VARIATIONS OF THE PLASMA PROCESSES AND EFFECT OF VARIOUS PLASMA AND SHIELD GASES

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Abstract: *Plasma cutting is very interesting and progressive technology. By cutting thermical and dynamic effects of the plasma's beam are utilize. The cut is smooth and accurate. This article presents variations of the plasma processes and effect of various plasma and shield gases. Attention is given to advantages and disadvantages of cutting with plasma.*
Key words: *plasma, plasma torch, plasma cutting, plasma gases, shield gases.*

1. INTRODUCTION

Plasma is the fourth and most highly energized state of matter: solid, liquid, gas and then plasma. In fact, plasma looks and behaves like a high-temperature gas, but with an important difference - it conducts electricity. The plasma arc results from electrically heating a gas (typically air) to a high temperature. This ionizes gas atoms and enables them to conduct electricity. A fluorescent light is an example of plasma in action [3].

A plasma arc torch spins a gas around an electrode. The gas is heated in the chamber between the electrode and torch tip, ionizing the gas and creating plasma. This causes the plasma gas to expand in volume and pressure. The small, narrow opening of the torch tip constricts the plasma and accelerates it toward the work piece at high speeds (20 000 ft/sec) and temperatures (up to 20 000^{o}C). The force of the high-intensity plasma jet pushes through the work piece and removes the molten metal. This jet easily cuts through metals with poor heat conductivity (stainless steel) or excellent conductivity (aluminum). The flame created by an oxy-fuel torch poorly (with excess warping or metal waste) that welding professionals don't bother to use it, they consider plasma arc cutting the standard process for these metals [5].

Fig.1 Plasma jet

2. VARIATIONS OF THE PLASMA PROCESSES

Conventional Plasma Cutting. This process generally uses a single gas (usually air or nitrogen) that both cools and produces the plasma [4]. Most of these systems are rated at under 100 Amps, for cutting materials under 16mm thick. Such systems are primarily used in hand held applications (fig.2).

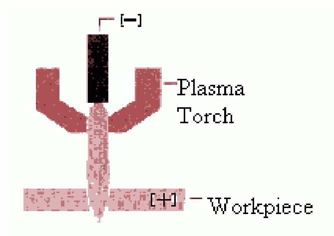

Fig.2 Conventional plasma cutting

Dual Gas Plasma Cutting. This process utilizes two gases; one for the plasma and one as a shield gas. The shield gas is used to shield the cut area from atmosphere, producing a cleaner cut edge. This is probably the most popular variation, as many different gas combinations can be used to produce the best possible cut quality on a given material (fig.3).

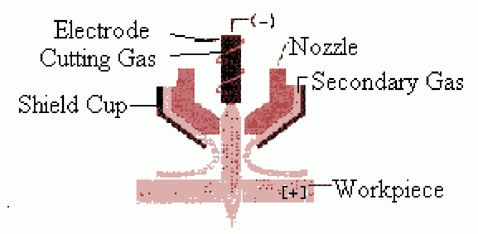

Fig.3 Dual Gas Plasma Cutting

Water Shield Plasma Cutting. This is a variation of the dual gas process where water is substituted for the shield gas. It produces improved nozzle and workpiece cooling along with better cut quality on stainless steel [4]. This process is for mechanized applications only (fig.4).

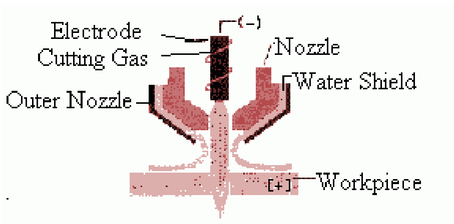

Fig.4 Water Shield Plasma Cutting

Water Injection Plasma Cutting. This process uses a single gas for plasma and utilizes water either radially or swirl injected directly into the arc to greatly improve arc constriction, therefore arc density and temperatures increase. This process is used from 260 to 750 amps for high quality cutting of many materials and thicknesses.(fig.5)

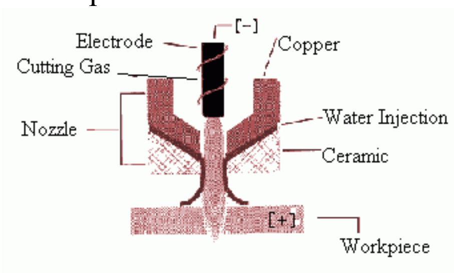

Fig.5 Water Injection Plasma Cutting

Precision Plasma Cutting. This process produces superior cut quality on thinner materials, (less than 13mm) at slower speeds. This improved quality is a result of using the latest technology to super constrict the arc, dramatically increasing energy density. The slower speeds are required to allow the motion device to contour more accurately. Mechanized applications only (fig.6).

