WA Technology

Shielding Gas Flow Variations Caused By Pipeline Pressure Changes

The Problem:

Flowmeters or fixed orifices are used to set shielding gas flow rate in pipeline delivery systems. The flow through both systems is dependent on the pipeline pressure. If the pipeline pressure varies so does the gas flow. Often the amount of shielding gas flow variation is not understood or measured and can easily change outside of the Welding Procedure Specification (WPS) allowable range.

Flowmeter Variations With Pressure Changes:

Flowmeters (ESAB L-32 shown at left) employ a measuring principle defined by Bernoulli in the 1700's. It is officially called a variable area flowmeter and utilizes a tapered tube with a ball that rises in the tube until there is a balance of the forces under the ball versus gravity. These devices are accurate and very repeatable. In addition to gas velocity, they are dependent on the density of the gas. Since gas density varies with pressure, flow readings are dependent on the gas velocity and pressure. All of these devices are therefore calibrated at a specific pressure (and temperature.) Many welding flowmeters are calibrated at 25 psi. A few are calibrated at 50 psi (like the ESAB L-32 shown.) Some are calibrated at 20 and 30 psi and those used for measuring CO_2 may be calibrated at 80 psi to avoid ice particles forming in the needle valve flow control passages. Therefore, if a flowmeter calibrated at 25 psi is used on a 50-psi pipeline it will not read accurately! In fact the reading on the flowmeter is significantly *lower* than the actually gas flow.

The following table shows published factors to adjust flow readings for differences in pipeline pressure from flow tube calibration pressure:

	Multiply Flowmeter Reading by Factor in Red to Obtain Actual Flow									
Flow Tube Calibration Pressure	Pipeline Pressure; psi									
	20	*25*	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*70*
20 psi	1.00	1.07	1.14	1.20	1.26	1.31	1.36	1.41	1.46	1.56
25 psi	0.93	1.00	1.05	1.12	1.18	1.23	1.28	1.32	1.37	1.46
30 psi	0.88	0.94	1.00	1.05	1.10	1.15	1.20	1.25	1.29	1.38
50 psi	0.73	0.78	0.83	0.88	0.92	0.96	1.00	1.04	1.07	1.15

Example of Table Use:

If the flowmeter is calibrated at 25 psi and the pipeline is operating at 50 psi then with a reading of 35 CFH on the flowmeter it will actually be flowing 35 CFH X 1.28 (the factor in Red from the table) = 45 CFH. Therefore if only 35 CFH is desired there is a 10 CFH waste or 10/35 = 29% gas waste!

This table is based on the difference in gas density and is good for all variable area flowmeters. For normal operating temperature ranges, its effect on flow readings can be ignored. Our tests validate and demonstrate the use of this approach for determining actual flow for the flowmeter reading.

Tests of Flow Rates When Pipeline Pressure Varies at a Fixed Flow Control Knob Setting

The following tests were made to measure and demonstrate the gas flow rate as pipeline pressure varies and the flow control knob setting stays at the initial setting. The results validate that the use of the pressure versus flow tables and are within experimental error of the theoretical values.

TEST PROCEEDURE:

A commercial pipeline flowmeter, Victor Model FM372, was used for these tests. It is calibrated at 25 psi. The Victor catalog states that all their flowmeters are designed, for we call, "*Automatic Flow Compensation*" to assure accurate flow when inevitable restrictions to flow occur. All Victor flowmeters are calibrated at 25 psi except model FM200 CO_2 flowmeter that is calibrated at 80 psi.

The Victor FM372 flowmeter was mounted on a test pipeline that is supplied from a 75 psi maximum delivery pressure inert gas regulator on an Argon/CO_2 shielding gas cylinder.

This allows variations to be made in pipeline pressure. The actual flow from the FM372 flowmeter was measured using a portable flowmeter, our part number WAT-PFM. It operates with the same principle as the pipeline flowmeter. Since it is designed to measure flow at the end of a MIG gun (photo upper right) it is calibrated at atmospheric pressure. It is not subjected to variations due to pressure changes since there are none!

For these tests, a technique used is one recommended in our *Lean Welding Manufacturing Self-Study Programs* to monitor shielding gas usage on an ongoing basis. Flow is measured directly out of the gas delivery hose (photo left.) In a production

operation, this approach allows a comparison of gas flow exiting the MIG gun nozzle versus that flowing into the wire feeder. It is a very good way to detect gas leaks in the wire feeder plumbing, gas solenoid and most important in the connection of the gun to the feeder. It can spot a leak in the small "O" ring that provides the gas seal. More details on what variations can be expected, how much gas may exit the wire inlet is provided in the instructions that come with the WAT-PFM (See http://netwelding.com/prod02.htm)

To validate the accuracy of the flow readings of the WAT-PFM, a calibrated regulator/flowmeter was placed on the shielding gas cylinder(picture right.) Flow readings were compared at the end of a hose attached to the flowmeter. Within the precision of our readings, the WAT-PFM read the same flow as the calibrated flowmeter from 20 to 40 CFH.

