The new revolution in digital GMA welding

CMT: Three letters – one new technology – innumerable benefits

CMT stands for Cold Metal Transfer. In the context of welding, “Cold” is a relative term, of course. Nevertheless, the fact is that in this new process, the workpieces to be joined - and above all their weld zones - remain considerably “colder” than they would do in conventional GMA (gas metal arc) welding. The reduced thermal input leads to advantages such as low distortion and higher precision. This, however, is just one of the distinguishing features of this new GMA technology for automated and robot-assisted applications. The other significant benefits for users include the higher quality of the welded joints, freedom from spatter, the ability to weld light-gauge sheet from 0.3 mm, and the facility for joining both galvanised sheets and steel to aluminium. By "higher quality", what is meant here is e.g. higher uniformity and reproducibility, and thus fewer rejects. As well as for welding, the new technology is also suitable for use with brazing processes. By the time CMT was ready for series industrial production, Fronius had invested five years' development work, and corresponding resources, in the CMT process and in the equipment to go with it.

The CMT Process

The CMT process is based on the dip-transfer arc - or rather, on a deliberate, systematic discontinuity of this arc. The result is a sort of alternating “hot-cold-hot-cold” sequence. This “hot-cold” process greatly reduces the arc pressure. In a normal dip-transfer arc, the electrode is deformed while being dipped into the weld-pool, and melts abruptly at high dip-transfer arc current. In contrast to this, the CMT Process is characterised by a wide process window, and by the resulting high stability. This is important when the welding torch is abruptly reorientated, for example.
There are three striking criteria which differentiate the CMT process from the familiar dip-transfer arc-process: The wire motions are incorporated into the process-control; the thermal input is diminished, and the metal transfer takes place without spattering.

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. This forward and back motion takes place at a frequency of up to seventy times per second (? 70 Hz). The wire retraction motion assists droplet detachment during the short circuit.

The conversion of electrical energy into heat is both a defining feature and a sometimes critical side-effect of arc-welding. By ensuring virtually current-free metal transfer, the CMT process greatly reduces the amount of heat generated. Also, the controlled discontinuation of the short circuit leads to a low short-circuit current. Owing to the interruption in the power supply, the arc only inputs heat into the materials to be joined for a very short time during the arcing period.

Until now, “spatter-free” arc welding has been somewhat wishful thinking - at best, an ideal to be aimed at. This is why serious publications, even when writing about systems with optimised digital process-control, have preferred to use the term “low-spatter”. All the more noteworthy, then, that after its extensive test experience with the CMT process, Fronius has chosen to refer to CMT’s “spatter-free metal transfer”. This is the result of the two co-ordinated effects: The forward and back motion of the wire, and the controlled short circuiting. Applications which were hitherto impossible, or only possible with a great deal of difficulty, can now become common practice.

Applications and potential

The CMT technology sets some brand-new standards in the welding engineering field. Indeed, the combination of integrated wire motions, reduced thermal input and freedom from spatter means that welding and brazing can now be used for certain applications which used to be "off limits" to them, as well as delivering benefits such as higher productivity and lower costs for rejects and post-weld machining.

These advantages are complemented by the high gap bridgeability, leading to better manageability of automated processes, and are underscored by the flawless appearance of the joining weld. Several fields of application are especially worthy of mention:

- Light-gauge sheets can even be “butt-welded” or “butt-brazed” from a thickness of as little as 0.3 mm. This means that e.g. aluminium sheets can now be welded with no need for any tools for clamping and holding, or for preventing drop-through or burn-through.

- In the past, aluminium-to-steel joints have only been possible using laser welding – and with major limitations, at that. CMT technology has achieved another of its development goals here: Both the metallurgical join and the appearance of the seam are 100% convincing.

The properties and potential outlined here give CMT technology every prospect of being successfully used in sectors and applications such as:
- Automobile and allied vendor industries
- Aerospace
- Structural and portal work.

In principle, CMT technology offers an alternative to all automated or robot-assisted GMA processes for joining thin sheets. This is also true with regard to the base and filler metals used. Further scope for utilisation will result from the additional innovative products currently being developed by Fronius in this sector, such as for welding magnesium.

The CMT welding system

Fronius has developed some new system components for this innovative process, all based on the company's existing digital family of machines. The wirefeed, for example, is characterised by novel solutions:
To begin with, there are two separate digitally controlled wire-drives, the front one of which moves the wire forward and back up to seventy times per second, while the rear one pushes the wire from behind. In order to decouple the two drives from one another, there is a wire buffer positioned between them. This process manages to move the wire while applying practically no force to it. The CMT system as a whole comprises the components set out below.

Power source

The machines of the TPS 3200/4000/5000 CMT series, with 320/400/500 A of power respectively, have the same basic features as the totally digitised and microprocessor-controlled inverter power sources of the corresponding TPS systems. As well as being suitable for all welding processes, they also incorporate the special functional package for the CMT process.

Remote control

The RCU 5000i remote-control unit has a full-text display, and weld-data monitoring with the Q-Master function. This remote-control unit stands out for its systematic menu structure and easy-to-follow user guidance and user administration features.

Cooling unit

Optimum cooling of the robot welding torch is ensured by the sturdy and dependable water-cooled FK 4000 R cooling unit.

Robot interface

The robot interface is suitable for all customary robots, irrespective of whether these are addressed digitally, in analogue or via field-bus.

