WA Technology

Excellent Short Question Received—Long Answer!

Received a question from a welding engineer who watched our "Setting Gas Flow" video:

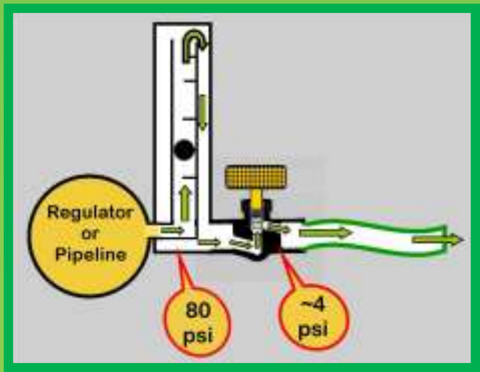
In MIG welding, a full Argon/CO_2 cylinder has a pressure of ~2500psi. How does an orifice or needle valve properly reduce the pressure to the 3 to 8 psi needed to flow the 30 to 35 CFH when welding?

The following is my reply: This is what happens with shielding gas as it flows from an Argon/CO_2 high pressure cylinder through to the end of a MIG gun nozzle:

1. As stated, the pressure in a full MIG shielding cylinder is ~2500 psi. Also 3 to 8 psi is all that is needed at the wire feeder/welder inlet to flow the needed 30 to 35 CFH.

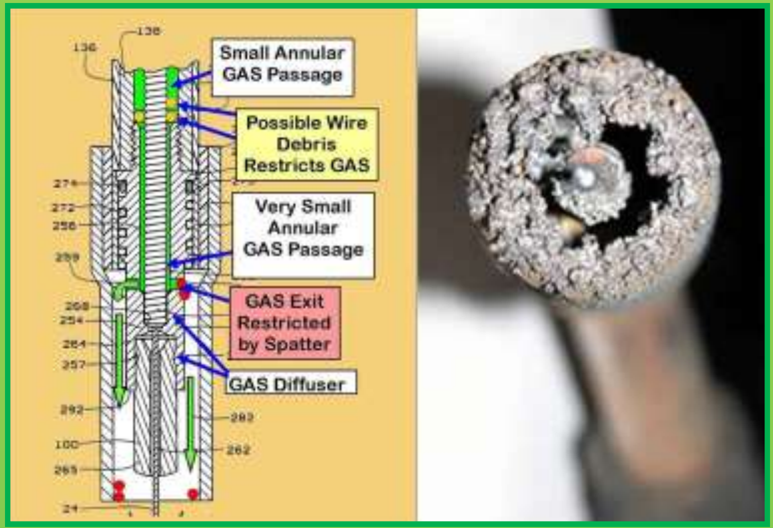
2. A regulator is placed on the cylinder, NOT just a needle valve or orifice, to reduce the pressure. Depending on the regulating device used, the minimum regulator pressure is 25 psi and the most is usually 80 psi. Regulator/flowgauges (photo right) employ a very small orifice on the output of the regulator and typically operate from 50 to 80 psi depending on the size of the orifice and desired flow rates. Therefore as the regulator pressure changes the flow rate changes (*note the output gauge is calibrated and labeled in **CFH NOT** psi***.)**

3. When a regulator/flowmeter is used (*one with a flow tube as shown in photo right***) a needle valve flow control is provided. The regulator is not adjustable; it is set at a fixed pressure. The minimum pressure used (or should be used) is 25 psi, some use 50 psi and ones used for CO_2 service may use 80 psi (***to avoid ice particles clogging the needle valve***.) With this device the flow rate is controlled by the amount of needle valve opening.**



4. As long as pressure is above 25 psi upstream of the orifice or needle valve, the flow is controlled by the velocity of the gas in the small orifice or needle valve (*this is called choked flow or more accurately stated choked velocity.)* **Gas velocity CANNOT exceed the speed of sound! That is similar to what is observed with lightening and thunder. You see lightening first since it travels essentially instantaneously, 300,000,000 m/sec. The thunder noise created by that lightening bolt travels at only 345 m/sec.**

