CUTTING & WELD PREPARATION
The Many Faces Of Plasma Cutting

By Tex Whiting

Plasma cutting is a thermal cutting process in which a beam of ionized gas heats an electrically conductive metal beyond its melting point and flushes molten metal through the kerf of the cut. The electrical arc is produced between the electrode (negative potential) in the torch and the workpiece (positive potential) being cut by ionizing a beam of pressurized gas at a temperature between 14,000 degrees and 26,000 degrees F. The ionized gas (plasma) is constricted and focused through a nozzle, which produces a dense plasma arc that melts and severs various types of metal. This is the principal process for both manual and mechanized plasma cutting systems.

Manual

Manual plasma cutting systems are moderately small power supplies that use a hand-held plasma torch for cutting various types of metals. These systems are maneuverable, versatile, and can be used for a variety of cutting applications. These power supplies have a range of cutting capabilities that is based on the output amperage of the cutting system. Power supplies commonly are rated as low as 7 to 25 amps and as high as 30 to 100 amps. Some power supplies, however, allow for hand-held cutting of up to 200 amps, but this is not typical. Manual plasma systems normally use shop air as the plasma gas and/ or shield gas, and they are designed so that they can be used with several incoming voltages. The input voltage is between 120 and 600, utilizing either one-phase or three-phase power transmission.

Manual plasma systems are most commonly used in the automobile repair, construction, and metal art industries.

Manual plasma cutting systems generally are used by fabricating shops that handle thin metal, factory maintenance, farm maintenance, welding repair centers, metal service centers (scrap and dismantling applications), construction work (such as buildings and bridges), commercial ship manufacturing, trailer manufacturing, auto repair work, and artwork. Typically, they are used in light-metal applications for trimming excess material. A typical 12-amp hand-held torch will cut a maximum of 3/16-inch.material at approximately 15 inches per minute (IPM). A typical 100-amp, hand-held torch cuts a maximum of 1 ¼ inches material at approximately 20 IPM.

Generally, a manual system is chosen based on the thickness of the material to be cut and the desired cutting speed. A system that delivers high cutting amperage cuts faster. However, when cutting at high amperages, it becomes increasingly difficult to control cut quality.

Mechanized
Mechanized plasma cutting systems generally are significantly larger then manual plasma systems and are used in conjunction with cutting tables, including a water table or downdraft table with a gantry system that runs on various drives and motors. Also, mechanized systems have a CNC and a torch height control (THC), which may include initial height sensing and voltage control. Mechanized plasma cutting systems can be incorporated into a punch press, laser cutting, or robotic cutting system. The size of a mechanized plasma cutting configuration is based on the table and gantry being used. Tables may be smaller than 4 by 8 ft. or larger than 48 by 120 ft. These systems are not easily maneuvered, so all of their components should be considered, along with the layout of the facility, before installation.

<u>Power Requirements</u>. Typical power supplies have a maximum amperage range of 100 to 400 for oxygen cutting and 100 to 600 for nitrogen cutting. Many systems have intricate cutting capabilities at lower amperage ranges, such as 15 to 50. Some systems allow for nitrogen cutting at 1,000 amps and higher, but they are not common. The incoming voltage for mechanized plasma systems is 200 and 600 with a three-phase power transmission.

<u>Gas Requirements</u>. Commonly used gases are compressed air, oxygen, nitrogen, and a mixture of argon/hydrogen for cutting mild steel, stainless steel, aluminum, and various exotic materials. Combinations of these gases are used as the plasma gas and assist gas. For example, for cutting mild steel, it is not uncommon to use nitrogen as the plasma cutting start gas, oxygen as the plasma cutting gas, and compressed air as the assist gas.

Oxygen is used for mild steel (carbon steel) because it produces high-quality cuts in the material up to 1 1/4 inches thick. Oxygen also can be used as the plasma gas for stainless steel and aluminum cutting, but it produces a rough-looking cut. Nitrogen is suitable as a plasma gas and assist gas as it produces excellent cut quality on almost every type of metal. It is used for high-current applications, cutting metal up to 3 inches thick, and as the assist gas when cutting with nitrogen and argon/hydrogen plasma gas.

Compressed air is the most commonly used gas, as both a plasma gas and an assist gas. It works relatively well for low-current cutting applications in metals up to 1 inches thick, leaving an oxidized cutting surface. It is used as the assist gas when cutting with air, nitrogen, or oxygen plasma gas.

An argon/hydrogen mix usually is the plasma gas of choice for cutting stainless steel and aluminum. It provides a high-quality cut, and it is required for mechanized cutting of material thicker than 3 inches Carbon dioxide also can be used as an assist gas when cutting with nitrogen plasma because it cuts most metals and provides good cut quality. Nitrogen/hydrogen and CH4 methane are two other types of gas occasionally used in the plasma cutting process.

Plasma and assist gases are only two of the critical choices that need to be taken into consideration when installing or using a mechanized plasma system. Gas tanks are available for purchase or rent, and they are offered in many different sizes, which means an area needs to be created to store them. A substantial amount of wiring and plumbing for gas and coolant is involved with the installation of a mechanized plasma system. Beyond the mechanized plasma system itself, a table, gantry, CNC, and THC will need to be chosen. OEMs generally offer an array of equipment choices that are adequate for any cutting application.

What mechanized process makes sense?
Because of the complexity involved in selecting a mechanized plasma cutting process, a substantial amount of time should be set aside to research various system configurations and criteria. Consider:

- Types of parts to be cut.
- Number of production pieces cut per batch.
- Desired cut quality and speed.
- Cost of consumables.
- Overall operating cost of the configuration (including consumables, electricity, gas, and labor).

The size, shape, and quantity of the production parts may dictate the type of CNC, table, and gantry required. For example, production parts that are small and intricate may require a gantry with a specialized drive package. The rack-and-pinion drives, servomotors, drive amplifiers, and encoders used on the gantry determine the cut quality and speed capability of the plasma system.

The cutting speed and cut quality also depend on the plasma system, the CNC, and the gases selected. A mechanized system that has current ramping and gas flow ramping at the beginning and end of the cut will increase consumable life. Furthermore, a CNC with high storage capacity, a variety of programming capabilities (such as freezing the height of the torch at the end of the cut), and fast processing speed (input/ output communication) will lead to a decrease in operational downtime and an increase in cutting speed and accuracy.

Ultimately, the decision to purchase or upgrade a mechanized plasma system or use a manual process should be based on the facts. Faced with such a decision, a fabricator should consider size, shape, and thickness of the material being cut.

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