Wirefeeder

The digitally controlled VR 7000 CMT ensures smooth wirefeed from all common types of wirepack.

Robot welding torch

The special feature of the compact Robacta Drive CMT is the digitally controlled, gearless, highly dynamic AC servo motor. This ensures precision wirefeed in both directions, and constant contact pressure.

Wire buffer

Located between the wirefeeder and the Robacta Drive CMT, the wire buffer "decouples" their two wire-drives from one another and provides extra storage capacity for the wire. Ideally, it should be mounted on the balancer, or on the third axis of the robot.

Figure 1: Welding and brazing ultra-light gauge sheets from 0.3 mm, joining steel to aluminium, welding galvanised sheets - these are among the many innovative applications of the new CMT technology from Fronius.

Figure 2: The CMT system - comprising the TPS 3200 CMT power source and the Robacta Drive CMT welding torch - is setting some brand-new standards in welding technology.

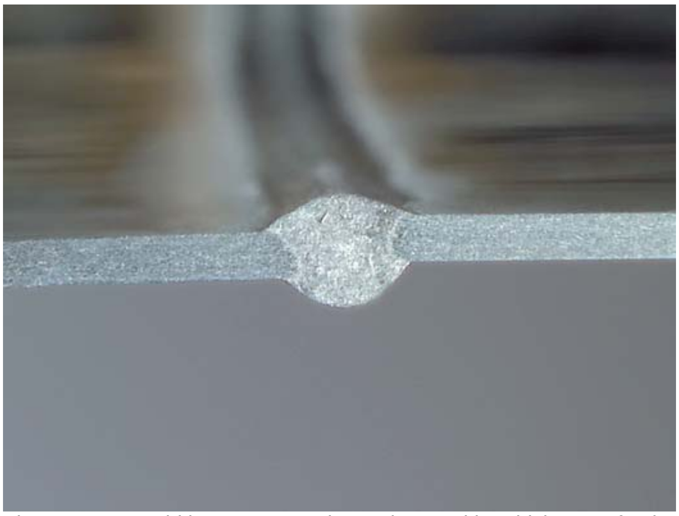

Figure 3: Butt-weld between two AlMg3 sheets with a thickness of only 0.8 mm: CMT-welded without using any clamping, holding or weld-pool backing devices.

Figure 4: CMT-brazed joint between a hot-dip galvanised sheet and an electrolytically galvanised one; sheet thickness 1.0 mm, filler metal CuSi3.

Figure 5: The principal phases in the new CMT process (from left to right):
1. During the arcing period, the filler metal is moved towards the weld-pool.
2. When the filler metal dips into the weld-pool, the arc is extinguished. The welding current is lowered.
3. The rearward movement of the wire assists droplet detachment during the short circuit. The short-circuit current is kept small.
4. The wire motion is reversed and the process begins all over again.

Figure 6: Fillet weld on a 1.0mm thick AlMg3 sheet, CMT-welded at a welding speed of 2.0 m/min.

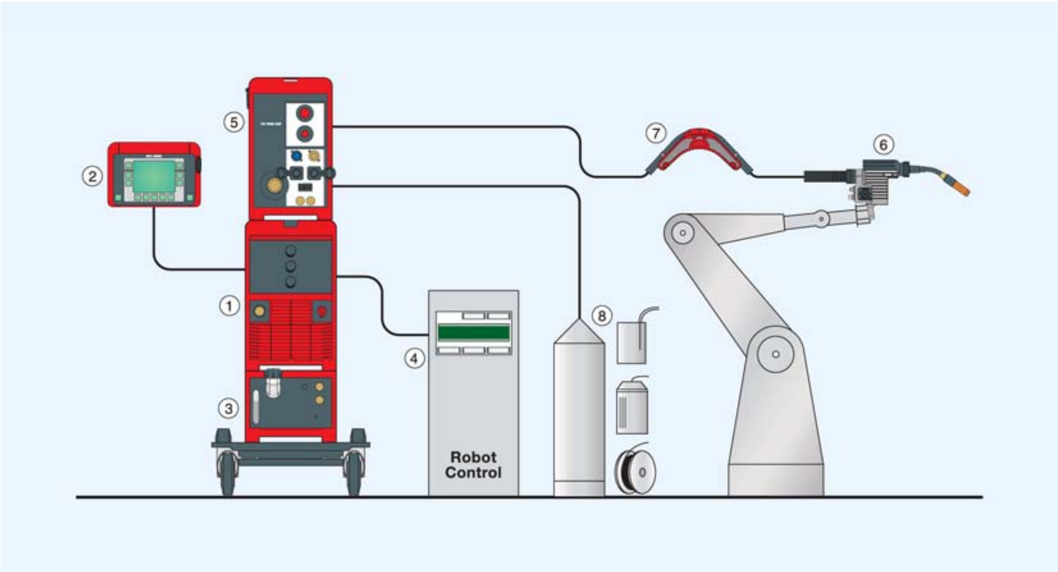

Figure 7: The system configuration of the new CMT technology and its various components:
1. TPS 3200/4000/5000 CMT power source,
2. RCU 5000i remote-control unit,
3. FK 4000 R cooling unit,
4. Robot interface,
5. VR 7000 CMT wirefeeder,
6. Robacta Drive CMT,
7. Wire buffer,
8. Wire supply.