WA Technology

Improving Weld Start Quality

(While Saving MIG Shielding Gas)

History, MIG Start Quality

The first 15 years of my career were in welding R&D with one of the leading welding companies at the time (renamed Praxair.) While managing the companies shielding gases and filler metals, 30 person R&D facility, we understood the shielding gas surge at a weld start was excessive and caused turbulent flow. However we never took the time to quantify the extent of the problem or methods to improve it. Since forming WA Technology in 1999, we have found from our research and fabricator visits, starting MIG (& TIG) gas surge not only causes inferior weld start quality it is also a major cause of shielding gas waste! (See Appendixes A and B for more details.)

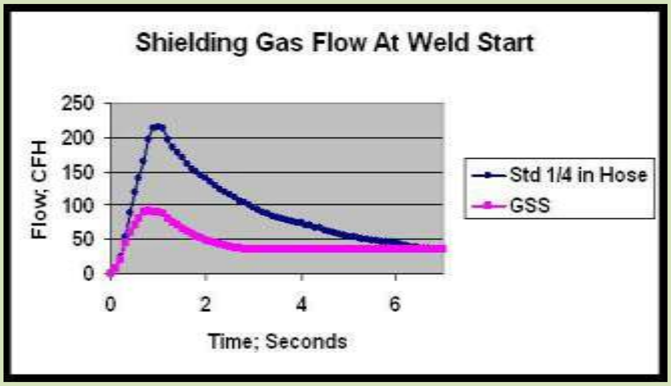
Testimonials: Improved Weld Starts

1st Testimonial:

When testing our patented Gas Saver System (***GSS***TM - US Patent # 6,610,957; Canadian Patent # 2,455,644) with the objective of reducing costs, the welding engineer and I were surprised when the repair welder immediately said he could see the difference! Not the gas savings but the improved weld starts! The tests showed a 40+% gas savings but more important to the welder, the improved weld starts. When his repair welds were completed they required Ultrasonic Testing (UT) before the repaired part could continue in production. UT was finding a significant amount of subsurface weld start porosity. The welder said he knew the starting gas surge was the cause and would cut the wire back to the tip and hold the nozzle well above the work when he triggered the gun to minimize the peak surge effect.

(Our tests showed those extra steps provided little help for the 3 second plus high surge flow problem!) With the **GSS** he immediately saw the gas surge was significantly reduced!

The following is a graph showing the starting flow test data from the welding station making the repair welds.



With a standard gas delivery system, the surge flow rate is very turbulent and mixes air into the shielding gas stream causing excess spatter and porosity. Note with their standard gas delivery system the flow exceeded 100 CFH for 2 ½ seconds. With the ***GSS*** peak flow was under 100 CFH and quickly returned to the preset 35 CFH. After using the **GSS** for 6 months the welder said he had very few rejects versus the common occurrence before!

2nd Testimonial:

Mike Buehner purchased two ***GSS***'s in October 2014 and our portable flowmeter (PFM.) Paraphrasing his comments about their use:

"Yesterday, I used my TIG welder to fix a bracket on a mower deck. I had a Victor 2425, 25 psi flowmeter and a GSS on the system. I used the PFM portable flowmeter to set the Argon at 12 CFH at the TIG torch. I found the arc starts are much better and the welds are the best I've had since I bought this TIG welder. A significant improvement.

On my MIG welder I used a 36 psi flowmeter and a GSS. Again, I used the PFM at the MIG gun to set the shielding gas flow. I no longer get a huge surge of gas when starting the weld and the shielding is much better producing far improved looking welds.

In conclusion, I have significantly better welds from using your portable flowmeter (PFM) and GSS hose system so I know exactly what the gas flow is at the torch and have much less of a gas burst at weld initiation. I used to take shielding gas flow for granted before looking into your products on www.NetWelding.com. I guess I didn't know what I didn't know! I can't speak to the gas savings yet because I haven't done enough welding since installing and using your products.

Thanks for your emails, and fast shipping of good products. Count me in as a happy customer!" (Note, Mike also said he downloaded and read the PDF **"MIG Gas Control"** available on top of every www.NetWelding.com web page.)

