ANALYSIS OF MODERN METHODS IN WELDING TECHNOLOGY OF TECHNICAL MATERIALS

Polak V., Dostal P.

Department of Technology and Automobile Transport, Faculty of Agronomy, Mendel University in Brno, Zemedelska 1, 613 00 Brno, Czech Republic

E-mail: vojtechpolak@seznam.cz

ABSTRACT

This thesis is focused on the characteristics of current methods in welding technology. First, the basic techniques that use thermal energy for joining materials are processed. Electric arc is analyzed here, as the main source of heat for fusion welding. In the next part, attention is given to special methods with high density of energy per area, which are in principle significantly different from the previous ones. In particular, this includes plasma welding, electron beam and laser. The modern methods also include the CMT welding process that allows joining dissimilar materials using the electric arc. This procedure successfully resolved the long-term problem of joining steel and aluminum in the automotive industry. Attention is given to the principle of CMT process, composition and description of the individual components welding sets and where is the most applicable.

The main objective of this contribution is a detailed analysis of the CMT welding process. Steel and aluminum as two mutually dissimilar materials are joined this method using a welding robot. Generated samples are then subjected to accelerated corrosion degradation in the salt chamber. In the next part, it will be investigated degree of corrosion degradation and penetration of corrosion materials by metallographic analyzes. Research will continue with other tests.

Corrosion is a slow, progressive or rapid deterioration of metal body properties such as its appearance, surface aspect or mechanical properties under the influence of the surrounding environment: atmosphere, water, seawater, various solutions, organic environments, etc. (Vargel Ch. 2004).

Key words: welding, electric arc, plasma, laser, CMT process, corrosion, degradation

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INTRODUCTION

Welding is one of the permanent kinds of connection two or more parts. The concentration is achieved by the heat at the melting temperature materials or pressure causing deformation of contact surfaces. It gradually developed several welding methods it is more possible supply of heat or kinetic energy to the place of welding. (Ambrož O. 2001)

CMT – connecting short-circuit electric arc

CMT stands for the signs – Cold Metal Transfer. It is basically a process MIG/MAG, which works unlike other conventional processes with very low heat input. The origin of CMT process is 1991. It originated in the Austrian company Fronius as a result of the gradual adaptation of the MIG/MAG needs joining steel to aluminum. In 2002, already known possibilities and advantages of CMT began the last phase of its development towards serial usability.

This technique is based on using methods releasing droplets using an alternating forward and backward movement of the wire. Alterations CMT welding melting electrode in a protective atmosphere, therefore combines the hot phase arc which melts the wire and the base material with the cold part of the process, wherein after contacting the melted wire to the molten pool decreases the current intensity and the wire is returned to the nozzle. This is supported by the Department of drops spatter with low heat input into the weld. Retraction wire runs up to 70 times per second. (Kubíček J. 2006)

Generally, it cannot combine metal arc welding, whose physical properties such as melting temperature coefficient of expansion or the electrochemical potential varies considerably. By CMT welding technology can be joining steel to aluminum made using electric arc. Its principle consists in that the aluminum side for the welded joint, the steel sheet of the solder joint. The advantage of this method, also called **„cold bonding“** is that it takes place at a much lower temperature than conventional welding, no deformation, and the resultant connection is not required to complete. (Motloch J. 2011)

MATERIAL AND METHODS

Materials for CMT welding process

The connection using this method can be carried out in conditions that are galvanized steel sheets, aluminum sheets must come from material AW5xxx or 6xxx series and as welding or soldering material is prescribed special alloy. The zinc coating on a steel plate acts as a flux and wets steel. It should be as thin as possible, up to 10 microns. Then the strength of the bond so high that the weld can withstand a tensile test and aluminum is torn.

For our work, it was used aluminum and steel sheet, where the basic data are listed in Table 1.

Tab. 1 Basic information about the welded materials

Material	Designation	Dimension [mm]	Surface working
Steel	DX51D + AZ150 AC	300 × 50 × 1.5	AlZn
Aluminium	AlMg3	300 × 50 × 1.5	-

CMT welding system

CMT welding is done solely for the use of fully digitized inverter power sources. The system operates very fast communication between its various components. In principle, CMT welding system is responsible hardware set up the MIG/MAG system of the latest technology.

