

GMAW Shielding Gas Flow Control Systems

BY GERALD D. UTTRACHI

Typical changes in shielding gas flow restrictions caused by spatter in the welding gun nozzle, spatter clogging some of the welding gun gas diffuser ports, bends in the welding cable, or debris in the welding gun gas hose passages can be automatically compensated to maintain a preset flow. From the time the GMAW process was introduced, typical shielding gas flow systems utilize a minimum pressure of 170 kPa (25 lb/in.²) as the output of regulator/flowmeters and flow gauge regulators for cylinder use or in pipeline gas supply. This pressure provides automatic flow compensation for the inevitable gas restrictions that occur in production.

Automatic Gas Flow Control

Self-compensating or automatic flow control is achieved by employing a minimum gas delivery pressure upstream of the shielding gas control orifice or valve. The phenomenon that creates this automatic flow compensation is referred to as critical orifice flow. In general, flow through an orifice is dependent on the upstream and downstream pressures. That is until the gas velocity in the orifice reaches the speed of sound. Once this flow velocity is reached, for a given upstream pressure, the flow rate stays the same regardless of the downstream pressure changes. When critical orifice flow is maintained, typical changes in flow restrictions caused by spatter in welding gun parts, gas hose bends, etc., have no effect on shielding gas flow. The downstream pressure automatically increases to compensate. No interaction by the welder is required.

Defining the pressure needed to have automatic flow compensation for restrictions that occur in production; the pressure upstream of the orifice or flow control valve must be more than 2.1 times (approximately twice) the downstream pressure. Both are measured as absolute pressure, which adds atmospheric pressure to the normal gauge reading — Fig. 1. The typical pressure

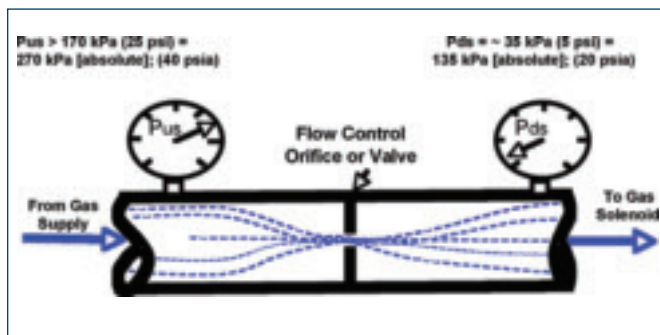


Fig. 1 — Automatic flow compensation requires the pressure upstream of the orifice or flow control valve to be greater than (approximately twice) the downstream pressure. Measured as absolute pressure = gauge reading + atmospheric pressure.

needed to flow shielding gas at normal rates through a gas solenoid, plumbing, and welding gun is about 35 kPa (5 lb/in.²) or stated as absolute pressure 135 kPa (20 lb/in.² atm). Therefore, the pressure upstream of the flow control device should be about twice that amount or an absolute pressure of 270 kPa (40 lb/in.² atm). When stated as normal gauge pressure, that is a minimum upstream pressure of 170 kPa (25 lb/in.²).

In flow tests reported by WA Technology with a typical system having a delivery pressure of 170 kPa (25 lb/in.²), the flows remained consistent and at a preset level when the solenoid through gun restrictions were varied from 21 to 55 kPa (3 to 8 lb/in.²). In similar tests conducted with a low-pressure system over the same restriction range, there was more than a 65% flow change with no manual change in the flow setting. When restrictions with the low-pressure system were varied over a smaller range of 24 to 48 kPa (4 to 7 lb/in.²) the flow changed more than 35%.

Extra Shielding Gas Needed at Weld Start

It is important to have some extra shielding gas supplied at the weld start to quickly purge the welding gun nozzle and weld start area of moisture-laden air. Stauffer, in a U.S. Patent in 1982 (Ref. 1), described the need, stating "... air leaks back into the torch and lines when welding is stopped. The air must be quickly purged and replaced with inert gas to produce high-quality welds. Also, it is critical to displace the air at the weld zone of the workpiece upon initiating the weld."

In normal gas delivery systems, extra gas flow is created by the higher delivery pressure building in the gas delivery hose when welding stops. Unfortunately, this excess gas exits the welding gun at a high velocity that creates turbulence in the shielding stream. This turbulence defeats the objective by pulling moisture-laden air into the gas stream. Once started, the turbulent flow will continue for a short time even after the flow returns to the proper preset level. This entrained moist air creates inferior starts with excess spatter and possibly internal or even visible porosity. The high surge flow also wastes significant shielding gas (Ref. 2). The volume of excess gas in the delivery hose, measured at standard temperature and pressure, is much more than the physical hose volume due to the higher pressure developed in the hose when welding stops. Much of this excess volume exits at high velocity and is wasted on each weld start. The extra gas should exit the welding gun at a flow rate that produces laminar flow. To achieve this objective, the maximum flow rate is only somewhat higher than that typically employed during welding. Preflow can be utilized to accomplish the objective of having a gas purge. However, it must be set sufficiently long to overcome the time it takes for the surge flow to reduce below a turbulent flow rate. Depending on the delivery hose length, this has been measured to be up to several seconds. Preflow is often an irritant to a welder, particularly for tack or short welds, and may

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be circumvented since there is a delay when the welding gun switch is pulled.

Methods of achieving a controlled amount of extra shielding gas at the start are defined in the Stauffer patent. Other more recent patents describe devices to control the volume and velocity of this extra gas while maintaining the pressure needed for automatic flow compensation (Ref. 3). For details of products that eliminate gas waste at the weld start while maintaining the minimum pressure needed for automatic flow compensation see *www.NetWelding.com*. Examples are presented of users of GMAW who reduced their total shielding gas use (waste) by up to 63% with improved weld starts. ♦

References

1. Stauffer, H. R. 1982. Application and Method for Reducing the Waste of Shielding Gas. U.S. Patent Number 4,341,237.
2. Standifer, L. R. 2000. Shielding gas consumption efficiency. *Fabricator* 30(6).
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