3nd ***Testimonial***:

Brad Fenley, an Argyle TX fabricator, called requesting a 6 foot long (FB6) ***GSS*** shipped overnight. He had a job to complete for a customer and was getting weld start porosity on most parts. He had adjusted all welding parameters including gas flow rate without improvement. He could hear the shielding gas surge at the weld start and found our web site that discusses how porosity can be caused by the turbulent ***"Blast of Gas"*** pulling in air. He uses a good MIG Spray Arc gas mix, 98% Argon/2% Oxygen, welding a carbon steel tube to a base.

We sent the ***Gas Saver System*** by Express Mail and it arrived the next day. He sent this email, ***"After putting the GSS hose on I have some of the best looking welds I've seen. I think out of 50 parts, I only had 2 or 3 to clean up. Thanks for the help."***

4th ***Testimonial***:

One of the several Caterpillar Tractor locations who have ***GSS***'s installed, reported:

"The GSS reduced the porosity problems previously encountered in several production cells."

They also noted after purchasing more ***GSS***'s for all their MIG welders,

"It has reduced rework numbers that were due to the excessive gas surge at the start."

5th ***Testimonial***:

Jason Insley ordered a ***GSS*** for his welder and after installing sent this note:

"Everything worked fine. And my weld starts have definitely improved since installing the GSS. Thanks again."

6th ***Testimonial***:

Al Hackethal reported ***GSS*** results in his shop: He wrote:

"Glad I found your website, I understood the theory, though in practice I understand it much better. I can't believe it. I'd never have thought a hose could make that much of a difference. I had a small job that had been waiting for a while. The weld quality is considerable better. Almost no splatter! I realized that the gas I'm buying is actually working the way it's supposed to.

Thanks for making products affordable!"

7th ***Testimonial***:

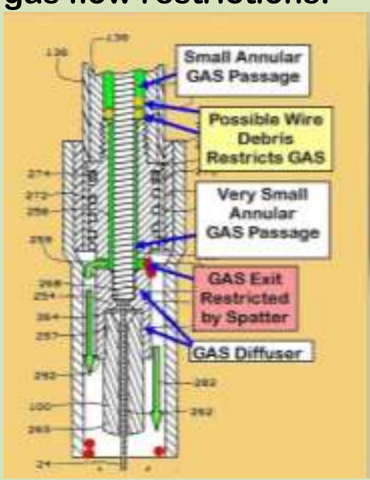
A custom fuel tank fabricator recently reported these results after their test of a ***GSS on a MIG robot***: ***"Immediately the arc starting problems went away. There have been little to none of the intermittent arc starts caused by the initial gas surge since converting over to the GSS. With our standard setup, approximately 1 out of every 3 arc starts had the "popping" arc starts associated with the gas surge and purge issues."***

This fabricator has purchased 51 ***GSS***'s.

Appendix A

Need for Extra, Non-Turbulent Start Gas

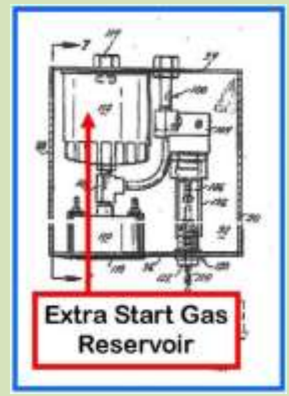
The original 1949 MIG patent (US # 2,504,868) in 4 claims stated *"the shielding gas must be, **non-turbulent** to exclude air from the arc."* For typical MIG nozzle sizes this is a maximum flow rate of about 60 to 65 CFH. In our R&D Lab we also understood the minimum pressure above the flow control orifice or needle valve needed to be a minimum of 25 psi to have what is referred to as "automatic flow compensation." That feature was needed because the very low flow rate of shielding gas will vary with small flow restriction changes. In MIG welding the small gas passage in the gun cable, as it is twisted and bent during use, causes flow restriction changes. Spatter build-up, especially blocking one or more of the gas ports in the MIG gun gas diffuser, cause gas flow restrictions.



