

COLD METAL TRANSFER (CMT) WELDING TECHNOLOGY

Turhan KURŞUN^a

^aCumhuriyet University, Faculty of Technology, Manufacturing Engineering Department,

Sivas, TÜRKİYE

tkursun08@gmail.com

Abstract: The cold metal transfer (CMT) process basically uses the same system as a Metal Inert Gas/Metal Active Gas (MIG/MAG) system. The CMT process concentrates on welding of thin sheet metal products from stainless steel, aluminum (Al), magnesium (Mg), Mg-Al alloys and dissimilar metals etc. The CMT technology is an alternative to MIG/MAG, providing advantages, such as reduction of distortions, high welding speed, good tensile performance and increased productivity. This is mainly due to low heat input, achieved by controlled movement of the electrode. CMT provides the most stable arc and a complete process regulation. Thus, it gives better results. In this study, the technology of cold metal transfer welding was investigated.

Keywords: Welding, CMT, Process, Metal Joint

Introduction

Fusion welding is an ideal and economical means of achieving good productivity. Fusion welding through MIG/MAG is achieved by coalescence of metals by melting continuously feed current-carrying wire. Its wide popularity is due to practical advantages offered like: continuously feed electrode, flux free operation, relatively low operator skills required, ease of automation. But, it is very important to reduce the negative effects of local melting at fusion welding of metals.

There are materials and applications that cannot withstand the constant heat of a welding process. During welding, temperature variations in welds and parent metals have important effects on material characteristics, residual stresses as well as on dimensional and shape accuracy of welded products. This is especially important in the case of thin sheet metal products, where control over welding distortions or deformations is difficult. The joining of dissimilar materials requires precise knowledge of the properties of each material. Aluminum is highly regarded due to its low specific weight and its excellent usability and processing characteristics. On the other hand, its strength and low cost make steel indispensable in many areas of industry. Other requirements primarily address anti-corrosion features, thermal expansion coefficient, and atomic properties. When joining steel and aluminum under the influence of heat, what is known as an intermetallic phase is created at the interface between the two materials. The more heat that is applied, the more extensive the intermetallic phase and the poorer the mechanical properties of the join will be.

The CMT process evolved from the continuous adaptation of the MIG/MAG process to resolve the problems posed by the joining of metals. CMT is a controlled process and allows the material transfer to take place with barely any flow of current (Talalaeva et al, 2012; Website1, 2017; Pickin et al, 2015; Pickin et al, 2011).

Cold Metal Transfer (CMT) Method

The CMT (Cold Metal Transfer) process is a revolution in welding technology both in welding equipment and applications (Website2, 2017). Cold metal transfer (CMT) is an automated welding process based on dip transfer welding, characterized by controlled material deposition during the short circuit of the wire electrode to the workpiece (Pickin and Young, 2013). CMT welding is a variant of MIG/MAG welding. This process has been developed for applications where a controlled low level of heat transfer is desired (Website3, 2017).

CMT is known as an innovated welding process based on short-circuiting transfer process with low heat input and no spatter. It is suitable to join the very thin sheets which are widely used in the machine parts (Lin et al, 2013). The principal innovation is that the motions of the wire have been integrated into the welding process and into the

overall control of the process. Every time the short circuit occurs, the digital process-control both interrupts the power supply and controls the retraction of the wire. The wire retraction motion assists droplet detachment during the short circuit, thus the metal can transfer into the welding pool without the aid of the electromagnetic force. Then the heat input and spatter can be decreased greatly (Feng et al, 2009). During the joining process, the low heat input is the key important factor, and it is directly related to the joining zone. Therefore, in order to obtain a joint with excellent performance, a lower heat input is preferred. In this situation, cold metal transfer (CMT) arc welding as a modified metal inert gas welding process is characterized by low heat input and no-spatter welding, which is very suitable for joining of metals (Zhou et al, 2014). The CMT welding equipment is shown in Figure 1.

