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Investigation On the Effect of Process Parameters On Weld Bead Geometry in TIG Welding

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***Abstract*: TIG welding is most vital and common operation used for joining of two similar or dissimilar parts with heating the material or applying the pressure by using the filler material for increasing productivity with less time and cost constrain. When changing the welding parameters, the quality, strength and weld bead geometry also affected. The TIG welding is done on the aluminium 5052 material by varying the welding parameters like welding current and welding electrode diameter. The effect on the weld bead geometry is studied and the changes made on the weld bead are noted. To analyse the strength of the weld joint or any deviation in their strength we should test the weld joint. We tested the weld joint by tensile and microscopic test. The tensile test gives any deviation in their strength and the microscopic test give the material structural changes.**

***Keywords*: TIG welding parameters, Effect of welding parameters, Effect of welding in weld bead geometry.**

1. Introduction

Aluminium based alloys have been widely used in automobile structures due to their unique properties such as high strength to weight ratio. The welding of aluminium aim to alloys has always represented a great challenge for designers and technologists. As a matter of fact, lots of difficulties are associated to this kind of joint process, mainly related to the presence of a tenacious oxide layer, high thermal conductivity, high coefficient of thermal expansion, solidification shrinkage and, above all, high solubility of hydrogen, and other gases, in molten state. The present work is deals with finding out the effect of welding parameters welding current, voltage, weld diameter on the weld strength of aluminium 5052 alloy.

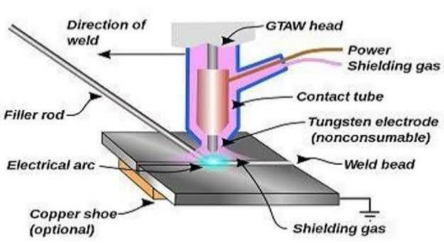

Fig. 1. TIG welding process

2. Material Selection

A. Aluminium 5052

This is the grade of aluminium we have to use in the project of weld bed geometry in TIG welding. This aluminium 5052 is used because of its high thermal capacity and able to be weld. This aluminium grade is alloyed with magnesium and chromium. It is moderately strong compared to the other aluminium grades. It comes under 5xxx series of aluminium alloys, it's used one who use magnesium as the primary alloying element. The yield strength, mechanical strength and ultimate tensile strength are also moderate in this material. This grade is high strength than the basic used aluminium grade 3003.The strength of aluminium 5052 varies in the cold work and hardening at the temperature. The aluminium 5052 is also able to bend and we can anodize aluminium 5052 material. The strength of aluminium is given below,

- Tensile strength (σt): 195–290 MPa (28.3–42.1 ksi)
- Thermal conductivity (k): 138 W/m*K
- Specific heat capacity (c): 880 J/kg*K
- Young's modulus (E): 69.3 GPa (10,050 ksi)
- Linear thermal expansion coefficient (α): $2.38*10^{-5}$ K^{-1}
- Density (ρ): 2.68 g/cm^3
- Melting temperature (Tm): 607 °C (1,125 °F)

5052 aluminium alloy has a yield strength of 193 MPa (28,000 psi) and an ultimate tensile strength of 228 MPa (33,000 psi), which means it is moderately strong when compared to other some popular alloys. These are the primary factors for the selection of the metal aluminium 5052.

In this project, we use aluminium 5052 metal in the sheet format in the size of 100×150mm and the thickness of 5mm, because the aluminium 5052 plate is subjected to the many of the testing so we buy the metal in correct size and suitable for the testing these points are noted for the project. The cost of aluminium 5052 is moderately and it is easily available in all the market and it is also suitable for TIG welding and also suitable for testing. During the welding process we have to check and change the welding parameters such as voltage, current, temperature etc., so it is also suitable for that. By considering all such parameters and we have a deep discussion

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and learning on the aluminium metals and we finalized the material aluminium 5052.

B. Tensile test

Fig. 2. Universal testing machine

Ductile testing, otherwise called pressure testing, is an essential materials science and designing test in which an example is exposed to a controlled strain until disappointment. Properties that are straightforwardly estimated by means of a ductile test are extreme elasticity, breaking strength, greatest extension and decrease in territory. From these estimations the accompanying properties can likewise be resolved: Young's modulus, Poisson's proportion, yield strength, and strain-solidifying qualities. Uniaxial pliable testing is the most regularly utilized for getting the mechanical attributes of isotropic materials. A few materials utilize biaxial malleable testing. The fundamental distinction between these testing machines being the means by which burden is applied on the materials.

1) Tensile specimen

We use aluminium 5052 plate of 100 *100mm.The readiness of test examples relies upon the reasons for testing and on the administering test technique or particular. An elastic example is typically a normalized test cross-segment. The shoulders are huge so they can be promptly grasped, while the measure segment has a more modest cross-segment so the twisting and disappointment can happen around there.

The shoulders of the test example can be fabricated in different manners to mate to different holds in the testing machine (see the picture beneath). Every framework has benefits and drawbacks; for instance, shoulders intended for serrated grasps are simple and modest to fabricate, however the arrangement of the example is subject to the expertise of the professional. Then again, a stuck grasp guarantees great arrangement.

2) Equipment

Grain size and direction and other primary qualities are straightforwardly connected to the mechanical and innovative properties of these materials. Primary attributes additionally rely upon ensuing outer impacts. These impacts include:

Substance impacts (for example consumption). Substance and additionally actual impacts (for example heat treatment measures) Mechanical impacts (for example following the shaping cycles, like producing, moving, bowing, and so on) Microstructure must be surveyed by magnifying lens (sound system magnifying instrument, light magnifying lens utilizing mirrored light, computerized magnifying lens or checking and transmission electron magnifying lens).

3. Results and Discussion

A. Tensile analysis

The tensile test is done on the weld specimen whose length and breadth are 200 mm and 20 mm. The thickness of the aluminium 5052 plate is 5 mm. There are four specimens with different parameter are varied during the welding process are listed below.

- The first specimen is welded with 100 A current and 1.6 mm electrode diameter. It is found that the shape of the weld bead is narrow and small.
- The second specimen is welded with 150 A current and 1.6 mm electrode diameter. It is found that the shape of the weld bead is narrow and depth of penetration is high.
- The third specimen is welded with 100 A current and 2.4 mm electrode diameter. It is found that the shape of the weld bead is larger and depth of penetration is low.

Table 1
Experimental result

Specimen/Load	Maximum load (kN)	Yield stress (MPa)
1	9940	96645
2	11060	109086
3	14410	116094
4	11100	102.538

The fourth specimen is welded with 150 A current and 2.4 mm electrode diameter. It is found that the shape of the weld bead is larger and depth of penetration is high.

Fig. 3. Before and after tensile test

B. Microstructure analysis

The microstructure of aluminium 5052 is examined by SEM. The changes in their microstructure of the heat affected zone is investigated. Fig. 3, shows the differences in the microstructure of heat affected zone of the four specimens.

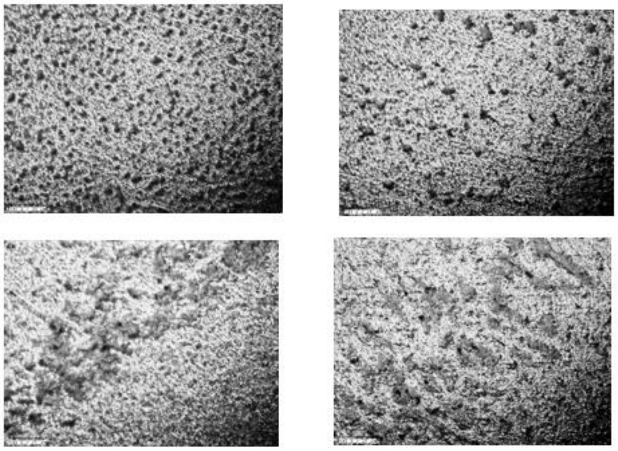

Fig. 4. Microstructure of HAZ of different specimens

The microstructure of aluminium 5052 material on the weld specimen, the views are given on the heat affected zone (HAZ). It shows the heat affected zoon in dark black marks, in the first diagram the heat affected is large at the center of the specimen and then decrease at outside and tensile test is very low. For the second specimen the heat affected is wider and it can be able to with stand the tensile load more. The third specimen shows the small dark spots hence it is very strong with respect to other specimens. Fourth specimen shows the very small and low dark spots and it is stronger than first specimen.

4. Conclusion

In this paper the experimental verification and the investigation have been made, in this method the current and the electrode diameter can be changed and results are taken out and the experiment gives good result in the correct manner. Due to the change in current and electrode diameter, the TIG welding gives good efficiency and strong welded joints in a fast manner. In this experiment all the process is done in an effective manner. First the problem identification is made and after the deep analysis on the on the topics we made the project in investigation on the effect on weld bead geometry in TIG welding and then the material selection is made into a deep after many researches the materials are confirmed and the dimensions are noted and also the place is identified for the welding and testing. From this conclusion can be made with the TIG welding system uniform welding of Aluminium plate can be possible. Welding strength or tensile strength of the weld joint depends on the welding parameters like welding speed and welding current. With the increase in current, tensile strength of the weld joint increases. Hardness value of the weld zone change with the distance from weld center due to change of microstructure.

References

[1] Venkatesh, S., Kumar, R.S., Sivapirakasam, S.P., Sakthivel, M., Venkatesh, D. and Arafath, S.Y., 2020. Multi-objective optimization, experimental and CFD approach for performance analysis in square cyclone separator. Powder Technology, 371, pp. 115-129.

[2] Kumar, R.S., Alexis, J. and Thangarasu, V.S., 2017. Optimization of high-speed CNC end milling process of BSL 168 Aluminium composite for aeronautical applications. Transactions of the Canadian society for Mechanical Engineering, 41(4), pp. 609-625.

[3] Kumar, S.R., Alexis, J.S. and Thangarasu, V.S., 2017. Experimental Investigation of Influential Parameters in High Speed Machining of AMS 4205. Asian Journal of Research in Social Sciences and Humanities, 7(2), pp. 508-523.

[4] Alexis, J. and Thangarasu, V.S., 2016. Prediction of machining parameters for A91060 in end milling. Advances in Natural and Applied Sciences, 10(6 SE), pp. 157-164.

[5] Kumar, R.S., Thangarasu, V.S. and Alexis, S.J., 2016. Adaptive control systems in CNC machining processes--a review. Advances in Natural and Applied Sciences, 10(6 SE), pp. 120-130.

[6] Suresh Kumar, R., John Alexis, S. and Thangarasu, V.S., 2015. Application of GA & ANN for the optimization of cutting parameters for end milling operation-A comparison. International Journal of Applied Engineering Research, 10(20).

[7] T Ramakrishnan, M Sathesh Babu, S Balasubramani, K Manickaraj, R Jeyakumar., 2021.Effect of Fiber Orientation and Mechanical Properties of Natural Fiber Reinforced Polymer Composites-A Review. paideumajournal.14 (3), pp. 17-23.

[8] Jeyakumar R, Balasubramanian K, Ramamoorthi R, Ramakrishnan T., Development of Compact Electro Gear Pump for Airborne Applications, 2021.

[9] Ramakrishnan, T. and Sampath, P.S., 2017. Dry sliding wear characteristics of new short agave angustifolia marginata (AAM) fiber-reinforced polymer matrix composite material. Journal of Biobased Materials and Bioenergy, 11(5), pp. 391-399.

[10] Thirumalaisamy, R. and Subramani, S. P, Investigation of physico-mechanical and moisture absorption characteristics of raw and alkali treated new agave angustifolia marginata (AAM) fiber. Materials Science, 24(1), pp. 53-58, 2018.

[11] Jeyakumar, R., Sampath, P.S., Ramamoorthi, R. and Ramakrishnan, T., Structural, morphological and mechanical behaviour of glass fibre reinforced epoxy nanoclay composites. The International Journal of Advanced Manufacturing Technology, 2017.

[12] Ramakrishnan, T. and Sampath, P.S., 2017. Experimental investigation of mechanical properties of untreated new Agave Angustifolia Marginata fiber reinforced epoxy polymer matrix composite material. Journal of Advances in Chemistry, 13(4), pp. 6120-6126.

[13] Ramakrishnan, T., Sampath, P.S. and Ramamoorthi, R., Investigation of mechanical properties and morphological study of the alkali treated agave angustifolia marginata fiber reinforced epoxy polymer composites. Asian Journal of Research in Social Sciences and Humanities, 6(9), pp. 461-472, 2016.

[14] Sathish, K., Ramakrishnan, T. and Sathishkumar, S., 2016. Optimization of turning parameters to improve surface finish of 16 Mn Cr 5 material. Advances in Natural and Applied Sciences, 10(6 SE), pp. 151-157.

[15] Ramakrishnan, T., Sathish, K., Sampath, P.S. and Anandkumar, S., 2016. Experimental investigation and optimization of surface roughness of AISI 52100 alloy steel material by using Taguchi method. Advances in Natural and Applied Sciences, 10(6 SE), pp. 130-138.

[16] Gokilakrishnan, G. and Varthanan, P.A., 2019. Development of manufacturing-distribution plan considering quality cost. International Journal of Enterprise Network Management, 10(3-4), pp. 280-304.

[17] Varthanan, P.A. and Gokilakrishnan, G., 2018. Simulation Based Swarm Intelligence to Generate Manufacturing-distribution Plan for a Bearing Industry under Uncertain Demand and Inventory Scenario. International Journal of Pure and Applied Mathematics, 119(12), pp. 2117-2134.

[18] Gokilakrishnan, G.E., Divya, S., Rajesh, R. and Selvakumar, V., 2014. Operating torque in ball valves: a review. Int J Technol Res Eng, 2(4), pp. 311-315.

[19] Venkatesh, S., Sakthivel, M., Saranav, H., Saravanan, N., Rathnakumar, M. and Santhosh, K.K., 2020. Performance investigation of the combined series and parallel arrangement cyclone separator using experimental and CFD approach. Powder Technology, 361, pp. 1070-1080.

[20] Venkatesh, S., Sakthivel, M., Avinasilingam, M., Gopalsamy, S., Arulkumar, E. and Devarajan, H.P., 2019. Optimization and experimental investigation in bottom inlet cyclone separator for performance analysis. Korean Journal of Chemical Engineering, 36(6), pp. 929-941.

[21] Venkatesh, S. and Sakthivel, M., 2017. Numerical investigation and optimization for performance analysis in Venturi inlet cyclone separator. Desalination and Water treatment, 90, pp. 168-179.

[22] Venkatesh, S., Bruno Clement, I., Avinasilingam, M. and Arulkumar, E., 2017. Design of Experiment Technique for Improving the Performance of

Stirling Engine. International Research Journal of Engineering and Technology, 4(5), pp. 62-65.
[23] NaveenPrabhu, V., SaravanaKumar, K., Suresh, T. and Suresh, M., 2016. Experimental investigation on tube-in-tube heat exchanger using nanofluids. Advances in Natural and Applied Sciences, 10(7 SE), pp. 272-279.
[24] Justin Dhiraviam, F., Naveen Prabhu, V., Suresh, T. and Selva Senthil Prabhu, C., 2015. Improved efficiency in engine cooling system by repositioning of turbo inter cooler, in Applied Mechanics and Materials, vol. 787, pp. 792-796.
[25] Naveen Prabhu, V. and Suresh, M., 2015. Performance evaluation of tube-in-tube heat exchanger using nanofluids. In Applied Mechanics and Materials, vol. 787, pp. 72-76.
[26] Manigandan, N., NaveenPrabhu, V. and Suresh, M., 2015. Experimental investigation of a brazed chevron type plate heat exchanger. International Journal of Science Technology & Engineering, 1(12), pp. 1-7.
[27] Dhiraviam, F.J., Naveenprabhu, V. and Santhosh, M., 2017. Study the Effects of Solar Assisted Vapour Compression Air Conditioning System for Winter Applications. International Journal for Scientific Research & Development, 4(11), pp. 505-508.
[28] Dhiraviam, F.J., Naveenprabhu, V., Satish, K. and Palanivelrajan, A.R., 2019, October. Emission characteristic in CI engines using zirconium porous medium in piston head. In AIP Conference Proceedings, vol. 2161, no. 1, p. 020012.
[29] Naveenprabhu, V., Dhiraviam, F.J., Gowtham, K.M., Gowtham, S., Tharick, R.A. and Arunkumar, R., 2019. Smart Hot Chamber in Refrigeration System Based on Waste Heat Recovery. Indian Journal of Science and Technology, 12, p. 20.
[30] Subramaniam, B., Natarajan, B., Kaliyaperumal, B. and Chelladurai, S.J.S., 2019. Wear behaviour of aluminium 7075—boron carbide-coconut shell fly ash reinforced hybrid metal matrix composites. Materials Research Express, 6(10), p.1065.
[31] Subramaniam, B., Natarajan, B., Kaliyaperumal, B. and Chelladurai, S.J.S., 2018. Investigation on mechanical properties of aluminium 7075-boron carbide-coconut shell fly ash reinforced hybrid metal matrix composites. China Foundry, 15(6), pp. 449-456.
[32] Balasubramani, S., Dhanabalakrishnan, K.P. and Balaji, N., 2015. Optimization of machining parameters in aluminium HMMC using response surface methodology. International journal of applied engineering research, 10(20), pp. 19736-19739.
[33] Ganeshkumar S, Sureshkumar R, Sureshbabu Y, Balasubramani S 2020, A Review on Cutting Tool measurement in Turning Tools by Cloud Computing Systems in Industry 4.0 and IoT, GIS science journal, vol 7, no. 8, pp. 1-7.
[34] Ganeshkumar S, Sureshkumar R, Sureshbabu Y, Balasubramani S, 2019, A Numerical Approach to Cutting Tool Stress in Cnc Turning of En8 Steel with Silicon Carbide Tool Insert, International Journal of Scientific & Technology Research, vol. 8, no 12, pp. 3227-3231.
[35] Venkatesh, S., Sivapirakasam, S.P., Sakthivel, M., Ganeshkumar, S., Prabhu, M.M. and Naveenkumar, M., 2021. Experimental and numerical investigation in the series arrangement square cyclone separator. Powder Technology, 383, pp. 93-103.
[36] Kumar, S. D. and Kumar, S. S., 2021. Effect of heat treatment conditions on ballistic behaviour of various zones of friction stir welded magnesium alloy joints. Transactions of Nonferrous Metals Society of China, 31(1), pp. 156-166.
[37] Kumar, S. D. and Kumar, S. S., 2020. Numerical and experimental ballistic performance of welded magnesium (AZ31B) plates. Emerging Materials Research, 9(4).
[38] Kumar, S. S., Kumar, S. D. and Magarajan, U., 2020. Investigation of mechanical and wear behaviour of graphene reinforced aluminium alloy 6061 metal matrix composite. Kovove Materialy-Metallic Materials, 58(5), pp. 341-349.
[39] Yessian, S. and Varthanan, P. A., 2020. Optimization of performance and emission characteristics of catalytic coated IC engine with biodiesel using grey-taguchi method. Scientific reports, 10(1).
[40] Sureshbabu, Y. and Ashoka Varthanan, P., 2014. Study the emission characteristics of catalytic coated piston and combustion chamber of a four stroke spark ignition (SI) engine. Journal of Chemical and Pharmaceutical Sciences, JCHPS Special, (4).
[41] Sureshbabu, Y., Ashokavarthnan, P., Balasubramani, S. and Naveenprabhu, V., 2019, October. Experimental investigation on four strokes catalytic coated spark ignition (SI) engine. In AIP Conference Proceedings, vol. 2161, no. 1, p. 020041).
[42] Sivakumar, Korra Nanda Naik, Optimization of weldment in bead on plate welding of nickel-based superalloy using Activated flux tungsten inert gas welding (A-TIG).
[43] D.S. Nagesha, G.L. Genetic algorithm for optimization of welding variables for height to width ratio and application of ANN for prediction of bead geometry for TIG welding process,
[44] Vishvesh J. Badheka, Experimental investigation on mechanism and weld morphology of activated TIG welded bead-on-plate weldments of reduced activation ferritic/martensitic steel using oxide fluxes.
[45] A. Chennakesava Reddy, Macro and microstructure evaluation of TIG weld on DSS (2304) withbead geometry at three positions.