As the wire moves toward the material and back to the motor drive unit burner rotated alternately forward and back. In contrast, the motor rotates continuously in advance in the wire feeder, because it has considerable inertia and it could not change direction so quickly. For this reason, it was necessary to insert between these engines the absorber, which compensates for the short term (absorbs) the differences in the length of wire between the two shifts.

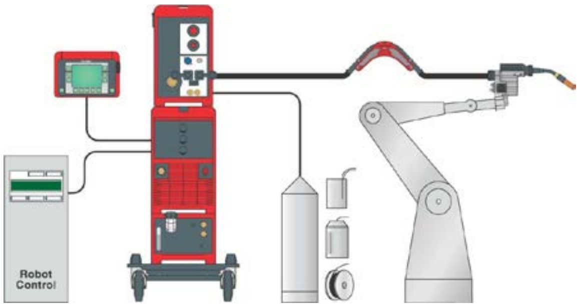

Fig. 1 Welding System CMT equipped for automated applications (Source: Fronius)

Corrosion Degradation

For the corrosion degradation, equipment made by the Liebisch Company was used. Accelerated corrosion test was carried out according ISO 9227 standard. The test was performed in a corrosive environment in the form of salt fog (atmosphere of NaCl) in concentration of 50 ± 5 $g.l^{-1}$ of distilled water. The density of the solution at this concentration and temperature of 25 °C is 1.0225 to 1.0400 $g.cm^{-3}$. This test is usually used for metals and their alloys, metal coatings, and organic coatings on metal surfaces.

RESULT AND DISCUSSION

Fastening welded materials

Because of the automatic welding robot it was created product for attachment welded materials.

This enabled us to provide lapped materials against movement and still weld at one position after replacing the other samples.

Fig. 2 Preparation for fastening welded materials

The resulting samples of CMT welding

CMT welding was carried out at a frequency of movement filler material from 50 to 70 Hz in argon (100%). As additional material was used solid wire alloy AlSi5 diameter 1.2 mm. Welding voltage: 11.5 V, arc length correction: 0 %.

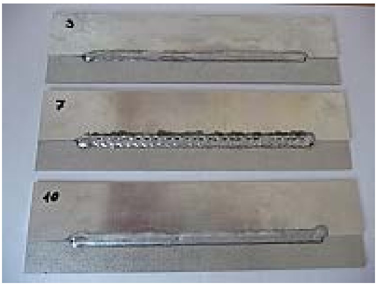

Fig. 3 Samples of welds made by different welding parameters

Fig. 4 Sample of weld by Fronius

Figure 3 shows an example of several samples that it was set different welding parameters. The sample weld 3 is satisfactory. Connection of materials is continuous with no obvious external defects. Sample 7 is visually unsatisfactory. It was used in SynchroPuls mode – completely unsuitable for joining these materials. Aluminum sheet is not continuously connected with galvanized steel. This weld has many external defects. Nice weld is evident in a sample of 10, there mode is selected CMT with oscillating torch. In the middle of the weld was faulty connection. It was a slight defect. For comparison, Figure 4 is a sample specimen CMT weld directly from Fronius.

Detailed overview of welding parameters of all samples that was created is listed in Table 2.

Tab. 2 Overview welding parameters of all generated samples

Sample	Speed welding nozzle **v [mm·s^{-1}]**	Welding mode	Welding current **I [A]**	Shielding gas flow rate **Q [l·min^{-1}]**
1	10	CMT	59	10
2	14	CMT	59	16
3	13	CMT	59	16
4	11 (1) 13 (2)	CMT	59	16
5	11 (1) 13 (2)	CMT	59	16
6	11 (1) 13 (2)	CMT	68	16
7	11 (1) 13 (2)	SynchroPuls	75	16
8	11 (1) 13 (2)	CMT	75	16
9	11 (1) 13 (2)	SynchroPuls	75	16
10	11 (1) 13 (2)	CMT (*)	78	16

Note: (1) .... the first half of weld length,
(2) .... the second half of weld length,
(*) .... flickering torch

CONCLUSIONS

In this work we will deal with monitoring the chemical composition the material in the heat affected zone locations. Research will continue static and fatigue tests, which will be continuously scanned and analyzed one of the NDT methods - acoustic emissions.

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