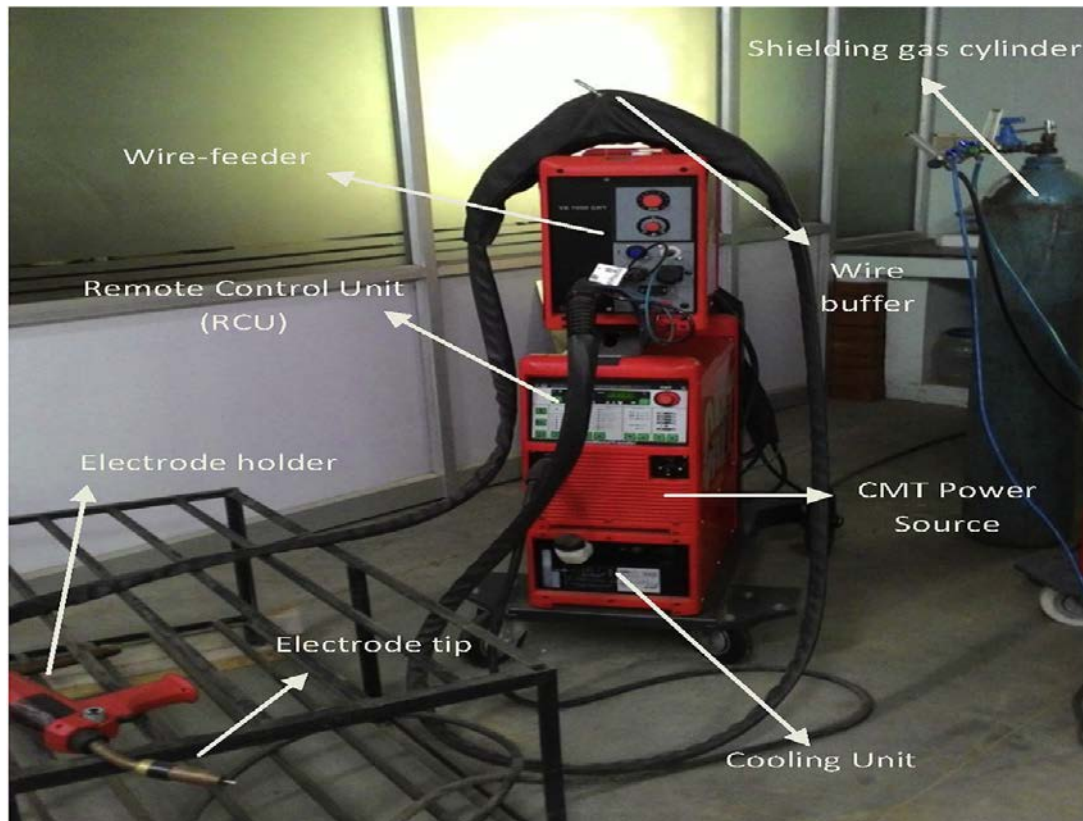


Figure 1. CMT welding equipment (Kumar et al, 2016).

A typical CMT welding electrical signal cycle is shown in Figure 2. A cycle can be defined as the period required to deposit a droplet of molten electrode into the weld pool. From the figure, we can divide the cycle into three phases: (1) the peak current phase. This is represented by a constant arc voltage corresponding to a high pulse of current. The high pulse current make the ignition of the welding arc easily and then heats the wire electrode to form droplet. In this phase, the brightness of the arc is very high. (2) The background current phase. The phase is represented by a lower current. Through the peak current phase, a little liquid droplet is formed on the wire tip. In order to inhibit the globular transfer, so the current decreases abruptly. This phase is the background current phase. Then the low current keeps constant until the short-circuiting process happens. (3) The short-circuiting phase. In this phase, the wire contacts with the weld pool and the arc voltage changes into zero and the arc extinguishes. The back-drawing force becomes the main factor to urge the droplet break away from the wire into the weld pool (Zhang et al, 2009).

