Possibilities of cost effective plasma cutting application

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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. Transiton between aggregate states is conected with energy level (figure 1). Plasma is electricaly conductive, disotiated and high ionisated gas. The number of positive and negative charged particles is equal. Also, plasma as a integral is electricaly neutral (the number of positive charged particle carrier – positive ions = the number of negative charged particle carrier – electrons).

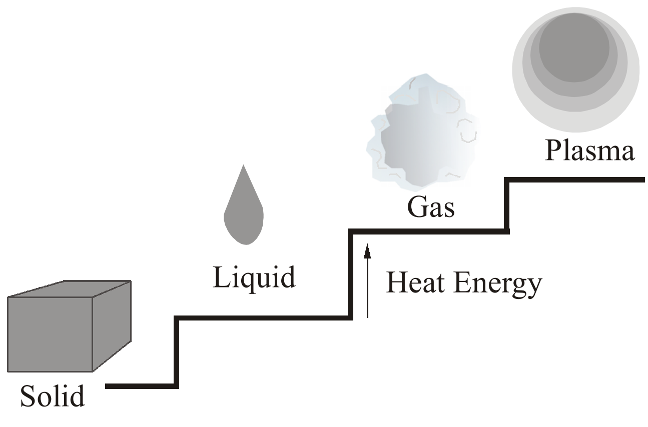

Figure 1. Agregate states depending of energy level

Transition to plasma state is a consequence of ionisation process (single atom gases; e.g. Ar, He, Ne) and dissociation process (more than one atom gases; e.g. N_2, H_2, O_2). Single atom gases cross to plasma state after ionisation process. Due to higher energy level (e.g. gases temperature lifting in electrical arc) the electrons in atom structure cross to higher level. Gases particles are chaotic moved and crashed. The result of that process is ionisation and forming positive and negative charged particles – ions. For double atom gases transition to plasma state, the process of dissociation (splitting of gas molecule in atoms) previously is necessary. Then follows described ionisation process. The energy necessary for transition to plasma state (dissociation and-or ionisation) is different for common used gases (figure 2). Energy source for this process is in highly concentrated electric arc. Plasma energy released on the material surface can be used for cutting or some other application (welding, heat treatment, marking, ...).

a) b)

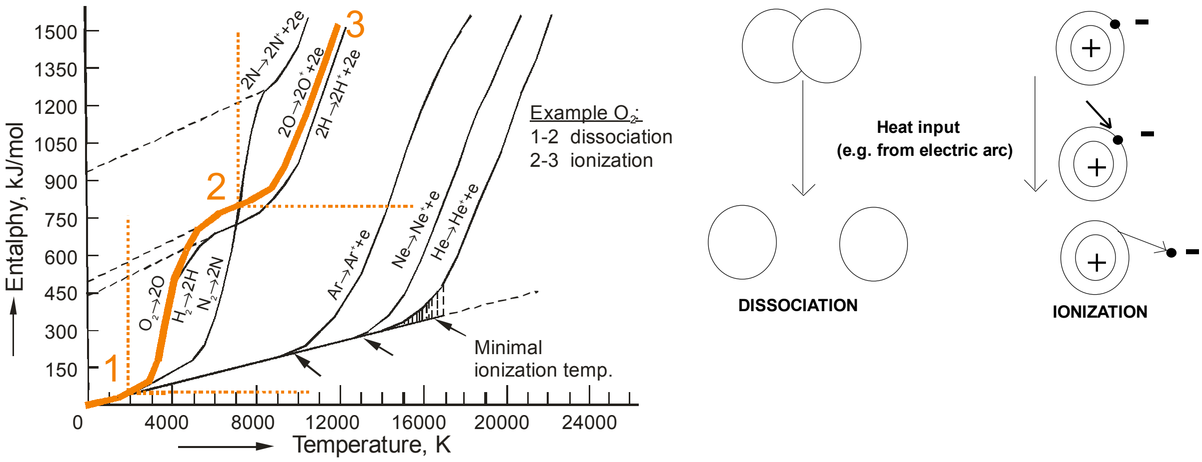

Figure 2. Heat effect of some plasma gases (a) and the scheme of dissociation and ionization process [1]

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 cuting with secondary swirl gas and concentrated plasma jet.