The most subtle, but important cause of flow restriction variations is that most MIG guns place the spiral wire liner in the already small gas hose. That liner accumulates welding wire debris; copper flakes, residual drawing lubricant and shop grinding dust. In between cleaning of the spiral liner, flow restrictions occur. By keeping the pressure above 25 psi the flow remains at the preset level because of a phenomenon called "choked flow." However this higher pressure, often 50 psi on pipeline supply and some cylinder flow control devices, causes excess gas to be stored every time welding stops.

When welding starts again that excess, high pressure gas exits the gun nozzle at a high, very, turbulent velocity.

In a 1982 patent, Stauffer defined the need for having some extra start gas to purge the weld start area (US # 4,341,237.) He added a reservoir to his device to supply that extra gas. We have found that not only is extra gas needed for a quality start, it must not flow at a rate that creates excessive turbulence. As noted in a recent Praxair publication, with typical MIG size nozzles used in production that should not exceed about 50 CFH. The maximum with the largest gun nozzle is about 65 CFH.



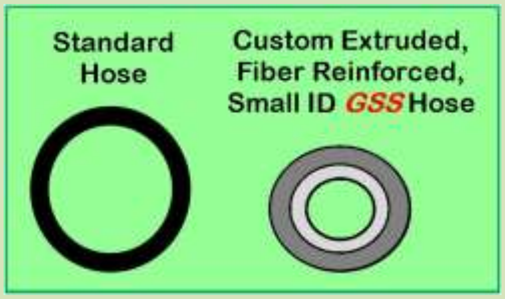
Since forming WA Technology in 1999, fabricator observations and measurements as well as our own lab work have shown MIG welders typically have peak flow at weld starts exceeding 150 to 200 CFH!

We invented a unique, simple, patented device, our Gas Saver System (*GSS*™) that provides sufficient extra start gas at a limited maximum flow velocity that minimizes turbulence. It also stores about 85% less gas at each weld stop, saving significant shielding gas waste. It does not alter system pressure so if using a typical quality flow control device, automatic flow compensation is maintained. It simply installs between welder, wire feeder or welding robot and flow control, beit a regulator/flowmeter or regulator/flowgauge on cylinder supply or a flowmeter or orifice flow control if mounted at the gas pipeline.

Appendix B

How Patented *GSS* Improves Starts-While Saving Gas

The *GSS* is a simple, easy to install, patented gas delivery hose system that does several things to imporve starts while saving a significant amount of shielding gas (typically 40 to 50% of total gas use is reported.) It accomplishes both by eliminating gas waste. It has no moving parts to wear, adjust and under normal use, break. We have customers with systms installed over 10 years without having to replace any parts. They have purchased more only when they added more welders!



Small ID, Heavy Wall Hose: The *GSS* utilizes custom extruded hose with a small ID and very heavy wall thickness. It is self-extinguishing and suitable for a welding environment. It is extruded in two layers and is fiber reinforced between them to enhance durability. A combination of the small ID and the construction reduces hose expansion when pressurized; reducing the internal volume compared to a ¼ inch hose by about 80%.

Peak Flow Orifice: The hose barb connecting ends are Compressed Gas Association 032 -"B" size. A peak flow orifice is installed in the hose barb fitting on the hose end that goes to the wire feeder, welder, or welding Robot.

This orifice is sized to limit the peak gas surge flow rate at weld start to a level that avoids excess turbulence. There is a small pressure drop across the orifice that further reduces the volume of excess stored gas. Typically this adds another 5 % savings for a total of 85% reduction in the starting gas surge volume. Longer hoses have an additional small pressure drop which further adds to the percent reduction in excess gas surge volume.

Pressure Drop in Gas Hose: With a typical ¼ inch ID gas delivery hose the pressure drop in 100 feet at typical MIG gas flow rates is under 1 psi! We have a number of customers on pipeline gas supply with 100 foot long ***GSS***'s, but most typically range from 6 to 25 feet. At 25 feet the pressure drop in a ***GSS*** is nominally 3 psi.

