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ADVANCED GAS TUNGSTEN ARC WELDING (SURFACING) CURRENT STATUS AND APPLICATION

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Gas Shielded Tungsten Arc Welding (GTAW) — a process well-known providing highest quality weld results joined though by lower performance. Gas metal arc welding is frequently chosen to increase productivity along with broadly accepted quality. Those industry segments, especially required to produce high quality corrosion-resistant surfacing, e.g. applying nickel-based filler materials, are regularly in consistent demand to comply with «zero defect» criteria. In this conjunction weld performance limitations are overcome employing advanced «hot-wire» GTAW systems. This paper, from a welding automation perspective, describes the technology of such devices and deals with the current status is this field, namely the application of dual-cathode hot-wire electrode GTAW cladding, considerably broadening achievable limits. 27 Ref., 2 Tables, 14 Figures.

Keywords: *GTAW (cladding), single-cathode GTAW, hot-wire welding, dual-cathode GTAW*

Arc welding, to the widest extent, is suggested utilised for fusion welding. The major remainder, i.e. weld surfacing, is supposed reasonably split into «hardfacing» and «corrosion-resistant» weld overlay [1, 2]. Economic considerations drive manufacturers to apply high performance surfacing processes, such as submerged-arc welding or resistance electroslag welding. Although producing broadly acceptable quality, these processes are specifically limited respectively due to compulsory use of flux (limited out-of-position capabilities), high dilution, or undesirable aspect ratios.

Controlled gas metal arc welding processes (e.g. CMT method) have been introduced to the industry coping with dilution related issues, e.g. corrosion [3], and thereby partially replacing submerged-arc and resistance electroslag welding. Surfacing applications exist, however, defining «zero defect» criteria paramount to prevent complicated rework, sustainably assure highest surfacing performance and maintaining long-term component durability. Though joined by limited performance in arc efficiency and weld deposition rate, gas shielded tungsten arc welding (GTAW)

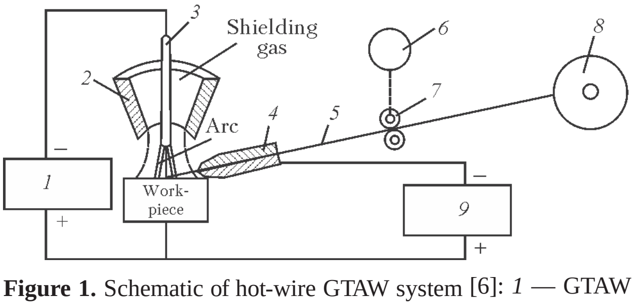

Figure 1. Schematic of hot-wire GTAW system [6]: *1* — GTAW power supply (CC mode); *2* — nozzle; *3* — tungsten electrode; *4* — contact tube; *5* — filler wire; *6* — wire feeder; *7* — feed rolls; *8* — wire reel; *9* — hot wire power supply (CV mode)

is frequently applied in such cases. To overcome lack of performance, systems have been developed modifying the wire feeding process hereby leading to either «cold-wire» or «hot-wire» GTAW. While the former was early revealing process instabilities and noticeably rather difficult deployable [4, 5], the latter appeared capable of tackling inconsistencies, mainly, by preheating the wire.

Manz [6] early described the advantages, e.g. a significant increase in weld deposition rate through beneficially using the resistive wire heating and, compared with cold-wire GTAW, hereby achieving wire feed rates 3 to 10 times faster into the weld pool [4]. Hot-wire GTAW systems continuously advanced are nowadays well-accepted because of providing user benefits [2, 7, 8]. Information on the operational relationship applying hot-wire and cold-wire GTAW is given in [6] and according to this author proper parameter set up would even allow the deposition of wire without any additional arc. This is due to electrical resistive heating of the wire of a specific composition and diameter according to [6]

$$I^2R = I^2L\rho/d^2(\pi/4), \qquad (1)$$

where ρ is the apparent resistivity of the wire material; *L* is the effective wire extension length; and *d* is the wire diameter. The energy required for melting the wire can be expressed as

$$E_{melt} = HF\delta d^2(\pi/4), \qquad (2)$$

where *H* is the heat content of the liquid wire volume; *F* is the wire feed rate; and δ is the apparent wire density.

Figure 1 adopted from [6] schematically depicts the hot-wire GTAW principle.

Wire feed rate can be computed as

$$F = I^2L(ES)/(\pi d^2/4). \qquad (3)$$

ES is here referred to as the «extension sensitivity constant» [6] dependent only on the wire material