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Effect of operating parameters of hybrid TIG-MIG welding on mechanical properties and weld bead quality: A review

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Abstract

There is always a constant demand for a welding process that can prepare the economically viable weld with high productivity and high quality within the least possible time. So, it is the need of the hour to focus on hybrid welding processes that reap the advantages of traditional welding processes by combining them. Hybrid welding of similar or dissimilar structural materials (SMs) has become more imperative due to all-time high requirements for structural parts having suitable mechanical and chemical properties. It is difficult to weld these SMs with traditional processes because of inconsistency between their thermo-physical properties, distortion, residual stress, and generation of thick and brittle intermetallic compounds (IMCs). Though there are some other hybrid welding processes associated with laser welding (LW), electron beam welding (EBW), friction stir welding (FSW), etc. which can produce weldments having thin IMCs but the applications of these techniques are hindered due to high cost, the need for special operating conditions (vacuum environment), and

special tool requirement respectively. That is why modified fusion arc welding processes are still dominant and the point of interest of researchers. In this article, the progress and research in hybrid Tungsten Inert Gas Welding - Metal Inert Gas welding (hybrid TIG-MIG) of various materials are reviewed from different perspectives, viz. influence of operating parameters on mechanical properties and bead quality. It is concluded that welds with high quality, strength, and productivity can be prepared using hybrid TIG-MIG comparatively.

Introduction

Generally speaking, hybridization combines two processes, species, concepts, etc., which are applied to reap the advantages of both participants. This method is used in the late 1970s in the field of welding to combine the LASER- MIG/MAG welding processes. Since the introduction of the hybrid welding concept, primarily the pairing of LW with either TIG or MIG electric arc welding has been experimented with and studied. These developed methods not only integrate the positive characteristics but also make up for the shortcomings of the welding process individually; thus, they are showing more success in enhancing weld quality with increased productivity. In the quest for superior weld quality, enhanced microstructural and mechanical properties, various hybrid welding techniques have been reported in the literature i.e., Laser-TIG by Liu et al. [1], and Moradi et al. [2], Laser-MIG by Yan et al. [3], TIG-MIG by Kanemaru et al. [4], Meng et al. [5], and Ding et al. [6], tandem-GMAW by Fang et al. [7], tandem-TIG welding by Leng et al. [8], etc. have been developed and analyzed.

So due to the advantages of the two processes, the HTMW is a unique way to increase the production and weld's quality. The MIG and TIG arcs together give the workpiece the appropriate joining characteristics. The objective of this paper to review the effect of operating parameters of HTMW on mechanical properties and weld bead geometry. This is discussed in the subsequent sections of this review article.

Section snippets

Materials and methods

The HTMW process is applied by various researchers to join different types of similar and dissimilar materials. These materials with their applications are listed below in Table 1.. From the table, it is depicted that majority of research work has been carried out on steel and aluminum alloys. The various types of designated steel i.e., IS2062, AISI 1008, SAE 1020, 304 steel, and Q235 series were used by researchers to prepare the steel weld. Similarly, the designated aluminum alloys, i.e., …

Influence of operating parameters on microstructures

The HTMW process is applied to weld similar and dissimilar materials, as depicted in the previous section. It is observed that during welding, localized melting and then recrystallization takes place, resulting in a change in microstructure, which is different from base metal, while joining of similar

and dissimilar materials. The melting of materials depends on operating parameters, i.e., current, voltage, welding speed, etc. This further contributes in change of microstructure of weldment. …

Conclusions

After reviewing the research performed by numerous researchers, the following findings are summarized below:

1. The hybrid TIG-MIG welding has enough potential to weld similar and dissimilar structural materials, i.e., SS, Al alloy, Ti alloy, and Mg alloy. …
2. The significant challenges faced by researchers in the HTMW process of dissimilar materials are due to differences in their physical and thermal properties. …
3. The microstructures and mechanical properties of welded joints through the HTMW process are …

…

CRediT authorship contribution statement

Brij Mohan Sharma: Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft. **Tapas Bajpai:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Visualization, Supervision. **Pankaj Kumar Gupta:** Methodology, Investigation, Resources, Data curation, Writing – review & editing, Supervision. **Vikash Gautam:** Methodology, Validation, Investigation, Writing – review & editing, …

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. …

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