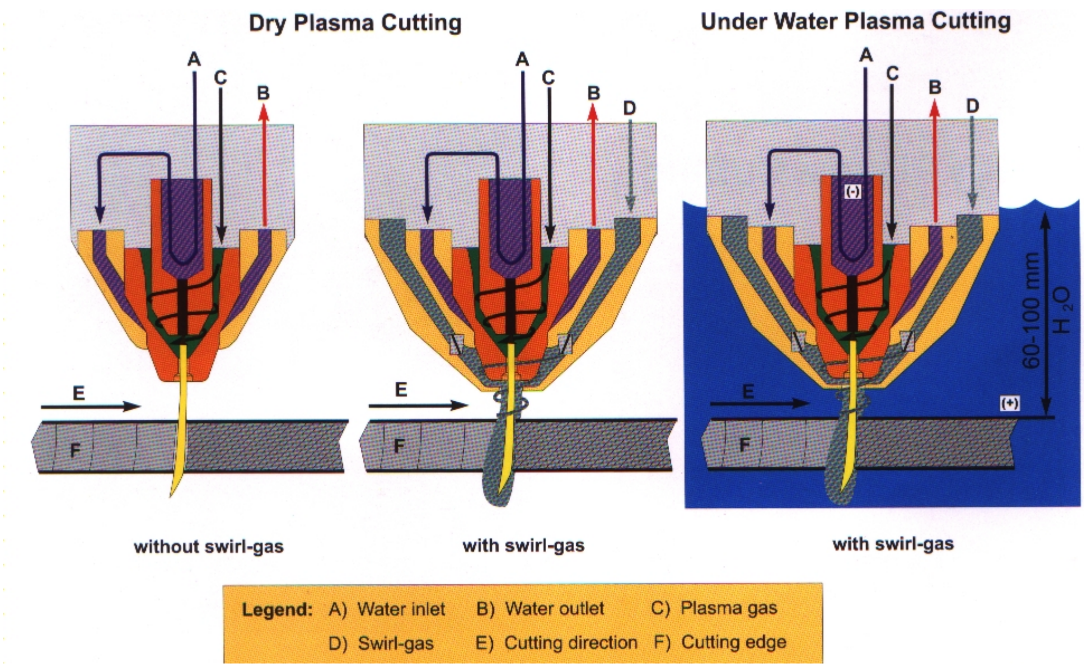

Figure 3. Modern plasma cutting processes concept [2, 5]

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, catode wearing and nozzle wearing. The effect of process parameters on the cut quality is given on figure 4.

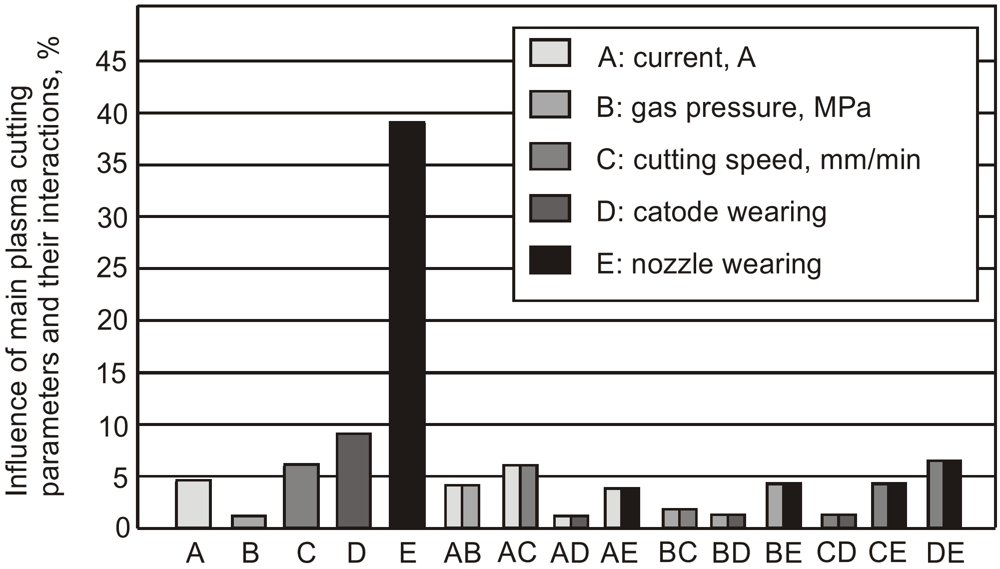

Figure 4. The influence of cutting parameters and their interactions on teh plasma cut quality [2]

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

Table 1. Plasma and secundar (swirl) gases for different material types plasma cutting [2].