The following table provides the results of the test:

Flow Rate Variations with Victor Model FM372

Flow control knob was adjusted for 20 CFH at 25 psi input which is the calibration setting for the FM372. The knob setting remained fixed for all pressures tests, simulating expected flow variations with pipeline pressure changes.

Pipeline Pressure	Flow Reading on Victor FM372	Actual Flow as Measured on Portable Flowmeter; WAT-PFM	Flow Using Pressure Correction Factors From Page 1
25 psi	20 CFH	20 CFH	20 CFH
30 psi	23 CFH	23 CFH	24 CFH
35 psi	24 CFH	28 CFH	27 CFH
40 psi	26 CFH	32 CFH	31 CFH
45 psi	27 CFH	34 CFH	33 CFH
50 psi	31 CFH	40 CFH	40 CFH

For the first test, the "pipeline pressure" was set at 25 psi, the calibration pressure of the FM372 flowmeter. The flow control knob was adjusted to a flow rate of 20 CFH. As expected, the WAT-PFM also read 20 CFH.

The pipeline pressure was increased to 30 CFH without changing the flow control knob setting. This simulates what would happen in production when pipeline pressure varies as welders are placed on line or removed from production etc. The FM372 now read 23 CFH, 3 CFH higher. The WAT-PFM read 24 CFH. The flow versus pressure table on page 1 was used to calculate the theoretical flow for the 25 psi calibrated flowmeter. It showed for a 25 psi calibrated flow tube reading with 30-psi inlet pressure that the correction factor was 1.05. Or the 23 CFH FM372 reading should be flowing 24 CFH. This is within the reading precision in the test.

Checking at the 40-psi inlet pressure, again with the same flow control knob initial setting, the FM372 reading increased to 26 CFH flow. The WAT-PFM read an actual flow of 32 CFH. A significant difference. Using the pressure compensation factor of 1.18 from the table on page 1 for 40 psi versus the calibrated 25-psi setting provides an expected theoretical flow for the 26 CFH reading on the FM372 of 26 X 1.18 = 31 CFH actual gas flow. This is within the reading precision of the 32 CFH measured with the WAT-PFM.

Checking at the 50-psi inlet pressure, again with the same flow control knob initial setting, the FM372 now read 31 CFH flow. The WAT-PFM read an actual flow of 40 CFH. Again a substantial difference. Using the pressure compensation factor of 1.28 from the table on page 1 for 50 psi versus the calibrated 25 psi setting provides an expected theoretical flow for the 31 CFH read on the FM372 of 31 X 1.28 = 40 CFH. This is the same reading as measured with the WAT-PFM and 29% more flow than read on the FM372 flowmeter.

What Are the Consequences of These Test Results?

We have observed that a majority of fabricators using flowmeters on pipelines are employing lower cost systems calibrated at 25 psi on pipeline pressure that is often set at 50 psi. Many are not considering the error due to pressure. Therefore, they are using gas flows significantly higher than they are reading on the flowmeter. Of interest, they may have performed their weld procedure qualification tests using cylinder gas supply in a laboratory. They could have used the same flowmeter attached to a regulator as they are using on the pipeline supply. Manufacturers of these flow devices often use the same flowmeter with regulators for cylinder supply and without regulators for pipeline supply. However, regulators used for regulator/flowmeter devices are always set at the fixed pressure for which the flowmeter is calibrated be that 25, 30, 50 or 80 psi! Therefore, flow readings are accurate when used on cylinder gas supply. Note, flow readings may vary as cylinder pressures get near empty.

Flow Variations with Orifices

We also tested flow variations with an orifice flow control device. Tests were made with our WAT-35AO Pipeline Orifice (See http://netwelding.com/Orifice_Flow_Control.htm) comparing theoretical flow for its orifice size and actual measured flow using the WAT-PFM with pipeline pressure variations. These are the results:

Pipeline Pressure	Theoretical Flow	Measured Flow in Test
25 psi	26 CFH	25 CFH
30 psi	30 CFH	30 CFH
35 psi	33 CFH	33 CFH
40 psi	35 CFH	36 CFH
45 psi	40 CFH	41 CFH
50 psi	43 CFH	44 CFH

As seen from the data, the flow is very predictable and (within the precision of our measurement readings) was equal to the theoretical flow based on orifice size and pressure calculations. However as with flowmeters, when pressure changes so does shielding gas flow.