5. Since the amount of gas is controlled by the orifice or needle valve — what is the pressure drop? It becomes whatever it takes to flow that volume of gas coming through the orifice or needle valve through the various flow restrictions that include: 1) the restrictions in the gas delivery hose [*actually that is very small***] 2) the gas lines in the feeder and solenoid [***also small***] 3) the hose in the MIG gun cable [***that can be several psi as that gas passage is very small***] 4) the small gas passages in the torch [***this is often the largest restriction such as passages leading up to and in the gas diffuser which has small holes that put the gas into the gun nozzle***] and 5) the flow through the gun nozzle itself [**which can be restricted with spatter**.]**



6. The restrictions defined in the statement #5, vary as the gun cable is twisted, looped and bent while welding; spatter builds in the nozzle and partially clogs some of the gas diffuser holes and the gun cable passages partially clog with wire debris (*from the wire drawing lubricant and copper flakes.***) In most MIG gun designs the steel wire liner is located in the small gas hose in the gun cable.**

7. Decided to check to see what the gas flow rate would be if just an orifice was placed on a 2500 psi cylinder (*actually dangerous!)*** Using the size orifice we employ as the peak flow rate limiting device in our Gas Saver System it would be about 3500 CFH!! Even sounds dangerous! To flow 35 CFH the orifice would have to be 0.0045 inches in diameter! If just this small orifice was used; when the pressure reduced in the cylinder the flow rate would be lower. For example when the cylinder pressure reduced to 1000 psi the flow rate with an 0.0045 inch diameter orifice would be 14 CFH.**

8. How did the flow rate change when the velocity is the speed of sound? The velocity is the speed of sound but the gas density decreases with reduced pressure so even though the speed is the velocity of sound, at lower pressure the gas density is lower (*proportional to the absolute pressure***) and therefore less gas volume goes though the small opening!**

To Make a Long Answer Longer:

The above discussion presents information on how gas flow systems work and how "choked flow" maintains the present flow regardless of varying restrictions that occur when welding. We performed the following flow restriction tests to show the results with a quality 25 psi regulator/flowmeter and a low pressure device some have attempted to use to reduce the gas surge at the weld start. These were introduced over 20 years ago and the problems they create caused them to be seldom used. Some occasionally try to revive what on the surface appears to be a logical solution to the surge problem. The following shows why it they are Not!

Details of Tests of Low Pressure Device:

A low pressure device (photo left) marketed to "Guard Surge" of start gas was tested and compared to a standard 25 psi Regulator/Flowmeter (photo right.)

The low pressure device required a pressure of only 9 psi to produce the test initial flow setting of 31 CFH. Because this pressure is well below the required 25 psi to have "automatic flow compensation," flow varied significantly as typical flow restrictions occurred.

Other low pressure devices have been sold which are designed to mount after a convention regulator/flow control device. Photo right is one such device. It operates at such a low pressure (comes set at 5 psi) flow rates will vary considerably from preset values.

The table below shows the test results with a Conventional Flow Control device and the low pressure device subjected to varying torch restrictions. Both were initially set to flow 31 CFH. The controls were left at the initial settings as if they were padlocked. Torch restrictions were then added and removed (as if the gas ports were alternately clogged and cleaned) to vary the amount of restrictions. The resulting flow rates are shown in the table below.