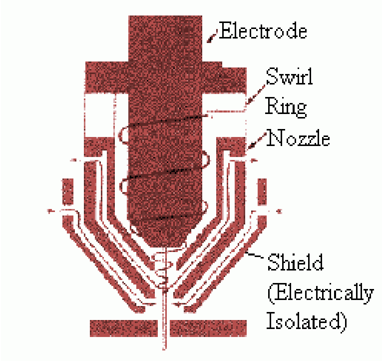

Fig.6 Precision Plasma Cutting

3.EFFECT OF VARIOUS PLASMA AND SHIELD GASES

There are many different plasma and shield gas combinations available [7]. These different combinations can be used to enhance the cut performance on different materials and applications. Be sure to consult with the plasma systém manufacturer to ensure that the system is compatible with a particular gas combination. Good cut quality is usually defined as perpendicular, smooth and dross-free edges.

Air. Air is the most widely used plasma gas, probably due to the fact that compressed air is readily available at virtually any location. This gas is used in most conventional and dual flow systems under 200 amps. Consumable parts life is acceptable (usually between 100 and 200 starts). Cut quality is acceptable on most materials, although some surface nitriting can occur on carbon steel, and some oxidation can occur on aluminum and stainless steel.

Nitrogen. This gas, when used in conjunction with Water Injection, produces the best cut qualities on aluminum and stainless steel. Good cut quality can be expected with dual gas on stainless and aluminum. Cut quality on most carbon steels is marginal due to surface nitriting and dross formation. Consumable parts life is excellent. This gas is used from 20 to 750 amps for cutting gauge to 100mm thickness materials.

Argon- Hydrogen. This gas, in a 35% Hydrogen, 65% Argon mixture, is used with dual gas systems to improve cut quality on stainless steel and aluminum from 10 to 50mm. It is also used with high power systems 750 to l000 amps for cutting stainless and aluminum to 150mm. Consumable life is excellent.

Oxygen. Oxygen is used for best cut quality on carbon steels. The cut edges are nitrite free, allowing good weldability, formability, and machinability. This gas is used from

15 to 260 amps for cutting gauge to 25mm steel. Consumable parts life, until recently, was marginally acceptable. With the advent of the new LongLife oxygen plasma systems (Precision, dual gas, and water injected) the consumable parts life is now excellent.

4. CONCLUSION

Plasma cutting, whether conventional or precision, is a fast, economical way to produce parts. Manufacturers should first understand the process, and then determine if this or another process produces the parts more effectively.

With advantages of plasma arc, for example: high speed of cutting, cutting of all materials, the quality of cut, is this technology often utilized in mechanical engineering.

Despite of the development trends in the area of computer aided manufacturing new knowledge and methods are still upcoming into the area of progressive technologies, and thus the options of solving the topical problems are appearing in this area.

5. REFERENCES

[1] Jurko, J.: Topics of drilling tools application in automated production. In: Proceedings of the International PhD Conference. ŽU Žilina - Súľov, 2003, pp. 31-34 (in Slovak).

[2] Marcinčin, J. N.: Technical preparation of production. FMT TU, Prešov, 2002.

[3] Maňková, I.: Progressive Technologies. Vienala Košice, 2000, pp. 225-240 (in Slovak).

[4] Sommer, C.: Non-traditional machining handbook. Advance publishing, Houston, 2000, 432 p. ISBN 1-57537-325-4

[5] Turňa, M.: Special methods of welding. Alfa Bratislava, 1989 (in Slovak).

[6] Vasilko, K. - Hrubý, J. - Lipták, J.: Technology of cutting and assembly. Alfa Bratislava, 1991, pp. 319-330 (in Slovak).

[7] Zajac, J. - Miškovičová, M. - Miškovič, V: Cutting facilities of new type of came cutting material. In: Proceedings of the conference PPTO, Košice, 1995, pp. 138-139.

[8] www pages: www.kjelberg.sk, www.winfa.sk, www.plasmaetch.com, www.hypertherm.com