iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: VI Month of publication: June 2023

DOI: https://doi.org/10.22214/ijraset.2023.53791

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Latest Developments in MIG Welding - A Review

Dar Saqib Nazir
Department of Mechanical Engineering, RIMT University, Mandi Gobindgarh, Punjab-147301

Abstract: By continually supplying a wire electrode and a shielding gas to protect the weld pool from air contamination, MIG welding has been used to combine two metals or alloys. In comparison to other traditional techniques of combining the alloys using straightforward arc welding processes, the delivery of inert shielding gas provides a number of advantages. Better tensile strength, finer grain hardness, high weld quality and appearance, microstructure improvement, and metallurgical characteristics over the parent metal are a few advantages of this welding process. Therefore, the main goal of this research is to analyse current developments in the MIG welding industry and shed light on those areas that have not yet reached their full potential. As a result, various MIG welding stories are gathered and examined in this study paper based on tests, parameters, and the types of materials used for welding. According to the majority of the publications cited, current was discovered to be the dominant parameter among them, however gas flow rate and angle of weld using modern techniques have not been employed up to that level. Some suggestions for the manufacturing industries are noted below based on the evaluation, which may prove helpful for industrial applications in the future.

Keywords: MIG welding, alloy; welding; hardness; strength, literature review

I. INTRODUCTION

Metal Inert Gas welding as the name suggests, is a process in which the source of heat is an arc formed between a consumable metal electrode and the work piece, and the arc and the molten puddle are protected from contamination by the atmosphere (i.e. oxygen and nitrogen) with an externally supplied gaseous shield of inert gas such as argon, helium or an argon-helium mixture. No external filler metal is necessary, because the metallic electrode provides the arc as well as the filler metal. It is often referred to in abbreviated form as MIG welding [01].It is common practice to use a shielding gas in MIG welding to help protect the weld joint from being contaminated. As the name implies, inert gas metal welding does not use shielding. Without shielding hydrogen, MIG welding is not possible. Another reason for this shielding gas suffocating the weld is because of the MIG welding process. This helps to provide air clear space where welding and fusion arc and fusion wire can work [02]. Gas metal-arc welding overcomes the restrictions of using electrode of limited length and overcomes the inability to weld in various positions, which is a limitation of submerged-arc welding [03] Changing the weld parameters (weld speed, welding current, arc voltage) and changing the composition of shielding gas, creates changes in penetration [04]. Gas Metal Arc Welding (GMAW), sometimes referred to by its subtypes Metal Inert Gas (MIG) welding or Metal Active Gas (MAG) welding, is a semi-automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed spray, each of which has distinct properties and corresponding advantages and limitations [05].

II. LITERATURE REVIEW

Ueyama and Nakata (2010) [06] suggested that by employing pulsed MIG welding, Mg alloy weld beads were produced. The welds' tensile strength is almost 91% more than that of the underlying metal. However, the primary issues with MIG welding of magnesium alloy continue to be spattering and welding stability. The parameter range for MIG welding of magnesium is constrained due to the accuracy required for the energy input into the filler wire. With variable filler wire sizes, wire speeds, and even base metal thicknesses, the parameters should adjust correctly. A power supply that allows for independent, non-linked changes in the parameters of wire speed, base current and time, pulse current and time, base voltage, and pulse voltage is necessary for the successful MIG welding of magnesium. If not, the power supply might not provide the right parameter for MIG welding of magnesium. Reutzel et al., (2011) [07] have put forth a volumetric double ellipsoidal heat source to represent both laser and GMA energy in a three-dimensional thermal finite element model. Zhang recently employed a similar strategy for the laser GMAW-P hybrid welding method. The original geometry in the works described above assumes that weld reinforcement is known and present prior to welding.

