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A Review Study on Dissimilar Metal Weld of stainless steel and copper on TIG Welding

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ABSTRACT

This review paper explains the basic principle of dissimilar metal welding and methodology of Gas tungsten arc welding (GTAW) also known as tungsten inert gas (TIG) welding. Dissimilar welding of metals has gained lots of interest from researchers worldwide due to its numerous benefits. This paper presents a review of the recent works done on TIG welding of dissimilar metals with the focus on properties, structure, and performance relationships. It also includes the influence of welding parameters on the quality of joints. The papers for investigation in this work were considered from 2009 to date 2021. A total of 20 research papers were chosen for our consideration after an in-depth examination of several such papers. There is a growing need for dissimilar welding due to its various benefits. Welding of dissimilar Metal is very challenging due to the dissimilarities in their chemical, physical, and metallurgical properties. Although other welding processes such as solid-state welding processes and some fusion welding techniques such as laser welding and electron beam welding have produced high-quality dissimilar Metal joints, their application has been limited due to their high cost. Consequently, the TIG welding technique has been widely employed for welding of dissimilar materials because of its low cost, stability, and high quality of weld produced. In this paper covers the all the technical aspects which affect the process and quality of GTAW joint. Effect on all the types of joint configuration is studied. All the technical aspects of GTAW all material is covered. Effect on welding quality of basic parameters like Current, Voltage, Welding speed, Gas flow rate has been studied. Finally, the area on which further more research can be carried out are identified.

Key words: *Gas tungsten arc welding (GTAW), tungsten inert gas (TIG), Variable Voltage, Wire feed speed, Variable current, Groove, gap between two plate and Plate thickness.*

INTRODUCTION

GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques. A related process, plasma arc welding, uses a slightly different welding torch to create a more focused welding arc and as a result is often automated.

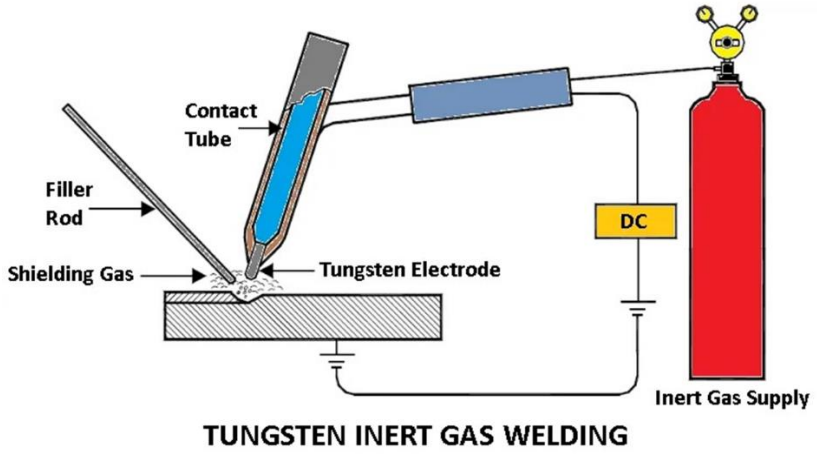

Figure 1.TIG Welding[2]

- The weld pool is shielded by an inert gas (Helium, Argon, Nitrogen) protecting the molten metal from atmospheric contamination.
- For most metal, the current is direct current or DC.
- The heat generated by the arc melts the work piece edges and joins them.
- In TIG welding, you can control the amount of heat by pressing a foot pedal or thumbwheel on the torch.
- If required filler rod may be used.
- It produces a high-quality weld of most of the metals.
- Flux is not used in the process.