BOTTOM LINE

The actual flow through a flowmeter used on a pipeline gas supply depends on the pipeline pressure. Many flowmeters are calibrated at 25 psi and higher pipeline pressure will have significantly higher flows than read on the flowmeter. For the flowmeter tested (calibrated at 25 psi) if the pipeline pressure is a typical 50 psi then at a flowmeter reading of 31 CFH the actually flow will be 40 CFH. That is 29% more actual flow that is read on the flowmeter! Published pressure correction factor tables can be used to define the actual flow from that read on the flowmeter.

What should be done? Use a simple, inexpensive portable flowmeter to define actual flow at the MIG torch nozzle. Our WAT-PFM (photo right) is inexpensive and has a large base to accept all nozzle sizes. It can also be used to check flow into the wire feeder and compared with flows at the MIG torch nozzle, as illustrated in our product instruction literature See: http://netwelding.com/prod02.htm to order the WAT-PFM.

If an orifice flow control is used to set flow, a portable flowmeter is a way to verify the actual flow. The flow through an orifice reduces about 8 CFH with a 10 psi pipeline pressure drop. Therefore, pipeline pressure drops produced similar flow variations in both *Flowmeters* and *Fixed Orifice* devices.

Shielding gas flows set on a pipeline flowmeter that is calibrated at a different pressure than the pipeline pressure could easily exceed the range defined in a Welding Procedure Specification (WPS!)

Do Your Pipeline Pressures Vary Excessively?

There are several things you can and should do:

1. Consider adding regulators before your flowmeter of fixed orifice to maintain pressure and flow. **DO Not Use** cylinder regulator/flowmeters; they will not maintain consistent output pressure at low inlet pressures. These regulators have valve seat size, diaphragms and springs to manage flow from 2500 psi cylinder pressure and will not maintain consistent pressure when inlet pressures are at the much lower pipeline pressure. The regulator shown on the right is designed to accept inlet pressures up to 200 psi and will deliver consistent output pressures in the 25 to 50 psi range.

2. We also have patented products that set flow using a properly designed pipeline station regulator that maintains pressure above that needed to retain "*Automatic Flow Compensation*."

For details about either approach, define what you would like consider and Email: Jerry_Uttrachi@ NetWelding.com with the following information:

1) Location: City and State
2) Pipeline pressure range observed
3) Type of existing flow control (flowmeter, orifice, other ?)
4) Range of gas delivery hose lengths employed

Gas Saver System (GSS) and Flow Rate Limiter and Lock (FRLL) Information

Our Patented Gas Saver System (GSS) Can Reduce Gas Use by Half or More!

How Much Gas Can Be Saved?

The best way to show the savings is with an example from one of our industrial customers who tested the system then bought them for all 35 of his MIG welders.

A Texas Truck Box manufacturer evaluated the system on a repetitive job, welding doors. With their standard gas delivery hose they welded ***236 doors*** with a full cylinder of shielding gas. Just substituting their gas hose with our patented ***GSS*** maintaining the same flow settings they welded ***632 doors***! That's a 63% reduction in shielding gas use.

Weld Performance Improvement

A small shop owner provided this feedback after he purchased a 3 foot ***GSS*** for his small MIG welder. Al Hackethal reported these findings:

"Well, I can't believe it. I never thought a hose could make that much of a difference. I had a small job that's been waiting for a while. The weld quality, and even penetration is considerable better. Almost no spatter! The weld seemed to be hotter and I turned my MIG down a notch. Initially thought that my imagination had kicked in, but then realized that the gas I'm buying is actually working the way it's supposed to. Glad I found your website. This is one of the few things that really works better than any info could suggest. I understood the theory, though in practice I understood much better after the first couple of welds. Now I have better looking welds and almost no spatter, which means less grinding and finish work! In addition, the tip was cleaner after the job I just did.
This will provide savings in time, labor and maybe even consumables too. As a one man shop there's never enough time for anything.

Al also has a TIG welder with 300 amp water cooled torch and bought one of our Leather Cable Covers. His email said this about it!

Oh, the leather wrap for my TIG hoses worked very well and fits perfectly. I'd just replaced the hoses and was looking for something to protect them that was better than the nylon wrap that's available around here. Now I'm "TIGing" again too, and much safer. It's good to know the coolant hoses are well protected. Much better than using a 300 amp TIG and then realizing that I was standing in a puddle of coolant, which is what recently happened. Can't pay the bills if I electrocute myself!