Such a method does not take into account the energy deposit from the arc or laser that actually takes place on the weld pool's distorted surface as a result of pressure effects. Gao et al. (2012) [08] have published a preliminary result for laser-MIG hybrid welding of AZ31 Mg alloy to produce one acceptable joint. It was hypothesised that by maximising the interaction of two heat sources, the instability problem in laser-MIG hybrid welding of magnesium alloys may be solved. Comprehensive studies on how welding parameters affect process characterization and joint performance are, however, lacking. Schubert et al., (2008) [09] According to their hypothesis, the temperature-time-cycle, mixing, and chemical compositions in areas with high crack sensitivities govern the production of hot cracks in aluminium welding. Additionally, in hybrid laser-MIG welding, deep-penetration hybrid welds without gaps or pores can be accomplished with extra heat and mass inputs from the arc and the filler droplets revealed a technique in which a double electrode GMAW (DE-GMAW) was suggested which uses a non-consumable tungsten electrode to skip some of the melting current in a traditional GMAW process. While the base metal current in DE-GMAW could still be adjusted at the correct level, it was advised that the welding current be raised to speed up the welding process. A novel procedure known as consumable DE-GMAW was recently created by improving the DE-GMAW process by switching out the non-consumable tungsten electrode for a consumable welding wire electrode. Zhou and Tsai (2013) [10] investigated the complex transport processes seen in spot hybrid laser-MIG keyhole welding, mathematical models and research methods are given. Numerous studies have looked at the fatigue characteristics of welded metals because they are crucial to the design of automobile components and because fatigue accounts for more than 90% of component failure. In order to identify the ideal welding circumstances, the effects of the welding process parameters and the welding metal on the fatigue strength have been studied. A unified approach that takes into account the effects of the strength mismatch ratio, post-weld heat treatment, and notch placement has been used to forecast the fatigue parameters of high strength low alloy steel welds, including the fatigue crack initiation life, fatigue crack propagation life, and total fatigue life. Similar fatigue life predictions of AISI 304L cruciform joints that were gas tungsten arc welded have been made and compared to experimental results. It has been claimed that the results from electron beam welding are superior to the fatigue behaviour of gas tungsten arc welds in stainless steel. Souza et al., (2014) [11] evaluated the significance inductance for the MIG/MAG process when working in the short-circuiting mode. It is well known that inductance controls the current increasing/decreasing rates (di/dt), which has an impact on the stability of the short-circuit transfer and, as a result, the creation of spatter. These writers claim that since the circuit inductance also depends on the arc, current, cables, etc., it is not possible to manage the influence of this parameter in welding alone by adjusting the inductance setting. As a result, settings for inductance locations rather than values are offered by commercial power sources. The "inductance factor" would thus be a better term to describe this setting. Rajakumar et al., (2022) [12] examined the mechanical properties of robotic-GMAW and conventionally produced low carbon steel joints. In comparison to traditional MIG welding, robotic MIG welding demonstrated higher mechanical characteristics and efficiency. Robotic GMAW welding at a current of 450A and a speed of 350 mm/min produced the highest tensile strength of 647 MPa and the micro hardness of 275 HV in the HAZ. Robotic MIG welded joints have a slightly greater micro hardness than traditional MIG welded joints. Khamari et al., (2023) [13] published a feasibility comparison between GMAW and shielded metal arc welding (SMAW) for IS 2062 plates of various thicknesses. In order to improve welding conditions, the work demonstrated a link between tensile strength, toughness, and micro hardness under three welding currents using IS 2062 steel plates. Haragopal et al., (2016) [14] the purpose of this work is to improve the mechanical qualities of MIG welded aluminium alloy joints by optimizing the process parameters like current values. The studies were carried out in accordance with an l9 orthogonal array. It was determined that the influence of current on ultimate tensile strength and pressure for impact energy was the greatest among the other parameters. Joints which were welded with high current values gave the highest tensile strength. Kim et al. (2017) [15] made an attempt in which multi pass welding and a neural network were utilised to construct an intelligent algorithm that could grasp the relationship between the process parameters and bead height and use that relationship to anticipate the process parameters for the ideal bead height in GMAW process. Regression analysis, graphical techniques, and response surface methodology are statistical tools that can more or less accurately predict the outcomes from the process parameters. However, the results are only applicable to the anchor points used for the regression analysis. Yanling Xu et al. (2018) [16] studied GMAW with pulse frequency, welding current, welding voltage, feed speed, weld frequency, gas flow rate, welding speed, wire diameter, shielding gas as input process parameters and tracked welding seam. After number of experiments on different specimen they concluded that out of different parameters used during experiment welding current has a significant effect on tensile strength of joints in MIG welding process. Tanaka et al (2019) [17] have created the plasma MIGW procedure to keep the MIGW arc stable. Metal transfer can be stabilised and the oscillation of the liquid column can be controlled thanks to the plasma MIGW's use of ionisation shielding gas flow. As a consequence, 100% argon shielding effectively stabilised the MIGW arc. The arc stability in pure argon MIGW is the product of these experiments.

