27	5.8	Bevel 45° w/ 1/16 land
7 to 7 Cover	Cover	170	72	6.8	200	72	8.5	
7 to 10		160	48	6.1	170	51	6.6	
7 to 12		120	36	4.75	160	45	7.34	
10 to 10		110	12	4.3	160	24	8	
10 to 12		100	15	4.75	146	24	8.22	
12 to 12		85	12	4.62	120	21	7.9	

Joint Prep Details

7 to 7	From the OD, Bevel both materials at 45o w/ a 1/16" Root Land
7 to 10	From the OD, Bevel both materials at 45o w/ a 1/16" Root Land
7 to 12	Taper the OD of the 7 gauge down to a matching 12 gauge thickness.
10 to 10	No prep
10 to 12	No prep
12 to 12	No prep

Table 3. New Tip Tig welding data, vertical.

Tip Tig-Vertical (22°)-Run 1

Material		Low Amps	Low Amps WFS	Low Amps Travel	High Amps	High Amps WFS	High Amps Travel	Notes
7 to 7	Root	170	27	5.3	200	27	5.8	
	Cover	170	72	7	200	90	8.6	
7 to 10		152	48	6.1	170	54	7.5	
7 to 12		125	36	5.7	160	45	7.5	
10 to 10		115	12	4.45	150	15	6	
10 to 12		105	15	3.9	145	18	7.6	
12 to 12		87	12	3.7	122	15	7.9	

Travel Speed Averages
5.45
7.7
6.5
6.48
5.0925
5.9625
5.75

Tip Tig-Vertical (22°)-Run 2

Material		Low Amps	Low Amps WFS	Low Amps Travel	High Amps	High Amps WFS	High Amps Travel	Notes
7 to 7	Root	170	27	4.9	200	27	5.8	Bevel 45° w/ 1/16 land
	Cover	170	72	6.6	200	72	8.6	
7 to 10		152	54	6	170	57	6.4	
7 to 12		125	36	5.5	155	45	7.22	
10 to 10		115	12	4.52	140	12	5.4	
10 to 12		105	15	5.15	140	18	7.2	
12 to 12		87	12	3.6	122	15	7.8	

Joint Prep Details

7 to 7	From the OD, Bevel both materials at 45° w/ a 1/16" Root Land
7 to 10	From the OD, Bevel both materials at 45° w/ a 1/16" Root Land
7 to 12	Taper the OD of the 7 gauge down to a matching 12 gauge thickness.
10 to 10	No prep
10 to 12	No prep
12 to 12	No prep

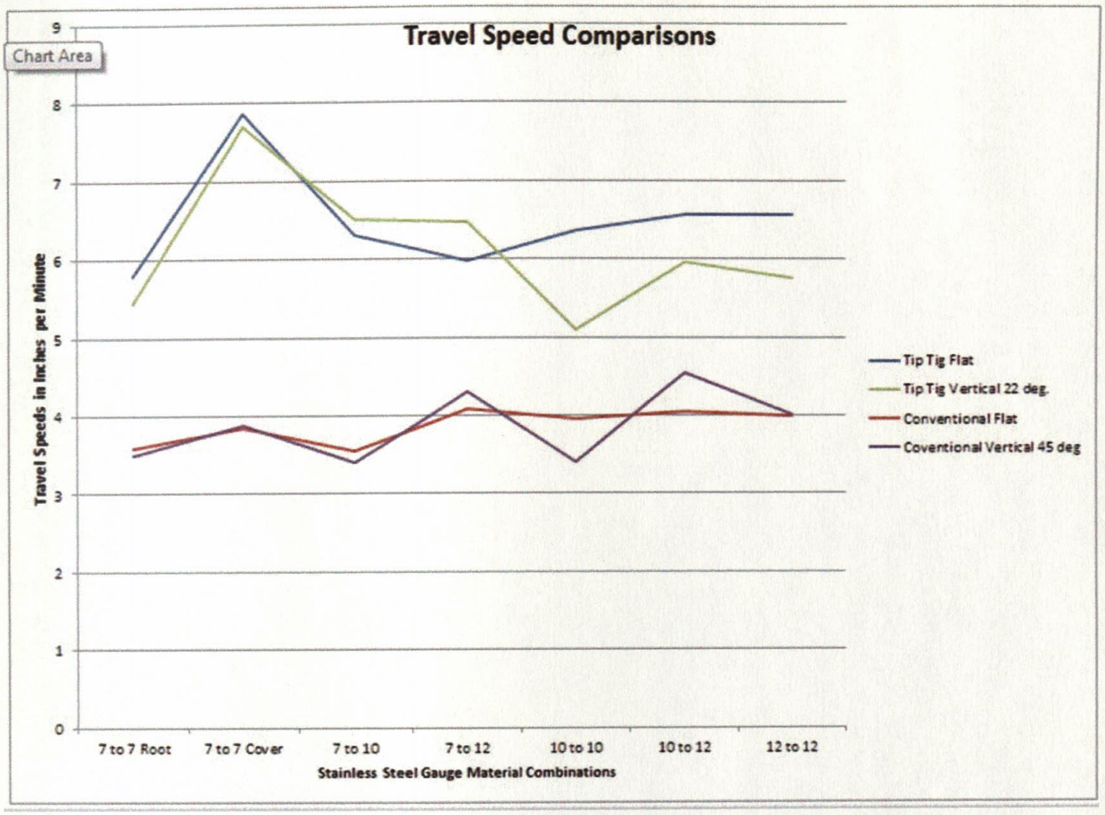

Figure 9. Travel speed comparisons, Tip Tig versus conventional GTAW.

Quality

The improved process maintains all the benefits of conventional GTAW welding while dramatically reducing the need for post weld cleaning, resulting in significantly lower labor costs. The welds are of consistent size which reduces the need to make minor repairs after our inspection department observes an irregularity or surface defect. This quality can be seen by even the more novice welders (Figure 10). Tip Tig circumferential welds show completion with an average weld deposition rate 250% greater than traditional GTAW (Figure 11).

Lower Heat Input

This can be seen especially on stainless steel as they will tint to a color associated with the heat that has affected the base metal. This can be an indication to the metal losing its corrosion properties, which would ultimately lead to an in-service corrosion failure.

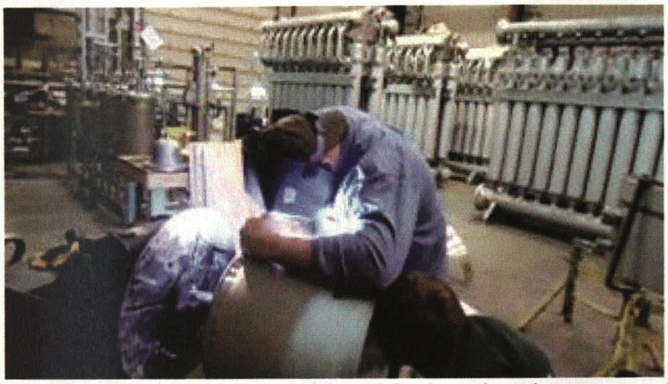

Figure 10. A welder welds with the Tip Tig process for the first time.

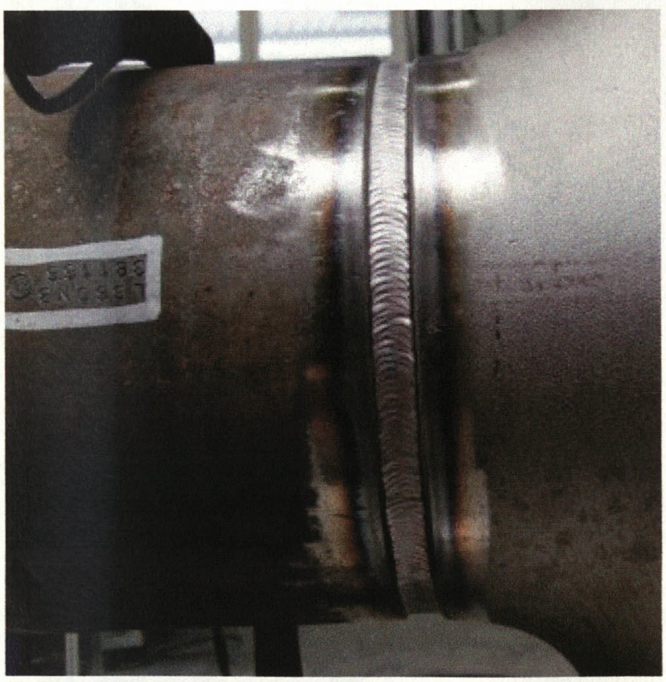

Figure 11. Tip Tig circumferential weld.