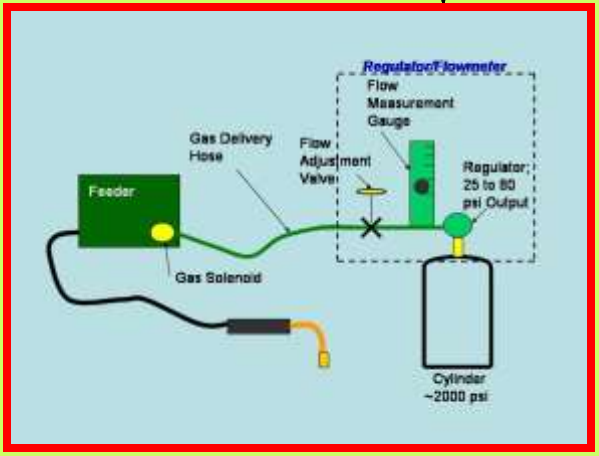
Thanks for making products affordable".

How Does The GSS Work?

Gas waste occurs every time you pull the MIG torch trigger even if it's only to inch the wire to cut off the end.

To keep flow at the preset level the gas pressure in the cylinder regulator will be between 25 and 80 psi.

Flowgauge regulators (those with a flow calibrated pressure



gauge) operate in this pressure range as well.) However to flow shielding gas though the welder and torch typically requires 3 to 5 psi depending on restrictions. Therefore every time welding stops the pressure in the gas hose raises to the regulator pressure of 25 to 80 psi. That stores up to 7 times the hose volume of gas in the hose. This is similar to your shielding gas cylinder which holds about 150 times the volume of gas as the physical volume of the cylinder due to the high pressure!

The patented ***GSS*** stores over 80% less gas then typical shielding gas hoses. In addition to the wasted gas (which you can hear when you pull the torch trigger) the high flow also causes air to be pulled into the turbulent shielding gas stream! This is like starting with the gas cylinder shut off! You have probably experienced that before when you forgot to open the valve!

It takes a short time for the shielding gas flow to return to a smooth less turbulent (laminar) flow even when the start gas surge flow reduces. That can take several seconds so when making short welds or tack welds you're not getting all the benefits of the shielding gas you're purchasing!

SUMMARY:

The ***GSS*** can cut your gas use in half or more. It also has a surge restriction orifice built into the fitting at the welder- wire feeder end. That limits peak flow (*but not your set flow*) to a level that avoids excess turbulence for better starts. It allows a controlled amount of shielding gas to quickly purge the weld start area.

All you need to do is replace the exiting gas hose from cylinder regulator to welder with our patented *GSS*. *It is available in various lengths at* www.NetWelding.com .

Or email us at:
TechSupport@NetWelding.com

ARE YOUR WELDERS SETTING EXCESS GAS FLOW?

Here Is What One Of Our Customers Said About Our Recently Patented Flow Rate Limiter and Lock.

TEXAS HYDRULICS SAVES 35% SHIELDING GAS WITH FLOW RATE LIMITERS

Texas Hydraulics utilizes MIG welding to fabricate hydraulic cylinders with bores ranging from 1 inch to 15 inches; with some 20 feet long. Doug Watkins, Welding Engineer for their Texas plants, found their welders were able to adjust flowmeters at any time at a shielding gas flow beyond the range of their Welding Procedure Specification (WPS). Some were found with the flow measurement ball pinned to the top of the flow

tube. Mr. Watkins indicates, "We have found with our flowmeters that can mean a flow rate of 100 CFH or higher is being used. In addition to the gas waste, any flow setting beyond about 50 CFH with our electrode extension pulls air into a turbulent gas shield. That air creates weld spatter and possibly internal (or even external) weld porosity."

By installing 30 WA Technology Flow Rate Limiters (WAT-FRLL) and limiting the maximum flow that can be set, they assured a quality shielding gas stream and eliminated gas waste. The maximum flow rate is now set at 40 CFH and this setting locked-in. After an initial gas use audit, the calculated shielding gas savings was measured at 25%. With follow up audits the actual savings

exceeds 35%.

According to Mr. Watkins, "By using the Flow Rate Limiters we are building a quality product and controlling our consumable cost which continues to be more valuable every day."

Doug sent the following message to WA Technology; *"I really appreciate your companies' assistance; it helps me do better at my job. WA Technology has contributed directly to helping us control our cost in welding consumables and help us remain competitive in our effort to provide the best product for the right price."*

Bottom Line

- Our recently patented Flow Rate Limiter and Lock (FRLL) fits most commercial flowmeters
- It fits over the flow control knob and attaches with a set screw.
- No alterations are made to the flowmeter itself.
- Simply set the desired maximum flow rate; Slip the FRLL over the flow control knob so the pin contacts the flowmeter body such that the knob can not be turned further in the direction of increased flow; Tighten the set screw with the supplied Allen wrench; and install the pin blocking access to the set screw and install the included keyed lock.
- Also available without the brass lock for less cost.

See http://netwelding.com/Flow_Rate_Limiter.htm for purchase details.

www.NetWelding.com

Products Covered by US Patents; 6,610,957; 7,015,412; 7,019,248 and 7,462,709