Materilal type	Plasma gas	Secundar gas
Structural steel	Air	Air
	Oxigen	Air or oxigen
	Oxigen	Air or air-nitrogen
High alloyed steel	Air	Air
	Argon-hydrogen	Nitrogen
	Argon-hydrogen-nitrogen	Nitrogen
Aluminium alloyes	Air	Air
	Argon-hydrogen	Air or nitrogen
	Air	Nitrogen-hydrogen

The influences of gun stand-off to cut width and cut quality are extremly 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]

Torch distance to workpeace, mm	Cut width, mm
1,0	1,45
2,0	1,50
3,0	1,55

2.1 Possibilities of modern plasma cutting concepts

Modern plasma cutting technology offers wide possibilities. At the figure 5, the possibilities of comonly used thermal cutting processes related to material type and thickness are given.

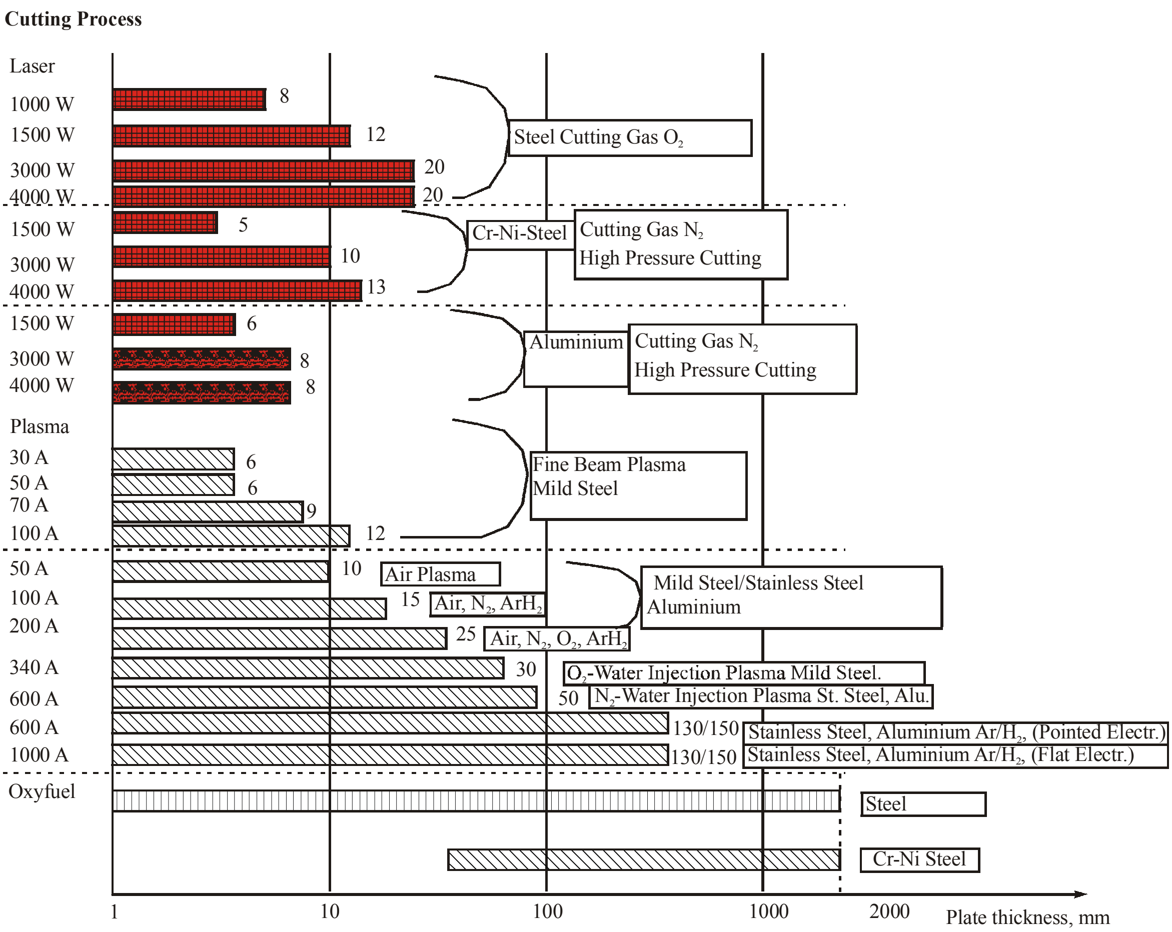

Figure 5. Possibilities of comonly used thermal cutting processes related to material type and thickness [3]