Reduced Moisture Permeation: A major industrial gas producer fabricates cryogenic liquid gas tanks and has over 200 ***GSS***'s. They found a significant reduction in moisture permeability with our ***GSS*** hose over their standard hose. They measured moisture levels in the shielding gas and the ***GSS*** had significantly less. They report for the past two summers, when humidity in the shop typically caused significant internal weld porosity, with the ***GSS*** the problem has been eliminated!

A report shows that because of the ***GSS*** materials, its heavy wall construction, and reduced gas volume in the hose, moisture permeation will be at least 8 times less than conventional gas delivery hoses.
Email Jerry_Uttrachi@NetWelding.com
if you would like a copy.

Appendix C

What Doesn't Work

Simple Orifices That Set Flow Rate at the Wire Feeder

The simple orifice device pictured left has been sold for over 40 years.

The original intent was to replace a flowmeter having a needle valve flow control when it was placed at the outlet of a 40 to 50 psi pipeline gas drop. It employs a fixed orifice to control flow rate to 35 to 40 CFH. Some fabricators have installed these at the wire feeder in attempt to limit the starting surge. When used at the wire feeder we often had customers complain their welders were drilling them out wanting more flow. Until we performed the research in the past 14 years and worked with these *"complaining welders,"* we often supported the management frustration that welders *"just didn't care about gas waste!"* We found two documented cases showing the real problem these welders were trying to fix!

Even though welders often didn't understand the technical reason for the problem, they saw the poor weld result!

Bar Joist Manufacturer

A Bar Joist manufacturer with 50 MIG

welders had orifices mounted at the wire feeder gas inlet to set flow rate. With their pipeline pressure, flows were 50 to 55 CFH, which should have been more than sufficient, but welders wanted more flow. The welding engineer called us and we found an interesting result. We moved the flow control orifice on one welder to the pipeline drop and installed our ***GSS***. This provided a controlled amount of extra gas to purge the weld start area at a rate that did not produce excess turbulence. The welder using the ***GSS*** instantly stated he saw a ***"better arc!"*** In bar joist manufacture, welders are close to each other. With the fixed orifice at the feeder, there was little extra gas to purge the MIG gun nozzle and weld start area. It was obvious that the welder with the ***GSS*** had less starting spatter for much of the short weld. The welding engineer decided to lower the flow rate to 35 CFH for a test on the welder with the ***GSS***. The arc was very stable, and more important the welder was still very happy! The ***GSS*** was still quickly supplying a controlled amount of extra gas at the start. It proved that providing more steady state gas flow, in this case 50 to 55 CFH, could not compensate for the inferior starts caused by the lack of extra starting shielding gas. After several months of testing to assure it worked in all draft conditions (which it did,) all 50 machines were equipped with ***GSS*** systems and flow control orifices placed back at the pipeline drop. About a year after installing the ***GSS***'s, their bulk gas supplier called and asked if their workload had reduced since there was a 30+% reduction in gas deliveries! When the welding engineer relayed the conversation with their gas supplier, he smiled and said production had not changed!

Another Bar Joist Manufacturer Validated and Quantified the Prior Observation

During a visit to another bar joist fabricator with 100 welders, we observed their flow settings in a similar situation. Rather than

placing orifices at the wire feeders they installed flowmeters at the feeder gas inlet. Fortunately they were a model that is calibrated at 50 psi so the observed readings were the actual flow since their pipeline is set at 50 psi. Observing the flow set on a majority of the feeders was very reveling. None were set lower that 50 CFH with about 50% set at 50 to 60 CFH. About 25% were set with the flow ball very close to the top, which for this flowmeter is 70 CFH. The remaining 25% had the flow ball pinned to the top! In our lab tests with a MIG gun attached to a feeder, we have found this flowmeter can flow 150 CFH with about ½ turn past the ball being at the 70 CFH maximum gauge mark!

