Optimize your plasma performance

10 steps to proper torch setup, maintenance

By Jim Watson and Jennifer Simpson

Plasma arc welding (PAW) uses plasma, a gas that has been heated to a high temperature and ionized. The plasma becomes electrically conductive, transferring an electric arc to the workpiece through a small orifice. This ensures a high concentration of heat to a small area. The shielding gas enters the arc zone and channels the plasma to the workpiece in a precise column.

Because of the advanced level of arc control and accuracy, PAW is suitable for use in precision welding applications. The weld that results is a product of high heat concentration delivered through the plasma torch and the shielding gas that protects the molten weld puddle against oxidation. Additionally, the arc is columnar, which reduces the chances of damage to adjoining components of the workpiece. The welding arc transfer allows thin sheets, fine wire, and miniature components to be welded.

The narrow columnar arc, however, accepts fewer tolerances than the wider arc of gas tungsten arc welding (GTAW). Even the slightest adjustment or process variation can cause premature torch failure or arc-starting difficulty, the most common problems associated with PAW.

For high-production work, it can be frustrating, not to mention expensive, if you have to stop production to replace a damaged torch. While your first instinct may be to blame the torch manufacturer, the problem actually may be associated with the setup and maintenance of your equipment or with your procedure.

Troubleshooting Torch Failure

Generally, torch failure is caused by a short within the torch that causes it to arc internally rather than arcing through the electrode to the workpiece. Maintaining a consistent procedure is key to improving arc starting, minimizing torch failure, and, most important, minimizing downtime. You can optimize the performance of your plasma torch by incorporating the following steps into your setup and maintenance procedures.

1. When setting up your plasma torch, don't modify any of the replacement parts, and be sure a qualified and trained individual services your torch. Torch parts are highly engineered components that should not be tinkered with. Incorrectly installing or cross-threading replacement parts can cause internal arcing.

2. Check for O-ring damage. This can be caused by assembling dry, unlubricated liners into the torch, or by failing to replace cracked or worn O-rings around the shield cup, torch body, or backcap. O-rings cost less than a dollar, making them easy, inexpensive protection against premature torch failure.

3. Check your gas pressure and flow rates, and be aware of the potential for shielding gas contamination. Use a high-quality flowmeter, and be sure to set the pressure and flow rate to the recommended setting for your equipment and application. Buy your gas from a trusted supplier, and make sure all the leads and fittings have been tested for leaks.

4. Use only original equipment manufacturer (OEM) or aftermarket replacement parts from a verified supplier. Variations in manufacturing processes from several manufacturers can cause tolerance stack-up problems that will lead to inconsistent welding performance.

While many end users worry that their equipment warranty will be void by using replacement torch parts from an aftermarket manufacturer, this is most likely not the case, though many OEMs may suggest otherwise. The use of high-quality parts in a high-quality system is the best way to avoid equipment problems.

Additionally, PAW is a global industry serving global markets. Your best option is to buy your welding products from a trusted, high-quality supplier who offers only carefully selected, quality products from known manufacturers.

5. Use precision-ground tungsten electrodes from a trusted preground tungsten electrode supplier. This will ensure that correct electrode tip geometry and ground finish are maintained. If you grind or regrind your tungsten in-house, use a dedicated tungsten grinder to avoid contaminating the electrode, and follow the equipment manufacturer's grind specifications closely.

6. Follow the manufacturer's settings guide for electrode setback and tip orifice size. Deep electrode setback can cause inconsistent arc starting and, ultimately, torch failure.

7. Confirm that you have selected the transfer-arc mode on the power supply and that the correct amperage is set for the torch you're using. It's important to avoid overpowering the torch, which causes excessive heat input.

8. Check the level of the water in the reservoir regularly, and change the cooling water at least once a year. Insufficient watercooling also can lead to excessive heat input.

9. Check the electrical integrity of the work lead cable, cable connection to the clamp, and workpiece. Improper cable insulation and poor connections can lead to internal arcing.

10. Maintain the proper tip-to-workpiece standoff. You can take the guesswork out of this process by using an arc voltage sensing control.

Start problems often are caused by inconsistent flow rates.

Torch-starting Issues

A common problem with a plasma torch is that it can be hard to start. In an optimal setup, the pilot arc is initiated between the torch electrode and nozzle tip. The arc then is transferred to the weld piece, delivering intense heat to a small area by forcing the gas and arc through a small orifice in the nozzle and tip. If the transfer is not initiated, you'll need to examine several factors.

Start problems often are caused by inconsistent gas flow rates. Again, buy gas from a trusted supplier and ensure that your equipment is leak-free. The plasma arc nozzle or tip orifice also can cause gas flow problems. It's important to make sure you're using the right size orifice for your welding application.

A leaking O-ring or backcap also can cause starting problems. Look for blueing on the tip of the tungsten, which indicates that outside air is leaking into the torch. This also will be apparent in the weld itself, which will have a grayish tint and may fail an X-ray inspection. Additionally, make sure to verify that the power supply's pilot board and pilot arc resistor are operating properly.

Poor-quality electrodes also can contribute to arc-starting problems and may not last as long. Again, always buy from a trusted supplier.

You may also consider using some of the new tungsten formulas, which are blends scientifically designed to balance migration and evaporation rates. Other new formulas are cryogenically treated to produce a more dense structure.

Finally, a simple step like having a check list on the production floor and making sure your welding engineers and shift supervisors adhere to it will go a long way toward building the kind of consistent procedures required by the precision of PAW. ■

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