The issues with the convex weld bead and shallow penetration that are caused by pure argon MIGW are not mentioned, though. Because of the molten pool's low temperature and high surface tension, convex weld beads form, and inadequate heat input results in shallow penetration. Therefore, increasing the amount of droplet heat is preferred to enhance bead form and shallow penetration. Due to the peculiar correlation between the welding current and the wire feed speed in the standard MIGW, it is challenging to enhance the amount of heat of droplets. Satyaduttsinh P. Chavda, Jayesh V. Desai, Tushar M. Patel (2020) [18] studied Taguchi's DOE Method and the MIG welding procedure. They proposed the notion of applying Taguchi's DOE Method to optimise the MIG welding process's parameters. In this study, they evaluated many earlier works from various papers and discussed the benefits of the Taguchi approach. They came to the conclusion that the most important parameters in the GMAW process include current, voltage, speed, shielding gas, gas flow rate, wire feed rate, wire diameter, etc. These parameters will affect the different weldment characteristics. G. Haragopal, P V Ravindra Reddy and J V Subrahmanyam (2021) [19] proposed a technique for formulating process parameters that enhance the mechanical characteristics of the aluminium alloy weld specimen (Al-65032) used in the manufacture of aeronautical wings. Process variables such gas pressure, current, groove angle, and preheat temperature should be taken into account in the investigation. The ideal balancing of the process parameters was achieved.

III. CONCLUSIONS AND RESEARCH IMPLICATIONS

In conclusion, MIG welding, or Gas Metal Arc Welding (GMAW), offers several research implications across various areas. From above discussions which were limited to only the last decade, researchers can focus on optimizing the welding process parameters to improve efficiency and weld quality. They can investigate the factors influencing weld quality and defect formation to minimize defects and enhance overall performance. Exploring the applicability of MIG welding to advanced materials can expand its potential applications. Integrating MIG welding with automation and robotics systems can enhance productivity and precision. Research can also address the environmental impact of MIG welding by exploring alternative shielding gases and reducing emissions. Finally, investigations into health and safety aspects can lead to the development of guidelines and strategies to protect welders from occupational hazards. Overall, research in MIG welding can contribute to advancements in process optimization, material joining, automation, environmental sustainability, and worker safety.

IV. LIMITATIONS

The literature review was limited to the last decade to explore the significant effects of the MIG welding in application.

V. ACKNOWLEDGMENT

The authors are thankful to the RIMT University, Mandi Gobindgarh (Punjab) for providing the platform for this research work.

