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AN EXPLORATORY SEARCH FOR THE INFLUENCE OF THE CO_2 CONTENT ON THE GMAW METAL TRANSFER AND PROCESS STABILITY.

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Gas Metal Arc Welding (GMAW, or also known as MIG/MAG process) is nowadays the most widely used welding process. It uses continuously fed electrode as a filler metal. The arc is shielded from the atmospheric contaminations by an inert gas, active gas or inert/active gas mixture.

The shielding gas plays an important role in the operational behavior of this process. According to the blend used for shielding, the transfer mode, penetration, bead geometry, arc burning stability, etc can be affected. One of the most popular mixtures is Ar+CO_2, which is suitable for short-circuiting transfer welding. It is recommended to choose the content of CO_2 in this mixture according to the given conditions, for example, low content of CO_2 is used for thin plates and higher percent of CO_2 for thicker plates. One explains it with the fact that increasing CO_2 makes the arc hotter. Some engineers also say that this active gas makes the short-circuiting metal transfer more stable.

However, it is not possible to find in the scientific literature clear recommendations concerning the best composition for certain parameter conditions. And there is no explanation for, in spite of what was said before, the most widely used mixture is 25%CO_2+75%Ar. Or for why not to use 100% of CO_2 always? Or at least 50%CO_2+50%Ar_2? And the most important questions are: how exactly the changing of the CO_2 content influences the welding process? And why? But, indeed, it is necessary to know the answers to all these questions because it can help to solve technologically many welding problems, such as, lack of penetration, excess of spattering, unstable metal transfer, uneven bead formation, bad bead appearance etc.

So, the objective of this work is to contribute to clear up how actually the content of CO_2 in the gas mixture will influence the metal transfer stability. For this aim, Ar/CO_2 gas mixtures with different contents of CO_2 (2, 5, 10, 20 and 100%) were used to weld carbon steel plates (3-mm-thick), with plain carbon steel wire (diameter equal to 1.2 mm). Three setting voltages for each content of CO_2 and non-changing in WFS were applied during the welding. The point is that the arc length and current determine the metal transfer stability. An arc length is reached by setting the voltage for given conditions. However, for different shielding gases a setting voltage will give different arc lengths. That is the reason for 3 voltages, in such a way that at least one voltage set will provide appropriate arc length to stable guarantee short-circuiting metal transfer. Then, after welding, according to Figure 1, the results will be estimated in the context of these setting voltages and only one setting condition for each gas blend will be compared to the others.

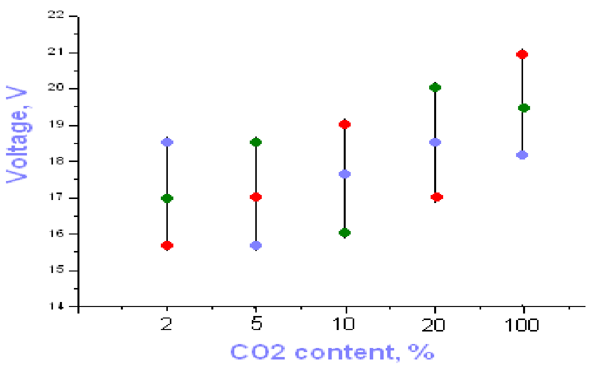

Fig.1.Hipotetic best results choice in the context of each gas
- no good condition; -worst; - best;

After welding and measuring parameters (U, I and WFS), it is necessary to compile the results. The acceptance criterion for performance comparison will be bead appearance, penetration and spattering level. A very important tool in this work is the stability index, developed at Laprosolda. It shows the regularity of short-circuiting and arc burnings times. The stability criterion is to have the smallest stability index, as long as the droplet frequency is greater than 28 Hz (for this wire diameter). The welding condition choice in the voltage set range is the one. For estimating metal transfer and then for comparison with calculations, high speed filming needs to be used for seeing metal transfer itself. So, all these ways to estimate and to calculate the results must show us the full picture of the influence of CO_2 on the process stability.

To date, the experiments with two different contents of CO_2 has already been carried out. These were made with 10% and 20% of CO_2 in the gas blend General results, given in Table 1, showed that at the same conditions (WFS and current) better results were using 10 % of CO_2: the spattering was less, bead appearance was better and, according to stability index, better metal transfer was in this case too.

Table 1. Table of results

№ of experiment	Content of CO_2, %	WFS, m/min	Current, A	Droplet frequency	Voltage, V	Spattering, %	Stability index*
1	10	2.66	125	34	16	6.9	0.42
2		2.66	123	35	17.4	7.6	0.45
3		2.66	124	29	19.1	6.4	0.58
4	20	2.66	126	39	17	15.5	1.19
5		2.66	124	29	18.6	16	1.01
6		2.66	125	36	20.2	24	0.85

**- the less is the index, the better is metal transfer regularity.*

So, looking at the first results, one can expect that further exploratory search will clear up the situation and, hopefully, it will let us explain the phenomenon of CO_2 influence on GMAW process stability.