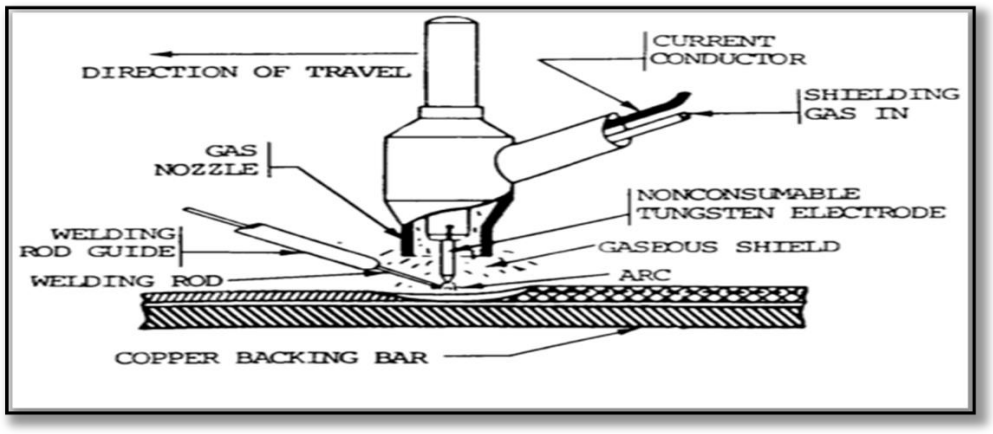

Figure 2TIG Welding[1]

LITRATURE SURVEY

A. Effects of TIG welding on stainless steel and mild steel plates [1]

In this paper the effect of TIG welding on stainless steel 304 and mild steel plates 351 Grade have been explained. During the study, mild steel and grade of stainless steel were joined using TIG welding. The tensile strength, hardness and bend test were investigated.

The bend test was performed on welded stainless steel and mild steel plates with some standard parameters like thickness of plate, angle of bend, bending diameter etc. Bend test of welded S.S and MS plate is successive in the experiment. There has been nothing observed problematic by bend test like crack on HAZ, more elongation at certain metal, etc. Two bend test technique like root bend and face bend have been performed.

The results show Tungsten Inert gas welding process is best for S.S and MS plate joint. During TIG welding the loss of Cr from S.S is very low so it resists from corrosion action in field. Furthermore, welding done under inert atmosphere to protect weld from hydrogen and other environmental threats. The strength of dissimilar metal welded by TIG welding is excellent as per report. Hardness value at the point of filler metal is maximum that is only the result to make experiment successive. Including all the test reports we get best result with TIG welding on related metals plates.

B. Analysis of welding joints and processes [2]

This paper is about to study microscopic and macroscopic behavior of few special and most commonly joints which is used by the industry when subjected to certain general types of loading. Each of the welded joints was put under metallurgical microscope and the welded Portion was examined for change in actual structure of the material. The experiment is explained using the strengths graphs of welding process, bending force and deflection of T joint and butt joint to find best welding process for a particular joint.

The microstructural effect of various welding processes on different welded joints and the bending moment data of different welded joints have been discussed. The results show that when a welding process is to be selected while welding following combinations would yield the best result: LAP JOINT - DC ARC WELDING, BUTT JOINT - MIG WELDING and T-JOINT - MIG WELDING.

C. Dissimilar metal welds of stainless steel and mild steel by TIG welding process [3]

In this work the Tungsten Inert Gas Welding of joining heat treatable of stainless steel and mild steel has been studied. The objective of study is to understand the various welding parameter like welding current, voltage, gas flow rate, inert gas, welding speed, electrode etc.Output parameters such as hardness of welding, tensile strength of welding, DPT, spectrography by using optimization philosophy. The main effort is to investigate optimal machining parameters and their contribution on producing better best weld quality.

The materials used for dissimilar welding were SS-316 and MS-E350BR, Material use 8 mm thickness. The chemical compositions of SS-316 and MS-E350BR alloy is given. This paper gives the

idea of the working of the TIG welding and from above Literature reviews it is clear that various work has been done on TIG welding. To study and optimized the welding output such as tensile strength, hardness of weld joints etc. on varying the input parameters such as welding current, voltage, gas flow rate, welding speed etc. and also some work on TIG welding withsumming gases has been carried out on various material similar as well as dissimilar materials.

D. Dissimilar materials welded specimen analysis using FEA [4]

The main focus of article was static structure analysis and discusses possible literature about welding. The Research Paper Using two different plate materials as plate material is SA106 (CS) and the second plate is STS 304(CS). These plates are welded with filler weld material M309, Welded specimen of thickness 3mm. In this paper study, two rectangular plates of dimension 30 mm X 50mm x3 mm made up of two dissimilar materials. SA106 and STS 304, separated by 3mm gap are modeled in ANSYS. The specimen is again analyzed for the thermal load as temperature. Butt welded joint specimen using gas metal arc welding (GMAW). The thickness of the simulation plate is 3 mm. A tensile force of 20000N was applied for static structure analysis.