REFERENCES

[1] https://www.researchgate.net/publication/317956208 Optimization and Prediction of MIG Welding Process Parameters Using ANN
[2] Madavi, K. R., Jogi, B. F., & Lohar, G. S. (2021). Metal inert gas (MIG) welding process: A study of effect of welding parameters. Materials Today: Proceedings. doi:10.1016/j.matpr.2021.06.206
[3] Syamal Mukherjee, “Metal Fabrication Technology”, PHI Learn- ing Private Ltd.
[4] A. Prof. Hani Chotai (2011) A Review on Parameters Controlling Gas Metal Arc Welding (GMAW) Process. International conference on current trends in technology, ‘nuicone.
[5] Ajit Hooda, Ashwani Dhingra [2012] optimization of mig welding process parameters to predict maximum yield strength in AISI 1040, ISSN 2278 – 0149.Vol. 1, No. 3,
[6] Zhou, J., & Tsai, H. L. (2008). Modelling of transport phenomena in hybrid laser-MIG keyhole welding. International Journal of Heat and Mass Transfer, 51(17-18), 4353–4366 [01] Song, G. (2010). Metal inert gas welding of magnesium alloys. Welding and Joining of Magnesium Alloys, 178–196.
[7] Le Guen, E., Carin, M., Fabbro, R., Coste, F., & Le Masson, P. (2011). 3D heat transfer model of hybrid laser Nd:Yag-MAG welding of S355 steel and experimental validation. International Journal of Heat and Mass Transfer, 54(7-8), 1313–1322
[8] Gao, M., Mei, S., Wang, Z., Li, X., & Zeng, X. (2012). Process and joint characterizations of laser–MIG hybrid welding of AZ31 magnesium alloy. Journal of Materials Processing Technology, 212(6), 1338–1346. [05]
[9] Bhattacharya, S., Pal, K., & Pal, S. K. (2012). Multi-sensor based prediction of metal deposition in pulsed gas metal arc welding using various soft computing models. Applied Soft Computing, 12(1), 498–505
[10] Meng, X., Qin, G., Zhang, Y., Fu, B., & Zou, Z. (2014). High speed TIG–MAG hybrid arc welding of mild steel plate. Journal of Materials Processing Technology, 214(11), 2417–2424. doi:10.1016/j.jmatprotec.2014.05 [07]
[11] De Meneses, V. A., Gomes, J. F. P., & Scotti, A. (2014). The effect of metal transfer stability (spattering) on fume generation, morphology and composition in short-circuit MAG welding. Journal of Materials Processing Technology, 214(7), 1388–1397. doi:10.1016/j.jmatprotec.2014.02 [08

[12] Grey-based taguchi method for multi-weld quality optimization of gas metal arc dissimilar joining of mild steel and 316 stainless steel O.S. Ogbonna a, S.A. Akinlabi b, N. Madushele a, O.S. Fatoba a,*, E.T. Akinlabi b https://doi.org/10.1016/j.rineng.2023.100963 [08] Variant of MIG welding of similar and dissimilar metals: A review https://doi.org/10.1016/j.matpr.2021.11.287

[13] Study of dual pulse gas metal arc welding process characteristics on IS 2062 steel https://doi.org/10.1016/j.matpr.2022.08.092

[14] Srirangan, A. K., & Paulraj, S. (2016). Multi-response optimization of process parameters for TIG welding of Incoloy 800HT by Taguchi grey relational analysis. Engineering Science and Technology, an International Journal, 19(2), 811–817. doi:10.1016/j.jestch.2015.10.003