This validates that welders see the result of lack of the needed extra starting gas and set a high steady state flow trying to compensate. The higher steady state flow can only help to some degree, it cannot make up for the lack of extra gas delivered quickly to the weld start zone. In fact setting high steady state flow defeats what the management thought they were accomplishing by putting the flowmeters at the wire feeders in the first place!

Low Pressure Devices

(Worse Case, Mounted at Wire Feeder)

To eliminate the higher pressure from causing the gas surge at the weld start some companies offered a low pressure device. Some mount at the wire feeder.

The low pressure, anywhere they are mounted, defeats what the engineers knew when flow systems for MIG (and TIG) were designed in the late '50's early '60's. That is the use of a minimum of 25 psi above the flow control is needed so that the flow reaches the *"speed of sound"* in the small orifice or needle valve and cannot exceed that velocity regardless of changes in downstream restrictions. That is why you see lightening before you hear the thunder! In fact Victor, Smith and ESAB only sell flow control systems that operate at 25 psi or higher pressure for that good reason!

Low Pressure Device Tested

The following table presents the results of a test made with a cylinder flowmeter having a fixed 25 psi regulator to determine if the flow remains consistent with changes in downstream pressure restrictions, as "choked flow" theory predicts. The restrictions were initially set at 5 psi and varied over the range we have found in industry, from 3 to 8 psi.

Flow Control Device *Locked at 31CFH Setting*	<< Typical Production Restriction Range >>>					
	3 psi	4 psi	5 psi	6 psi	7 psi	8 psi
Conven-tional = 25 psi	31 CFH	31 CFH	31 CFH	31 CFH	31 CFH	31 CFH
Low Pres-sure = 9 psi	37 CFH	34 CFH	31 CFH	27 CFH	23 CFH	16 CFH

We also tested a commercial low pressure device called a "Gas Guard." At the flow rate we checked, it was operating at 9 psi. That is well below the minimum 25 psi needed for automatic flow compensation.

The test results show that with the conventional regulator/flowmeter the flow remained at the preset 31 CFH, the same as it was set with the starting 5 psi total pressure needed to flow the gas through wire feeder and MIG gun.

With the "Gas Guard" the flow varied from a high of 37 CFH to a low of 16 CFH. Of note, the flow calibrated pressure gauge read the same 31 CFH for all tests, since the pressure didn't change! However the flow did! When flow drops, welders may just increase the flow level trying to compensate. When the conduit spiral wire liner and spatter are cleaned they will typically not go back and reduce the higher flow level the previously set!

Mounting Flow Control at Wire Feeder:

Any device, beit simple orifice, flowmeter or flow control regulator mounted at the wire feeder or welder will limit start surge but also not deliver the needed extra gas to purge the weld start area of air. The best way to show the lack of sufficient starting gas when mounting a low pressure device at the wire feeder is with a graph from the "Gas Guard'" manufacturers brochure found on their website:

The above graph was copied from the manufacturer's website and we superimposed the yellow line to show what the flow rate would be with a ***GSS***. Looking at their data, it shows a standard gas delivery system has a peak flow of 130 CFH. They show their "Gas Guard" has a peak flow not much higher that the steady state flow of 30 CFH. They show the peak occurring at about 2 seconds after the weld start. Note the ***GSS*** has a peak flow of about 70 CFH occurring quickly to provide a quality purge of air and it is back down to the steady state flow in about 2 seconds. It does have slightly more gas used at the start but that is needed to purge air from the weld start area. This "Gas Guard" starting flow is about the same as if using a simple orifice -it lacks sufficient start gas to properly purge the weld start area of air! Combined with its lack of "automatic flow compensation" makes it have both problems!

It is not just our tests and their own graph where problems are observed. A number of fabricators have complained about the "Gas Guard" poor performance. It costs more than our patented ***GSS*** that works! Some managers are reluctant to try our inexpensive patented system after they reject and discard "Gas Guards!"