Conclusion of this paper this stress goes on decreasing with the increases in the thickness of the plate the maximum pressure at this loading state was found to be 229MPa at one end of plate.

E. Influence of welding speed on tensile strength of welded joint in TIG welding process [5]

This paper deals with the investigation of effect of welding speed on the tensile strength of the welded joint. Experiments are conducted on specimens of single v butt joint having different bevel angle and bevel heights. The material selected for preparing the test specimen is Aluminum AA6351 Alloy. The strength of the welded joint is tested by a universal tensile testing machine and the results are evaluated.

- The depth of penetration of weld bead decreases with increase in bevel height of V butt joint.
- Maximum Tensile strength of 230 Mpa was observed at weld speed of 0.6 cm/sec (for 40 0 bevel and 1.5 bevel height).
- Tensile strength is higher with lower weld speed. This indicates that lower range of weld speed is suitable for achieving maximum tensile strength.
- Bevel angle of the weld joint has profound effect on the tensile strength of weldment. Bevel angles between 30 to 45 are suitable for maximum strength.

The heat affected zone, strength increased with decreasing heat input rate

F. Effect of welding current on weldments properties in MIG and TIG welding [6]

This study includes investigation of the effect of electrical current on the weldment mechanical properties. Medium carbon steel & stainless steel were welded using two types of joints (single Lap joint and single v-groove Butt joint). The results showed a significant increase of welding temperature with current for TIG lap welding and an insignificant increase of welding temperature with current for MIG lap welding. The temperature values were in TIG weldments higher than from MIG weldments for all specimens' welded lap & butt types joints. The ultimate tensile strength values for weldments butt joint types was higher than from the lap joint types for all weldments welded by TIG welding

process. The amount of heat generated was for TIG welding process specimens higher than from MIG welding process specimens for butt and lap type joints

G. Mechanical characterization of dissimilar welded joint of SS202 and SS304 by tungsten inert gas welding [7]

The object of this paper is to investigate the mechanical properties and microstructure analysis of welded joint between SS202 and SS304 with two different filler metal SS308L and SS316L by tungsten inert gas welding

Following conclusions are carried out through this study,

- 1-Due to grain refinement and unique metal composition of welded joint fabricated by TIG process with filler SS308L exhibited higher strength value 488.61 MPa, whereas lower ultimate stress was found in base metal (SS202)
- 2-At high welding speed, there is chance of welding defects and improper penetration of weld metal tales place. Welding defect like porosity can drastically affect the properties of welded joint

H. A review on brazing parameters and the experiments used to analyze the parameters [8]

This paper presents the different parameters like Failure Mechanisms, interaction layers, wetability, brazing temperature and effect of different filler materials which affect the successful brazing of components and the different tests used to analyze the parameters. The paper concludes that The American Welding Society (AWS) defines brazing temperature of using a filler metal (solder) having a liquidus above 840°F (450°C), and below the solidus of the base metals. This paper provides an insight into the existing brazing techniques and the test methods, so that the researchers can easily understand some of the overall developments.

I. Investigation of TIG welding on dissimilar materials using nondestructive testing (NDT) and radiography testing (RT) [9]

The study analyzed the effect of TIG dissimilar welding processes Between 1)Aluminium and Mild Steel & 2)Copper and Mild Steel those material grade are AA2024-T3 grade Aluminium and 308L grade Mild Steel. It includes investigating the effect of filler material on weld quality, strength and hardness of the joint by silicon bronze and Copper Filler materials.

The result showed A Possible solution is obtained for the Welding of Aluminium and Mild Steel. The Welding Speed is Very low when Silicon Bronze filler rod is used in the TIG welding for Copper and Mild Steel, It can be replaced by the Copper Filler rod which has high Welding Speed.

J. Experimental study on influence of filler rods in gas tungsten arc welding [10]

Objective of this paper is to study the influence of filler rods used in TIG welding process as it considerably affects the welded structure and analyze which filler rods should be selected to best suit the welding process exclusively for joining Mild Steel plates. Two kinds of filler rods Mild steel of diameter 2.5 mm and Stainless steel of diameter 2 mm are used to find parameters like stress, strain and hardness.

The research concludes that First specimen MS (MS) sustain stress without failure due its similar crystal structure (BCC) on the other hand second specimen have failed within the lower stress range. Thus, to gain maximum strength of weld bead, welding should be done using similar metals with maximum solubility.

K. Comparative study of different filler materials on aluminum alloys using TIG welding [11]

This Paper is focused on the investigation of the effect of Aluminum filler materials, 4043 and 5356 on the mechanical properties like tensile strength, percentage elongation and bending strength. Three varieties of Aluminum 6061, 6063 and 6082 grades are considered as the base metals for welding. Argon inert gas environment is used during TIG welding process. Double V butt welded joint is considered for preparing the welding joints. Experiment includes 36 samples for testing to assessing the tensile strength, elongation and bending properties. In the tensile test observation carried out with 6061-5356 samples have the higher Tensile strength and the 6063 got the low tensile strength but higher elongation. In the bend test 6063-4043 got the highest bending angle, the load bearing capacity was highest for 6082-4043.

L. Weldability and process parameter optimization of dissimilar pipe joints using GTAW [12]

This study includes welding of dissimilar metals, carbon steel and stainless steel pipes which find wide application in the field of chemical, oil and petroleum industries. Carbon steel pipe specimen (A106 Grade B) and stainless steel pipe specimen (A312 TP 316L) of Ø6" ID, thickness 7.11mm and length 150 mm each were selected for the experiment. Taguchi method is used to formulate the experimental layout to rank the welding input parameters which affects the quality of the weld and is influenced by the parameters like gas flow rate followed by current and bevel angle.
In the Results tensile strength, gas flow rate, optimum range of shielding gas flow rent and bevel angel were discussed. It was also found that the weld and the SS base metal was free from susceptibility to IGC and also gave higher tensile strength for the heat input range mentioned above.

M. Optimization of TIG welding process parameters for welding of dissimilar metals taking SS-304 as base metal [13]

The study includes comparison of mechanical joints on the basis of ultimate tensile strength and hardness tests. Taguchi method was used primarily for optimizing the process parameters involved in welding of dissimilar joints. Mechanical joints obtained in the form of stainless steel- mild steel, stainless steel- carbon steel and stainless steel-stainless steel were used for the study. Ultimate tensile strength was used as major parameter to perform the optimization study. Analysis of variance (ANOVA) method was also used for performing the optimization study and study performed by Taguchi method was validated by using ANOVA method.

The study is focused on attaining optimized values of ultimate tensile strength (UTS) and vicker's hardness during dissimilar welding for three different samples. Taguchi and ANOVA approach has been used to analyze the problem. Main effect plots, ANOVA tables, Rank tables, are used to investigate the results from the collected data.

N. Analysis and experimental investigation of welding characteristics of SS304 and SS410 TIG welded material [14]

This experiment carried out on ss410&ss304 stainless steel plate are using tungsten inert gas process the argon gas are using panned of experiments stainless steel specimen of dimension 8cm width, 15cm length,5mm of thickness which have to plate same parameter of two grade demand for improved productivity of efficiency and quality pose of challenges to the welding industry. TIG welding gas are used argon wire feed speed. There are four type of testing tensile test, hardness test, impact test and salt spray corrosion test were performed and discussed.

O. Mechanical properties study of copper/stainless steel dissimilar weld joints [15]

The objective of the present investigation was to measure the mechanical properties of dissimilar weld joints of copper to stainless steel 304, fabricated using Tungsten inert gas (TIG) welding process. As-welded specimens were heat treated to a temperature of 650 °C for 1h, 2h and 3h. Tensile strength and micro hardness measurements were made to analyze the effect of post weld heat treatment on the mechanical properties of dissimilar weld joints of copper and stainless steel.

P. Gas tungsten arc welding of copper and mild steel [16]

In this paper, copper and mild steel were welded using a gas tungsten arc welding (GTAW) process. To determine the weldablity factor, tests are needed to provide information on mechanical strength, potential defects in structure, and nature of failure. Mechanical testing included transverse tensile tests, micro hardness tests, and bend tests. Mild steel and copper welded together using GTAW process. The tensile test, chemnical composition of structure and the average Vickers hardness for copper has been discussed.

Q. Modelling and optimization of process parameters for TIG welding of aluminium-65032 using response surface methodology [17]

The paper includes investigation of the effect of TIG welding process parameters on welding of Aluminium-65032. Response Surface Methodology was used to conduct the experiments. The parameters selected for controlling the process are welding speed, current and gas flow rate. Strength of welded joints were tested by a UTM. Percent elongation was also calculated to evaluate the ductility of the welded joint. The effect of TIG welding parameters like welding speed, current and gas flow rate on ultimate tensile strength and percent elongation in welding of Al-65032 has been studied. From the study it was observed that welding speed has the most significant effect on both UTS and percent Elongation followed by welding current. However gas flow rate has least significant influence on both UTS and percent elongation.

R. Experimental and investigation of A6061/SiCp/B4C by using TIG welding process [18]

The experiment and analysis on the fabricated composite material has been carried out in the study. The results of the composite material which is fabricated by using TIG welding process are results are explained. Fabricated composite material is tested by using brinell hardnes test and also the SEM analysis test has been taken to find out the microstructure of the reinforcement particles like boron carbide and silicon carbide.

S. Comparison of hardness and tensile strength of TIG and MIG welding using T. Stainless steel-202[19]

In this paper the study is done on welding technique (TIG or MIG) to find which welding technique is the best for stainless steel-202. The comparison is done on the basis of mechanical properties of the welded joint of TIG and MIG welding on stainless steel-202. It was observed that TIG welding has better in Tensile strength and hardness. It is found that the maximum hardness is found in TIG and the minimum hardness is found in MIG welded joint. The hardness pattern in the weld region in two welding processes is like, TIG > MIG and also the yield strength, ultimate tensile strength, and percentage elongation is also maximum in case of TIG.

U. Joining of dissimilar materials ss304 and copper plate using laser welding [20]

The research is based on experiments on laser welding of 2mm thick AISI 304L stainless steel and 2mm thick pure copper plate using the Nd:YAG laser machine. In this study, a statistical design of experiment (DOE) will used to optimize selected LBW parameters (laser power, welding speed and pulse duration). Taguchi approach is using to design the experimental layout. A statistical design of experiment (DOE) method taguchi approach with help of MINITAB software method will utilized to develop an effective model to optimize weld strength and weld geometry by incorporating process parameters such as welding speed, laser power and pulse duration. Tensile strength of joint is determined using a universal testing machine (UTM).

CONCLUSION

Based on the previous literature review we find out that so many researchers has carried out work done on following these welding parameters (Gas Pressure, Current, Voltage, Position, Groove angle, Gap between two plates, Different types of welded joints) and also work done on these mechanical properties like (tensile strength, Bending, elongation, hardness and fatigue limit and modulus of elasticity) in many different metals (Aluminium, Mild Steel, stainless steel , cast Iron, carbon steel and also work is done on dissimilar welding materials are (SS TO MS, Aluminium TO Mild Steel, Copper to Mild Steel, SS202 TO SS304, stainless steel to carbon steel) have been found. From all the above mentioned research papers and other studies it has been observed that there is a research gap. i.e., on the tig welding till right now dissimilar welding stainless steel and copper welding has not been performed and research about mechanical properties. Thus the research gap is observed now. and my future work is based on this research gap is continued.

REFERENCES

1. Panchal, K. "Experimental Investigation of TIG welding on Stainless steel and Mild steel Plates." *Journal of Emerging Technologies and Innovative Research (JETIR)* 3 (2016): 25-32.
2. Srivastava, Akash, et al. "Analysis of Welding Joints and Processes." *International Journal of Computer Applications* 6 (2016): 20-26.
3. Sayed, Aamir R., Yogesh V. Kumbhare, Nikhil G. Ingole, Parvin T. Dhengale, and Nainish R. Dhanorkar. "A Review Study of Dissimilar Metal Welds of Stainless Steel and Mild Steel by TIG Welding Process." *Int. J. Res. Appl. Sci. Eng. Technol.* 7 (2019): 370-373.
4. Ashwani Kumar, Sanghpriya Gautam, Yatika Gori, Pravin P Patil "DISSIMILAR MATERIALS WELDED SPECIMEN ANALYSIS USING FEA"jurnal of critical review 6 (2019)
5. Hussain, Ahmed Khalid, Abdul Lateef, Mohd Javed, and T. Pramesh. "Influence of welding speed on tensile strength of welded joint in TIG welding process." *International journal of applied engineering research* 1, no. 3 (2010): 518.
6. Hasan, Aysha Sh, Obed M. Ali, and Adnan M. Alsaffawi. "Effect of Welding Current on Weldments Properties in MIG and TIG Welding." *International Journal of Engineering & Technology* 7, no. 4.37 (2018): 192-197.
7. Keshari, Rahul Kumar, and Poshan Lal Sahu. "Mechanical characterization of dissimilar welded joint of SS202 and SS304 by tungsten inert gas welding." *Vol-3, Issue-4* (2019): 245-252.
8. Mathew, K. J. "A review on brazing parameters and the experiments used to analyze the parameters." *ijser*. (2013).
9. Sakthi S , Azhagunambi R "INVESTIGATION OF TIG WELDING ON DISSIMILAR METERIALS USING NON DESTRUCTIVE TESTING (NDT) AND RADIOGRAPHY TESTING (RT) " Vol-6 Issue-5 2020 IJARIIE
10. Saheb, Shaik Himam. "Experimental study on influence of filler rods in gas Tungsten Arc welding." In *AIP Conference Proceedings*, vol. 2166, no. 1, p. 020007. AIP Publishing LLC, 2019.
11. Rakesh, Mangalagiri, and T. Ravi Kumar. "Comparative Study of Different Filler Materials on Aluminium Alloys using TIG Welding."
12. Sathish, R., B. Naveen, P. Nijanthan, K. Arun Vasantha Geethan, and Vaddi Seshagiri Rao. "Weldability and process parameter optimization of dissimilar pipe joints using GTAW." *International Journal of Engineering research and applications* 2, no. 3 (2012): 2525-2530.
13. 1Sunil Patidar, 2Dheeraj Soni 1Research scholar, 2Assistant Professor "Optimization Of Tig Welding Process Parameters For Welding Of Dissimilar Metals Taking Ss-304 As Base Me" Publication Since 2012 Year 2020, Volume 8, Issue 4
14. RAMKI, S., and K. SHANMUGANANTHAM. "ANALYSIS AND EXPERIMENTAL INVESTIGATION OF WELDING CHARACTERISTICS OF SS304 AND SS410 TIG WELDED MATERIAL."
15. Yogesh Singla , Rakesh Joshi " Mechanical Properties Study of Copper/Stainless Steel Dissimilar Weld Joints" Modern Approaches on Material Science (MAMS) Published: March 10, 2020
16. Musa, S. Kalpakjian-SR Schmid-H. "Manufacturing Engineering and Technology." (2009).
17. Palani, P. K., and M. Saju. "Modelling And optimization of process parameters for TIG welding of Aluminium-65032 using response surface methodology." *International Journal of Enginnering Research and Applications* 3, no. 2 (2013): 230-236.
18. Subramani, N., Murali, V.A., 2017. EXPERIMENTAL AND INVESTIGATION OF A6061/SiCp/B4C BY USING TIG WELDING PROCESS. *International Research Journal of Engineering and Technology*, *4*(2), p.1921.
19. Kumar, Saurabh, and G. Ravi. "Comparison of Hardness and Tensile Strength of TIG and MIG Welding Using Stainless Steel 202." *International Journal of Scientific & Engineering Research* 4 (2017): 264.
20. PRANAMI, RAJKUMAR M., and MAYANK N. MADIA. "JOINING OF DISSIMILAR MATERIALS SS304 AND COPPER PLATE USING LASER WELDING."