Flow Control System	< Typical Production Restriction Range; psi >					
	3 psi	4 psi	5 psi	6 psi	7 psi	8 psi
Conventional = 25 psi	31 CFH	31 CFH	31 CFH	31 CFH	31 CFH	31 CFH
Low Pressure Device = 9 psi	37 CFH	34 CFH	31 CFH	27 CFH	23 CFH	16 CFH

Results:

The Conventional System was a standard regulator/flowmeter with an outlet pressure of 25 psi upstream of the flow control needle valve. Shielding gas flow remained at the preset desired level of 31 CFH even when the restrictions in the feeder/torch system ranged as low as 3 psi to as high as 8 psi. The Low Pressure device tested installs at the feeder and is sold to reduce the shielding gas surge at the start. It does reduce the surge (actually too much so!) Note the gas flow varied from 16 CFH to 37 CFH as restrictions were added and removed from the system. The flow control settings and regulator pressure did not change; it remained at 9 psi in this case. Unfortunately the flow calibrated pressure gauge included with this device is only reading the 9 psi pressure so it did not change either! It read about 31CFH for all the tests! This gives the false impression that the flows remained constant. You can be out of the flow range defined in your Welding Procedure Qualification and not know it! Only a measurement at the torch (or in our tests also with an accurate flow meter installed the delivery system) revealed the gross error.

The low pressure device mounted at the feeder also creates a problem any flow control device placed at the feeder causes (whether a flow control orifice, flowmeter or a needle valve.) It does not supply sufficient extra gas at the weld start to purge the torch nozzle and weld start area. This creates inferior starts with excess spatter and internal if not visible weld defects.

Reported Production Problems with This Low Pressure Device

AUTOMOTIVE OEM

A welding engineer at a major automotive sub supplier reported that after purchasing 32 of the same low pressure device we tested, he discarded them, having found:!

- **Lack of sufficient extra gas at the start made inferior starts and**
    - **Large flow variations from preset levels were evident when he would check flow at the torch.**

He stated; "*Even if the flow was blocked, the flow calibrated pressure gauge supplied with these devices had the same preset reading!*"

INDUSTRIAL EQUIPMENT MANUFACTURER

An interesting example of a flow problem attributed to the same low pressure surge device we tested was uncovered at this large manufacturer. The welding engineer discussed a porosity problem he was having in one plant making the same part with the same procedures, welding materials etc as another of their plants where no problem existed. It was persistent so he sent me an extensive fishbone trouble shooting diagram which covered many of the potential issues. It appeared to be Nitrogen porosity so I recommended checking wire chemistry, shielding gas quality and for gas leaks in their pipeline that pull in air. They even switched to cylinders to test shielding gas quality - same problem. It definitely sounded like a Nitrogen porosity problem and I asked if their flow rates were excessive. They were not and were the same in both plants.

When I checked back to see what if any of my recommendations had worked I was told that plant with the problem had been using the "surge guard" gas savers, the same one we had tested! They were removed and the problem was resolved!

The variations in flow caused by this product, as seen in our tests, contributed to the problem. Since these low pressure flow controls mounted directly at the feeder there was also insufficient extra gas flow at the start to purge the gun nozzle and weld start area of air. This can cause start porosity for the first few inches of welding, which has been observed in similar situations when orifices, low pressure or for other flow controls are placed at the feeder.

Other production problem examples have been reported with low pressure devices. Email Jerry_Uttrachi@NetWelding.com if you have questions.

Bottom Line:

Asked simply "What time is it?" I responded with "How to Make a Watch!" For a simple question about setting MIG gas flow — the answer is complex.

As noted, some folks have sold low pressure devices to control gas surge at the weld start in attempt to avoid gas waste. However these devices do not control and maintain the preset flow. The flow varies with the inevitable restriction changes when welding. Welders are smart and increase the flow when the restrictions occur. They never reduce it after, so we have found when these devices have been tried flow rates are set very high to compensate for the most restrictions - actually wasting gas! Management may get mad and blame the welders for setting these high flows and try to lock or ultimately discard these devices! They may then be reluctant to try our patented low cost Gas Saver System! Since they did not understand why these low pressure surge reducing devices created these difficulties and unhappy welders, they also don't appreciate why our patented Gas Saver System *Does Not* have these problems! Our Gas Saver System does not alter the pressure that has been designed into quality flow control systems since MIG was invented! In fact, I learned these flow control principles from engineers who designed MIG gas control systems in the 1950's!

Thanks for the great question.

Jerry Uttrachi

President, WA Technology

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