Reducing Gas Surges Improves GMAW Profitability

Measures are outlined that can help lower your gas costs

BY RICHARD GREEN

Do you like throwing money into the wind? Well, you could be doing just that if your company is performing gas metal arc welding (GMAW). Every GMAW arc start has the potential for excess waste because of gas surge.

Installing the optimum gas flow control equipment is a proven source of cost savings that can impact a company's operating efficiency and profitability. Other factors such as adjustability, pipeline layout, and distance from the gas solenoid valve also impact cost. This article reviews the benefits and drawbacks of controlling shielding gas coverage with flowmeter, flow gauge, and flow orifice technology with and without local pressure control.

The ideal candidates for maximum cost savings are those weldments that require multiple tack welds or a large number of short welds. In this scenario, the gas control system pressurizes and depressurizes as the wire feeder solenoid valve actuates. Think of the feeder solenoid as a dam opening and closing the flood gates of gas. Typically, the operator experiences a gas surge built up behind the solenoid valve, which could lead to erratic arc starts and porosity caused by siphoned atmosphere. The hose length, device proximity to the solenoid valve, hose diameter, and static gas pressure impact the volume of gas buildup behind the solenoid valve. Peak surge and surge duration are terms used to describe the severity the operator experiences.

Determining Peak Surge

Peak surge is the maximum instantaneous flow observed that is defined by the pressure drop across an orifice. For the calculations in this article, we will assume a sharp-edged orifice and sonic flow. Sonic flow is the range in which $\Delta P \leq \frac{1}{2}$ of the inlet pressure, or as referenced in CGA E-4 for air $P_2/P_1 \leq 53$ (Ref. 1). The flow rate can be calculated within a 4–5% margin of error using the following equation:

$$Q = (816.6\, C_v P_1)/(GT)^{1/2} \text{ (Ref. 1).}$$

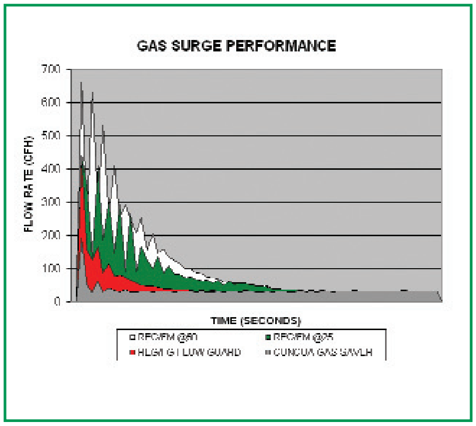

Fig. 1 — Gas surge performance of flowmeter (FM) and flow gauge (FG) calibrated at various pressures.

C_v is a term used to describe an orifice or valve's fluid flow capacity. As reference, a C_v of 1 means the valve or orifice can flow 1 gal of water with a ΔP of 1 lb/in.^{2}. The C_v can also be related to the surface area of the orifice or the open area of a regulating valve such as a pressure regulator's seat. Examples of the C_v values listed in CGA E-4 Table A1 for sharp edge orifices are C_v 0.01 for an orifice diameter of 0.025 in., C_v 0.03 for 0.043 in., and C_v 0.1 for 0.079 in. (Ref. 1). G is the specific gravity of the gas, 1.38 for argon and 1.52 for carbon dioxide. T is the inlet gas temperature expressed in the Rankine scale calculated as °R = °F + 460. P_1 is the inlet pressure expressed in pounds per square inch (lb/in.^{2}).

Peak surge is also affected by the inlet pressure and spring closing forces acting on the regulator's seat. Gas coverage settings are usually set in the flowing condition. As the seat closes, the static pressure filling the hose exceeds the preset value by cumulative forces closing the seat, causing the pressure in the hose to rise 5–15 lb/in.^{2} higher than the calibration pressure. This in turn increases ΔP across flow devices such as flowmeters, orifices, or flow gauges leading to greater waste. The calibration pressure can vary from manufacturer to manufacturer as much as 20–80 lb/in.^{2}. In general, flowmeters yield lower surge than orifices because the float material provides some backpressure as compared to the orifice. In either case, both discharge the shielding gas to the atmosphere.

Surge duration is the time it takes the flow device to settle from the peak surge to the desired flow rate. The amount of gas stored in the hose reservoir impacts surge duration. As the hose diameter, length, and static pressure increase, the duration of the surge and subsequent waste increase.

Flow Control Equipment

Not all flow control equipment guards

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against gas surge as expected. Figure 1 illustrates in red a flow gauge that is designed to limit the duration and peak of the gas surge. However, this type of flow gauge typically requires pressure greater than 10 lb/in.^{2} to obtain 20 ft^3/h flows. The flow gauge configuration incorporates an adjustable regulator, a fixed orifice, and a calibrated flow gauge that converts the ΔP across the orifice to cubic feet per hour of shielding gas. Flow gauges can operate between 10–75 lb/in.^{2} depending on the orifice diameter and desired flow rate. Gas waste can vary among flow control equipment two to six times as illustrated in Fig. 1. The flow values in Fig. 1 were measured with a laminar flow element, inlet and outlet transducers, and a thermocouple to compensate for temperature in nitrogen. The values were collected using data-acquisition software.

Reductions in gas surge can also be achieved by coupling a noncompensated flowmeter, an orifice, and an adjustable regulator, as illustrated in Fig. 2. The operator adjusts the regulator pressure while observing the flow on the scale in the flowmeter. The flowmeter accurately displays the gas flow rate even when the regulator is adjusted to as low as 3 or 4 lb/in.^{2} This minimizes the static pressure buildup in the hose. The gray curve in Fig. 1 shows the reduction in gas peak surge and surge duration because of this design.

Optimism is high at this point that a 20% reduction in gas cost is achievable, but care must be taken when specifying gas-saver regulation equipment. The flip side of reducing gas surge is it takes longer for the gas to travel from the solenoid to the end of the weld gun. Depending on the amount of air movement, the welding gun should be limited to 15 ft to ensure sufficient gas coverage upon arc initiation. Remember, with gas-saver equipment, the designed flow rate is what you get and not the surge in excess rate of 600 ft^3/h.

Fig. 2 — Surge-reducing regulator incorporates a lockout and a noncompensated flowmeter.

With adequate gas coverage ensured, a simple spreadsheet can be used to determine the payback and subsequent cost savings by weldment as illustrated in Fig. 3. By quantifying the number of arc starts per part and the number of parts per shift, the manager can make an informed decision. Coupled with the cost per cubic foot, the data can then be translated into savings by management.

Installing the best equipment for the application will ensure cost savings is realized — and not taken by the wind.♦

Reference

1. CGA E-4-1994, *Standard for Gas Pressure Regulators*. Compressed Gas Association, Inc., pp. 31, 35.

	REG/FG GAS GUARD	REG/FM @25 PSI	REG/FM @50 PSI
NUMBER OF ARC STARTS PER PART	8	8	8
PRESET GAS FLOW RATE	35	35	35
REGULATORY TYPE	0.0104	0.0133	0.0185
NUMBER OF PARTS PER SHIFT	125	125	125
NUMBER OF SHIFTS PER DAY	1	1	1
NUMBER OF DAYS PER MONTH	20	20	20
COST PER $CCFT	$3.20	$3.20	$3.20
CAPITAL INVESTMENT	$120.21	$120.21	$120.21
SAVING PER YEAR	$79.87	$102.14	$142.08
PAYBACK IN MONTHS	$18.06	$14.12	$10.15

Fig. 3 — Chart illustrates the financial savings and payback in months of the non-compensated flowmeter/regulator in Fig. 2 compared to other designs in same applications.