POSSIBILITIES OF COST EFFECTIVE PLASMA CUTTING APPLICATION

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Plasma, cutting, cost effective application, cutting tolerances

1. Introduction

Plasma technology had the great improvements in the last several years. During the last 50 years plasma technology is studied and constantly developed. Today, it is possible to achieve very fine cutting surface and very precise cutting tolerance for different technical materials which are comparable with laser cutting surface and cutting tolerance. In the industrialy developed word plasma technic is recognised as a cost effective cutting technique.

2. Basic concept of plasma cutting technology

Beside solid, liquid and gas aggregate state, plasma is known as a forth aggregate state. Transition between aggregate states is connected with energy level (figure 1). Plasma is electrically conductive, disoriented and high ionised gas. The number of positive and negative charged particles is equal. Also, plasma as a integral is electrically neutral (the number of positive charged particle carrier – positive ions = the number of negative charged particle carrier – electrons).

![Figure 1. Aggregate states depending of energy level](image-url)
highly concentrated electric arc. Plasma energy released on the material surface can be used for cutting or some other application (welding, heat treatment, marking, ...).

![Diagram of plasma gases and dissociation/ionization process]

**Figure 2. Heat effect of some plasma gases (a) and the scheme of dissociation and ionization process [1]**

### 2.1. Modern cutting techniques

Depending of application task, type and dimensions of material, modern plasma techniques are (figure 3):
- dry plasma without secundar gas
- dry plasma with secundar swirl-gas and concentrated plasma jet
- under water plasma cutting with secondary swirl gas and concentrated plasma jet.

![Diagram of dry plasma cutting and under water plasma cutting]

**Figure 3. Modern plasma cutting processes concept [2, 5]**

The most important influencing parameters on cut quality are: main plasma cutting parameters, type and compositions of plasma and secundar gas, torch leading system and torch distance to material cutting surface.
The main plasma cutting parameters are: current, gas pressure, cutting speed, cathode wearing and nozzle wearing. The effect of process parameters on the cut quality is given on figure 4.

![Figure 4. The influence of cutting parameters and their interactions on the plasma cut quality [2]](image)

According to material type, the following gases are proposed for plasma cutting (table 1):

<table>
<thead>
<tr>
<th>Material type</th>
<th>Plasma gas</th>
<th>Secondary gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural steel</td>
<td>Air</td>
<td>Air or oxygen</td>
</tr>
<tr>
<td></td>
<td>Oxigen</td>
<td>Air or air-nitrogen</td>
</tr>
<tr>
<td>High alloyed steel</td>
<td>Air</td>
<td>Nitrogen</td>
</tr>
<tr>
<td></td>
<td>Argon-hydrogen</td>
<td>Nitrogen</td>
</tr>
<tr>
<td></td>
<td>Argon-hydrogen-nitrogen</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Aluminium alloys</td>
<td>Air</td>
<td>Air or nitrogen</td>
</tr>
<tr>
<td></td>
<td>Argon-hydrogen</td>
<td>Nitrogen-hydrogen</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td></td>
</tr>
</tbody>
</table>

The influences of gun stand-off to cut width and cut quality are extremely important at high precise plasma cutting processes (so called Hi-Focus and Hi-definition plasma cutting). The influence on cut width is shown in table 2.

![Table 2. The effects of gun stand-off to cut width [2]](image)

2.1 Possibilities of modern plasma cutting concepts

Modern plasma cutting technology offers wide possibilities. At the figure 5, the possibilities of commonly used thermal cutting processes related to material type and thickness are given.
Figure 5. Possibilities of commonly used thermal cutting processes related to material type and thickness [3]

According to tolerance of cutting specimen, modern plasma technology is comparable in some cases with laser cutting process (figure 6).

Figure 6. Part side variations in relationship to part thickness for different cutting processes [3]
3. Retrospection to cost effective of plasma cutting

Due to development of modern plasma technique with precise concentrated jet, it is possible
to significantly reduce energy consumption. Today, for cutting high alloyed steels and aluminium
alloyes of medium and higher thickness there are no economical alternative. Also, for the cutting
of structural thin and medium thickness steels, CNC systems with precise torch leading became
interesting from the costs saving as well as cut quality point of view.

Modern high quality and high concentrated plasma cutting systems offer cut quality which is in
some cases comparable to the laser cut quality. Also, start investments for implementation plasma
cutting technology are significantly lesser than investments for laser cutting system. But, each
cutting technology has advantages and disadvantages, and before investment in cutting equipment,
it is necessary to perform seriously cost effective analyse.

In domestic industry there is rather slow involving of plasma cutting technology, mostly as air
plasma. CNC systems available for oxy-gas cutting are suitable for plasma cutting, also. Some
domestic companies use the both. At the figure 8 an example of thick stainless steel air CNC plasma
cutting is given.

a) b)

Figure 8. An example of stainless steel air plasma cutting in bellows production process. b) detail of cut surface quality b) welded cylindrical ring after air plasma cutting and cold forming process
An example is from belows production and plasma cutting process is unavoidable cutting process, but first of all cost effective cutting process. The cut surface is acceptable quality, but it is possible to obtain even more quality cut surface using gas plasma process (e.g. FineFocus plasma cutting system).

4. Conclusion

The equipment for plasma cutting can be effective investment in production nowday. The productivity and cut quality as well as investments in modern plasma equipment is resonable in processes where stainless steel and aluminium alloys are used. Beside the mentioned benefits, the ratio of plasma cutting equipment in our industry is not satisfactory. One of possible reasons can be in rigid safety requirements and additional costs related to human and environment protection.

However, the plasma cutting technology still remains cost effective cutting process in modern industry.

References


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