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

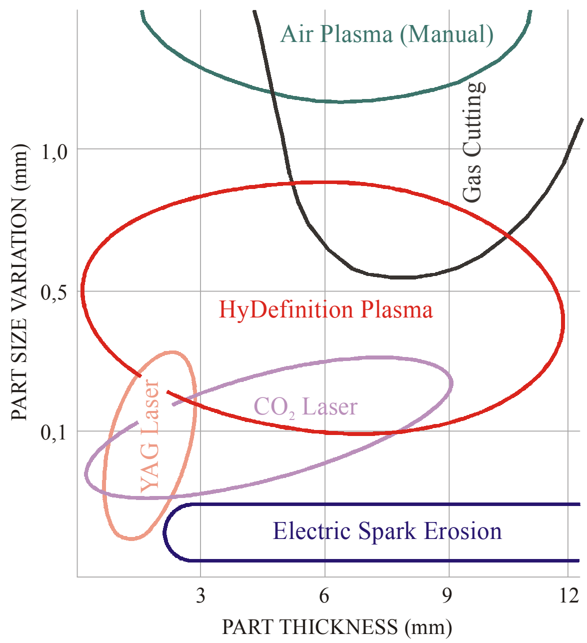

Figure 6. Part side variations in relationship to part thickness for different cutting processes [3]

Figure 7. Modern CNC plasma cutting concept for ecconomical industrial application

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 ecconomical 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 qualiy wich is in some cases comparable to the laser cut quality. Also, start investments for implemantation 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 analyise.

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

a) b)

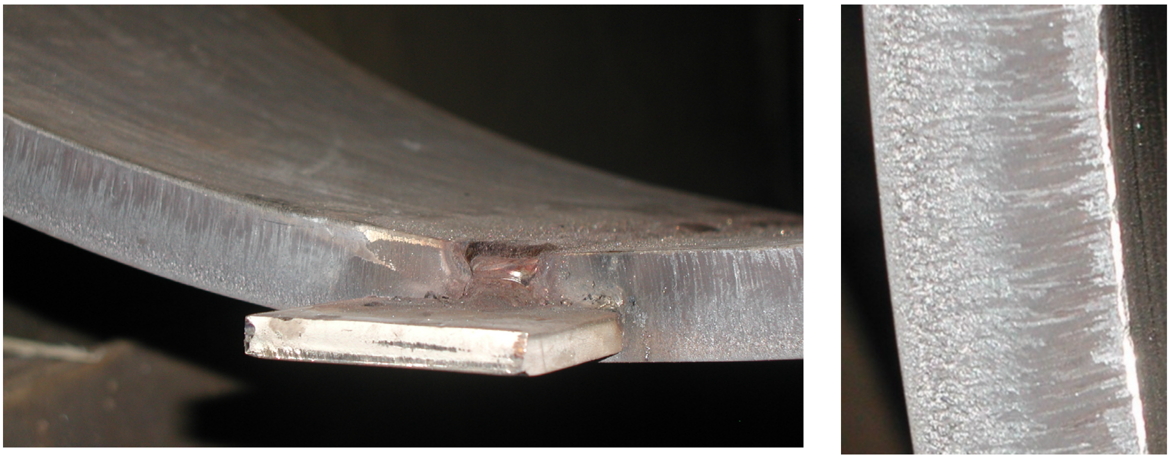

Figure 8. An example of stainless steel air plasma cutting in bellows production process. b) detail of cut surface quality b) welded cylindrical ring after air plasma cutting and cold forming process

An example is from belows production and plasma cutting process is unavodidable 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 proces (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 alloyes 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 safty requirements and additional costs related to human and environment protection.

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

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