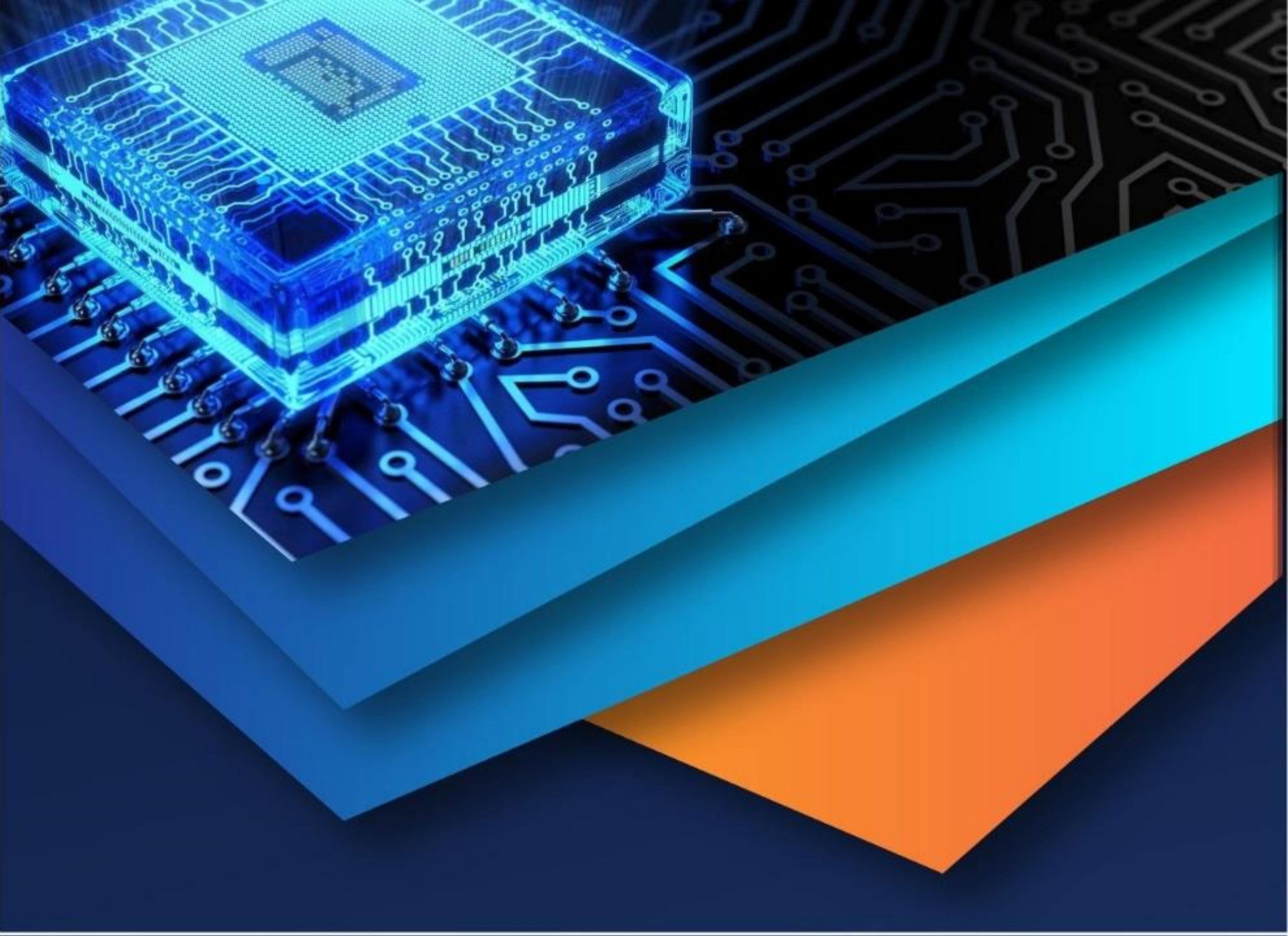
[15] Srivastava, S., & Garg, R. K. (2017). Process parameter optimization of gas metal arc welding on IS:2062 mild steel using response surface methodology. Journal of Manufacturing Processes, 25, 296–305. doi:10.1016/j.jmapro.2016.12.01

[16] Kumar, S., & Singh, R. (2019). Optimization of Process Parameters of Metal Inert Gas Welding with Preheating on AISI 1018 Mild Steel using grey based Taguchi Method. Measurement, 106924. doi:10.1016/j.measurement.2019.10

[17] Aoki, A., Tashiro, S., Kurokawa, H., & Tanaka, M. (2019). Development of novel MIG welding process with duplex current feeding. Journal of Manufacturing Processes, 47, 74–82. doi:10.1016/j.jmapro.2019.09.009

[18] Kanakavalli, P. B., Navaneeth Babu, B., & Vishnu Sai, C. P. N. (2019). A hybrid methodology for optimizing MIG welding process parameters in joining of dissimilar metals. Materials Today: Proceedings. doi:10.1016/j.matpr.2019.05.396

[19] Sakthivel, P., Manobbala, V., Manikandan, T., Mohammed Arman Salik, Z., & Rajkamal, G. (2020). Investigation on mechanical properties of dissimilar metals using MIG welding. Materials Today: Proceedings. doi:10.1016/j.matpr.2020.05.488



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY