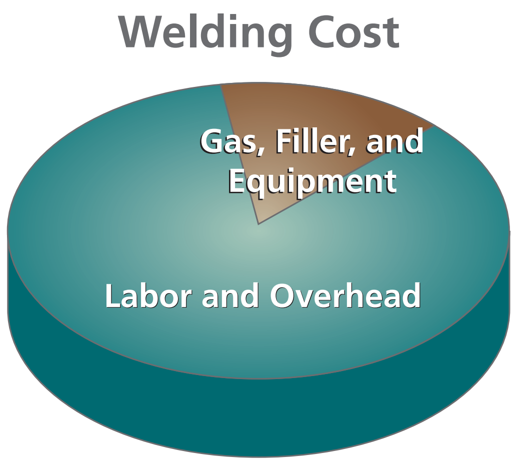
MATHESON SelectPRO Bulletin

Productivity Improvement • **R**educed Cost Per Weld • **O**ptimization of Processes

Weld Cost Analysis



At MATHESON, we are committed to partnering with our customers to help them be the most competitive in their respective industries. As part of that commitment, we work with customers on welding cost reduction. Every day we see opportunities to help our customers save money in their welding operations.

In this bulletin, we'll discuss MIG welding, but many of the principles can be applied to any process and technology.

Managers working at fabricators and manufacturers must make decisions about welding-related costs all the time. These decisions might be about comparing outsourcing versus in house fabrication – or perhaps considering the payback on a capital expense such as a robot. At the core of it all is the complicated question of how to accurately calculate Cost Per Piece in the first place. We will open the discussion on that question here. You be the judge on what works for your shop.

One misconception is that the cost of materials – gas, filler, flux, consumable parts – is the path to savings. Many fabricators find it easier to add up the costs of consumables for the shop versus quantifying other weld-related costs. However, it has been shown that cost reductions derived from labor savings and quality improvements are typically more impactful, more controllable, and more sustainable. MATHESON can help you examine these factors.

General Concepts – Inputs

While almost all welding variables can be calculated or measured (heat input, operator efficiency, arc on hours, deposition rate, etc.), effective cost analysis starts with understanding the input data. The first inputs that will be discussed are wire feed speed and wire diameter as they relate to melt off rate.

In a GMAW process, melt off rate is the rate at which the wire feeds out of the contact tip. It differs slightly from deposition rate, because:

- some wire is lost to fume
- some wire is lost to spatter and does not become a useful part of the weld
- in the case of flux-cored wire, some of the wire becomes slag

The point of the difference is that melt off rate is the full measure of the wire consumed, and not just the filler deposited. However, if we assume that the wire lost to spatter and fume is minimal, we can use the melt off rate as a good indicator of the deposition rate (the AWS CWS Manual shows this to be between 90 – 97% of the melt off rate) for a GMAW process.

Melt off rate and deposition rate are directly proportional to wire feed speed for a given diameter of wire - that is to say, a 10% increase in wire feed speed for the same wire would represent a 10% increase in deposition rate if the deposition efficiency is constant. Going from 300 ipm to 600 ipm would represent a 100% increase in deposition rate if diameter and deposition efficiency remained the same; and the change represents a 50% reduction in the arc on time needed to make a given weld.

This series of ***SelectPRO* Technical Bulletins** is offered as general guidance. Welding technology can be quite complex, and each application has its own unique challenges. MATHESON welcomes the opportunity to discuss with you your choices of welding materials, techniques, and processes.

However, the melt off rate and deposition rate are exponentially proportional to wire diameter. That is to say, going from 0.035 to 0.045 diameter wire represents a 28.6% increase in ***diameter*** but a 65.3% increase in melt off or deposition rate (if all other factors remain constant, including wire feed speed).
Note: (1 + 28.6%)2 = 1.653.

The second input to be discussed is weld size. Fillet welds are called out by their leg size; however, the actual cross-sectional area of a fillet weld is based on the length of the leg SQUARED. So, making a weld with 3/16-inch fillet weld instead of 1/8-inch represents 124% more arc on time, filler metal, and gas (assuming the wire diameter and wire feed speed are the same). These increases represent the impact of overwelding.

It should be apparent to even the most casual observer that arc on time (the welding time when the arc is on) can be impacted by 25%, 50%, or 100% by controlling only deposition rate and overwelding. That same casual observer may infer that the cost of the weld can be impacted by 25% - 100%. But there is more! There is an important factor to be discussed, which is the low percentage of time that the arc is actually on in the hands of a typical welder, in a typical shop, in a typical application.

According to the AWS *CWS Manual for Quality and Productivity Improvement*, "there are three potential sources of overwelding:"

1. **Design Engineering -** the design engineer may specify more weld than is needed. While safety factors are common, it is also not uncommon for design engineers not to be entirely familiar with the details of the calculations around forces on a weld and failure.
2. **Welder -** welders come to work committed to doing a great job and to making welds that don't break. When a welder overwelds at his or her own discretion, it is not always a case of "trying too hard." The welder may be making a judgement to add a safety factor; the weld specs may not indicate weld size; it may be a matter of training or technique; or the welder may not have a proper fillet gauge at hand (or know how to use it).
3. **Parts Fit Up -** when parts have gaps, the welder is required to use more welding to bridge the gap and then make the properly sized weld.

Arc On Time Versus Non Arc On Time

While the calculations regarding reducing the time the arc is on are exciting (for example: 50% savings!) most welding operations have the arc on for only 10-20% of the welder's time.

Let's say for this example the welder has an arc on percentage (also referred to as "operator factor") of 15%. And let us say that we are now able to make the welds at twice the previous rate! Since the arc on time is 15%, that puts the arc on time at only 9 minutes each hour. Therefore, if the deposition rate is doubled, our 2x rate improvement impacts only those 9 minutes. In this example, if all other factors stay the same, a ***100% increase in weld speed*** delivers a savings of only 4.5 minutes out of 60, or 7.5% time savings.

A 7.5% time savings on a part is certainly nothing to sneeze at, but we must not get myopic in our focus only on the arc on time. 80-90% of the total time to weld a part is while the arc is NOT on. So, understanding this larger chunk of time can be more impactful than the arc on time itself.

Some things to look for in non-arc on time:

- Do welders spend time waiting on cranes?
- How much time does it take welders to get necessary parts?
- How much time does it take welders to lay out the parts to weld?
- Can tooling or fixtures help reduce time to lay out parts?
- Can laser etching be done in the cutting process to reduce time to lay out parts?
- How much time is spent grinding? Can this be reduced?
- How much time is spent on rework or quality issues?
- How much time is spent waiting for inspection?
- Would a positioner save time over positioning large parts with a crane to access different joints?
- What other non-value-added tasks should be evaluated?

This is a special challenge for estimators at contract manufacturers. Let us assume that the estimator has rigorous weld procedures and controls on the welding machines that allow the estimator certainty of the projected arc on time required to within 20%, for a given piece.

Let us assume for this example that because of stringent adherence to weld procedures the estimator can determine with relative certainty that the arc on time required is 7.2 minutes. Now let us assume that the estimator uses a 12% arc on time (operator factor) to determine what the 'non arc on time' is. In this example we are assuming that the percent arc on time is not measured for that part but used as a best guess based on macro-level assumptions for the shop.

The estimator may use the 7.2 minutes and divide it by 0.12 to come up with a weld time (arc on time plus non arc on time) of one hour. If, when the part is welded, we determine the arc on time was 20% higher or 20% lower, the arc on time could be little as 5.76 minutes to as much as 8.64 minutes. This min/max window is a total of 2.88 minutes, or just 4.8% of 60 minutes.

The Five "DO" Goals, according to the AWS

According to the American Welding Society's *Certified Welding Supervisor Manual for Quality and Productivity Improvement* (2005), The Five Welding "DO" Goals in GMAW cost reduction are:

1. **Reduce Weld Metal Volume**
2. **Reduce Arc Time Per Weldment**
3. **Reduce Rejects, Rework, and Scrap**
4. **Reduce Work Effort**
5. **Reduce Motion and Delay Time**

We touched on item #1 in our discussion of overwelding, and both items #1 and #2 in our discussion of deposition rate and weld size. The CWS Manual has some additional information on item #4 that fits in well with our discussion on evaluating the non arc on time activities. According to the CWS Manual, ***Some of these opportunities include the following:***

- ***Alignment of Subassemblies and Parts***
- ***Ease of Use Welding Fixtures***
- ***Weld Accessibility***
- ***Weld Position***

According to the CWS Manual, the #5 welding "DO" that is noted is "affected by work area layout, weld fixturing and tooling, equipment downtime, and any hand, foot or body movement that is required to complete the welding."

Other Factors

The example above involves a simple adjustment of wire feed speed. If only welding was that simple! Other factors - such as a change in process; adjustment of voltage; change in shielding gas; change of filler composition – can combine for additional benefits in terms of weld penetration, overall quality, simplified cleanup, reduced reject/rework, improved operator comfort (fume reduction) – with each factor having its own impact on welding cost reduction.

Those factors are outside of the scope of this document. A MATHESON Gas Professional can help you consider your options.

MATHESON *SelectPRO* Program Partners can expect:

- Increased productivity
- Reduced cost
- Optimized performance
- Better working environment
- Improved gas selection and gas management
- Improved deposition rate and performance
- Improved quality and fit up
- Reduced porosity
- Fewer rejects and reworks
- Improved workflow
- Higher customer satisfaction
- Improved profitability

Contact **MATHESON** today to discuss how our ***SelectPRO*** Program can help you.

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TB-SP-104 12/2022

Printed in USA