Fabricators Reporting Problems with Low Pressure Devices and Orifices

The following 4 fabricators reported discarding the "Gas Guard" devices when they found it had the problems we outlined:

Automotive OEM Supplier

A welding engineer in a plant who purchased 32 of the same low pressure device we tested stated:

"After purchasing and using 32 low pressures "so called" gas saving devices (photo left) that mounted at the wire feeders we decided to discard all of them! There were two major problems:

1) *Lack of sufficient extra gas at the start made inferior welds and*

2) *Large flow variations from preset levels were evident when flow was checked at the MIG gun.* In fact, he also stated; *"Even if the flow was blocked, the flow calibrated pressure gauge supplied with these devices had the same preset reading!"*

Heavy Equipment Manufacturer

A very interesting example of problems with the same low-pressure device mentioned above was discovered after extensive testing. This fabricator had two plants making the exact same part. Both used the same wire, gas, welding conditions etc. However, one was getting porosity and the other none. After looking at 30 variables it was discovered that one of the key problems was the plant having porosity was using low-pressure "Gas Guard" devices mounted at the feeder! They were removed as part of the solution and the problem was resolved. Quite probably, the variable flow rates being encountered were causing either too low or perhaps an excessive flow rate if the welders were setting excess flows when restrictions caused flow to reduce. As in our tests, the flow-calibrated pressure gauge would not show these variations! Flow calibrated pressure gauges only work properly when "choked flow" is established

Bar Joist Manufacturer

The Bar Joist manufacturer mentioned previously had installed 50 of the "Gas Guard" device several years before we visited. However they were all supposed to be discarded because in inconsistent results and unhappy welders. All 50 were discarded in favor of the orifices they placed at the feeders. Those are the ones we repositioned to the gas pipeline drop and they then installed our ***GSS***.

When viewing each gas drop with the head of maintenance to see where the orifices being relocated could be placed, we discovered one welder with the "Gas Guard" still in use. The maintenance manager was surprised as they were all to be discarded! Of interest it was set at the highest reading on the gauge, 80 CFH!

Catalytic Converter Production

A manufacturer of catalytic converters had 70 new robotic MIG welding cells installed. The systems integrator installed a model of low-pressure surge reducing flow control regulator flow control at each pipeline drop. It was a low pressure "Gas Guard" model designed to mount at a pipeline drop. It was quickly observed by the welding engineer that flow variations were occurring when measured at the MIG nozzle for both the MIG welding robots and several manual MIG welders using the same flow control device. The welding engineer saw one of our videos and had the low-pressure device manufacturer visit, but they were no help. He called us and we recommended these "Gas Guard" regulators be replaced with standard flowmeters. After replacing all with conventional flowmeters mounted at the pipeline, flows remained at preset levels during production. That solved the shielding gas flow problems!

BOTTOM LINE

The ***GSS*** provides sufficient extra gas at the weld start to purge air and provide lower spatter starts. Without a sufficient gas purge it's like starting in air! If you every forgot to open the gas cylinder when starting to MIG weld (haven't we all!) you know what that is like! Note, the peak flow orifice in the ***GSS*** "***does not***" restrict the flow setting from a quality cylinder or pipeline flow control; it only limits the peak flow surge rate (unless welders are setting very high gas flows then it will limit flow to about where the ball hits the top of the flow gauge. However it will not allow the very high flows most flowmeters are capable of delivering with wide open needle valves!)

Any device mounted at the wire feeder to set flow will limit gas surge but will not provide sufficient extra gas to purge air from the weld start zone. As noted previously, Stauffer defined the need very well in his 1982 patent. Welders will see this inferior start and find increasing the steady state flow (their only option) will make some improvement. When they use our ***GSS*** they get an optimum amount of extra gas at a maximum velocity that avoids excess turbulence.

Low pressure devices, whether mounted at the feeder, cylinder or pipeline will not provide consistent flow as the inevitable production flow restrictions occur. Welders seeing the effects of low gas flow or insufficient start gas will increase the steady state flow trying their best to compensate. When system restrictions are reduced they typically will not go back and lower the flow! The engineers who designed MIG and TIG flow control systems when the processes were introduced knew what they were doing! They employed a "choked flow" design that requires a minimum of 25 psi above the flow control needle valve or flow control orifice.

www.NetWelding.com
Email: TechSupport@NetWelding.com