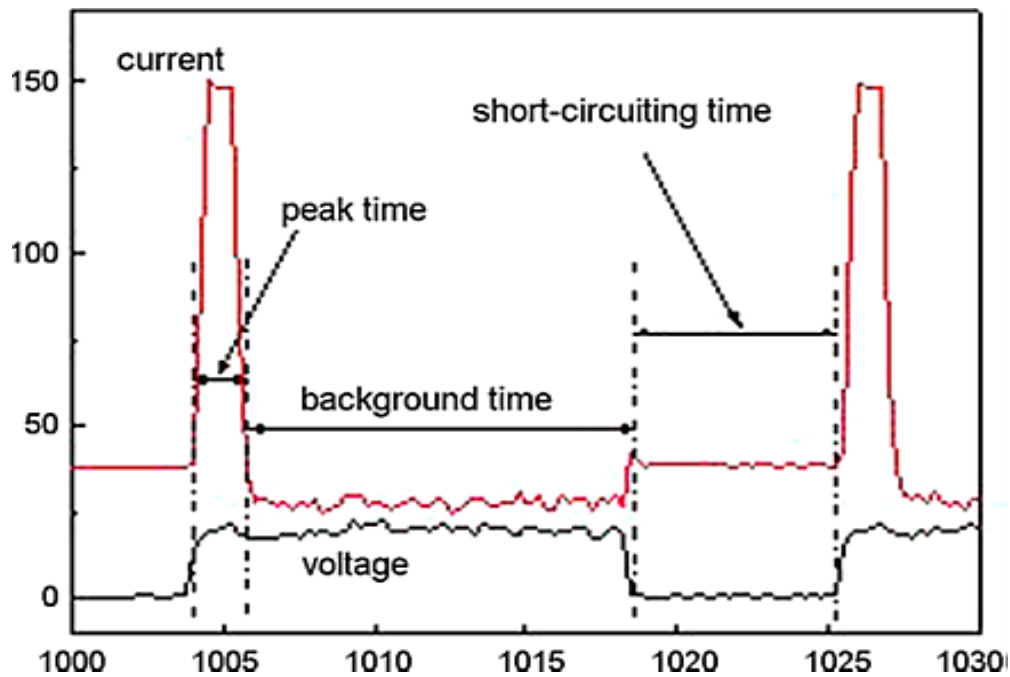


Figure 2. The current and voltage waveforms of the CMT process (Zhang et al, 2009).

The only major difference between most of the systems relates to whether they are regulated by software or hardware. The exception is the CMT system, which integrates control of the motion of the wire into the welding process control to support droplet formation and detachment. This principal phases of wire motion control is shown in Figure 3 (A,B,C,D). During the arcing period, the wire motion towards the weld-pool (A), When the wire dips into the weld-pool, short circuiting occurs, the arc is extinguished and the welding current is lowered (B), at which point the wire is retracted, the rearward movement of the wire assists droplet detachment during the short circuit (C). Metal transfer supported by surface tension in the melt means that the current can be maintained at a very low level; with reduced heat input and spatter. After opening of the short circuit, the wire motion is reversed and the process begins all over again (D). In this case, the process cycle is random, with the oscillation frequency varying with time; but typically around 70 Hz. Up to 70 shifts of cold and hot phases are made every second and this decreases the thermal influence on the workpiece (Website4. 2017).

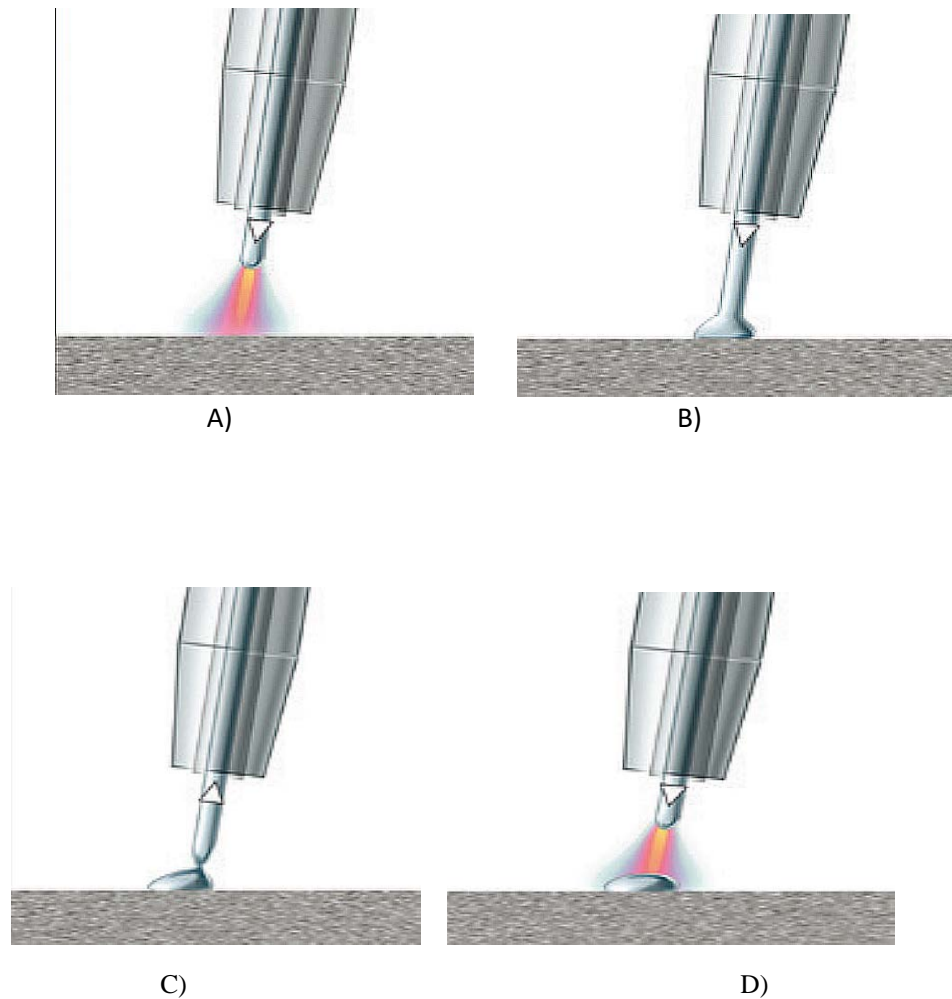


Figure 3 (A,B,C,D). Principal phases of wire feed control in the CMT process (Website4. 2017).

Conclusions

The CMT process has a universal range of application and sets brand-new standards in welding technology. CMT has a number of more than satisfactory mechanical and technological characteristics. The CMT Process is suitable for use in all industrial sectors: from the automotive and supplier industries to industrial plant and pipeline construction, to maintenance and repair work. Essentially, all automated or robot-assisted tasks are suitable. All customary base and filler metals can be used. There are a number of other extremely interesting potential applications, including the spatter-free brazing of coated sheets, the light-gauge welding of aluminum, welding of magnesium, dissimilar metal joining and controlling of the intermetallic compound layer thickness. A large number of trials are currently in progress. CMT process is likely to be suitable for many applications in the future.

References

- Talalaeva, R., Veinthala, R., Laansoo, A. & Sarkansb, M. (2012). Cold metal transfer (CMT) welding of thin sheet metal products, *Estonian Journal of Engineering*, 18, (pp. 243-250).
- Website1.(2017):https://www.fronius.com/cps/rde/xchg/fronius_international/hs.xsl/79_9399_ENG_HTML.htm#.WVajaDbatMs
- Pickin, C.G., Williams, S.W. & Lunt, M. (2015). A heat source model for cold metal transfer (CMT) welding, *Journal of Thermal Analysis and Calorimetry*, 122, (pp. 741-746).
- Pickin, C.G., Williams, S.W. & Lunt, M. (2011). Characterisation of the cold metal transfer (CMT) process and its application for low dilution cladding, *Journal of Materials Processing Technology*, 211, (pp. 496-502).
- Website2.(2017): http://loewener.dk/wp-content/files/3111_cmt_manuel_uk.pdf
- Pickin, C. G. & Young, K. (2013). Evaluation of cold metal transfer (CMT) process for welding aluminium alloy, *Science and Technology of Welding and Joining*, 11, (pp. 583-585).
- Website3. (2017): http://www.awl.nl/en/technologies/arc_welding/cmt

- Lin,J., Ma, N., Lei,Y. & Murakawa, H. (2013). Shear strength of CMT brazed lap joints between aluminum and zinc-coated steel, *Journal of Materials Processing Technology*, 213, (pp. 1303-1310).
- Feng,J., Zhang,H.& He,P.(2009). The CMT short-circuiting metal transfer process and its use in thin aluminium sheets welding, *Materials and Design*, 30, (pp. 1850-1852).
- Zhou,Y.& Lin,Q.(2014). Wetting of galvanized steel by Al 4043 alloys in the first cycle of CMT process, *Journal of Alloys and Compounds*, 589, (pp. 307-313).
- Kumar,N.P., Vendan, S.A. & Shanmugam, N.S. (2016). Investigations on the parametric effects of cold metal transfer process on the microstructural aspects in AA6061,*Journal of Alloys and Compounds*, 658,(pp.255-264)
- Zhang,H.T., Feng, J.C., He, P., Zhang,B.B., Chen,J.M. & Wang, L.(2009). The arc characteristics and metal transfer behaviour of cold metal transfer and its use in joining aluminium to zinc-coated steel, *Materials Science and Engineering A*, 499, (pp. 111-113).
- Website4. (2017): <http://www.twi-global.com/technical-knowledge/job-knowledge/mig-mag-developments-in-low-heat-input-transfer-modes-133/>