Costs

The Tip Tig process maintains all of the benefits of conventional GTAW welding while dramatically reducing the need for post weld cleaning, resulting in significantly lower labor costs. Tip Tig uses conventional welding wire spools rather than the expensive cut to length GTAW rods resulting in further cost savings.

Labor

Tip Tig eliminates the need to feed the GTAW wire by hand and operate the foot control at the same time as is needed with conventional GTAW welding. Fatigue and ergonomic concerns are further reduced by considering the faster Tip Tig weld speeds, also resulting in less arc time.

Consumables

As stated previously, conventional GTAW requires the filler material be fed by the welder. This is done using a filler rod and gradually touching the filler material into the molten metal where it becomes consumed. Typical sizes are in the 3/32 in. diameter range ±1/32 in. These filler rods come in 36 in. cut lengths and when the operator consumes this down to 4 in. of material, this is often discarded as there is not enough material to feed this into the hot molten puddle without being subjected to the intense hazardous heat of the welding arc.

The regular GTAW manual wire feed rate utilized with the 3/32 in. wire is 8 in./min. When converting the wire feed rate of 8 in./min of 3/32 in. wire to an 0.035 wire, commonly used with Tip Tig, the result is 56 in./min. The 56 in./min of 0.035 wire would deposit approximately 0.8 lb./hr. With a typical manual GTAW welding time of 20 min per/hr., the GTAW average weld deposition rate is slightly less than 0.3

lb./hr. The high skills required for the manual GTAW process and the very low deposition rates that are responsible for typical slow GTAW weld travel rates of 3 to 5 in./min are the cause of many weld costs and quality issues at A&B. With regular GTAW we used an average hourly, manual weld time of 20 min/hr. In contrast to regular GTAW, the Tip Tig when used as a manual process is a semi-automatic welding process. As the Tip Tig wire is constantly fed, this not only increases the weld deposition, but it dramatically increases the arc on time and reduces the weld arc starts and stops that occur with regular GTAW. With Tip Tig, we have seen an average hourly arc on time of 40 min/hr.

CHAPTER 3: CONCLUSION

The ability to capture and prove savings has been substantial. With increased throughput and decreased fabrication times, more work orders can be accepted and processed. The Tip Tig process has provided much more consistency in quality and has given the welding process a measurable metric. With the average age of welders continuing to decrease, training will be an essential regimen to sustain consistency. Tip Tig takes out a large amount of the human factor in that it has automated the wire feeding process. This will promote a consistent and quality product.

With an average 10-foot diameter tank size including 1,275 in. of weld metal, our annual consumable savings in welding wire and gas surpasses $50,000. The new and improved welding process captures 3,060 hours of labor saved if fully implemented, amassing over $275,394.00 in savings and allowing the ability to fulfill additional work orders each year.

Recommendations

With the potential savings captured, A&B can pay for 18 brand new welding systems in the first year. This investment will arrange the company to be the leading fabricator in their competitive market. With the new welding machines purchased, the old conventional welding systems do still hold value for small parts that are less likely to be standardized, however the Tip Tig welding procedure can be adapted to sustain these jobs as well. There are also companies willing to purchase used welding equipment giving A&B the option to minimize maintenance on that inventory.

With the new welding systems on hand, a training program will be essential to embrace the change in how A&B manufactures tanks. This can be a challenge in itself as the more experienced welders do tend to be reluctant to a change from what they have become comfortable and accustomed to. However, the company needs to make the commitment to standardize their practices and operate effectively in a lean manner to remain their customer's premier tank manufacturer. In our current technological era, welders who are in the infancy of their careers tend to adapt well to the new digital interfaced equipment. The new generation of welders is ever increasing and this has been linked to the new image of a cleaner welding environment that is less toxic and labor intensive. Introducing new and advanced welding equipment will be a recruiting advantage to acquire highly skilled and dependable employees. Maintenance personnel will also be affected. Fortunately, Tip Tig offers a training program to assist preventative maintenance programs, machine calibrations and diagnostics.

In closing, the new advancements in GTAW technology for welding thin gauged stainless steel materials is a necessity in the current market and to secure long-term goals of business development and growth within A&B. With a short-term payback on the investment, A&B needs to make this commitment to proceed with a welding systems upgrade to secure its future

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