IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 3, October 2024

Investigation of Friction-Striving Welded Joints of Comparable Aluminum Alloys

Ajay Kumar Verma, Roshan Kumar Sinha, Shubham Patra, Shyam Kumar Sharma, Panchanand Kumar Mandal, Vivek Kumar Yadav and Shivam Kumar

Department of Mechanical Engineering

K. K. Polytechnic, Dhanbad, India

Abstract: *The purpose of this project is to use friction stir welding (FSW) to fuse two identical aluminum alloys together and investigate the properties of the welded joints. Aluminum alloys are best welded by friction welding, a solid state joining technique. We can strengthen the welded region by adjusting the FSW parameters, such as tool feed, tool rotation speed, and tool design. The main benefits of friction welding are its solid state nature, low distortion, lack of melt-related flaws, and good joint strength—even for alloys that traditional welding methods deem unworkable. Additionally, because the process doesn't require filler, friction welded joints are free of filler-induced issues or faults. They also have low hydrogen contents, which is a crucial factor for welding steel and other alloys that are vulnerable to hydrogen damage. In this case, the feed, profile, and load are all held constant, but the tool's rotating speed is considered the variable parameter. To determine the efficiency of the weld, mechanical characterisation tests such as tensile, impact, and hardness tests would be performed on the specimens*

Keywords: friction stir welding

I. INTRODUCTION

A solid state welding technique called friction stir welding is carried out at temperatures below the alloy's melting point. The friction heating is produced by a specifically contoured spinning tool that passes across the joint line while the work parts are fixedly held in place. Friction heating is produced by the tool compressing the joint line through the joint line. By mechanically churning the hot, plastic material and crushing the joint line, the tool breaks up the oxide. The resulting joint has a finer grain structure than the base metal. The process of friction stir welding is renowned for its enhanced weld strength and modified grain structure. Because friction stir welding has fewer heat-affected zones than TIG and other traditional welding techniques, it is recommended above other conventional welding procedures. In actuality, TIG is a very traditional welding technique that has been around for at least 60 to 70 years. It is employed to combine metals that produce extremely stable oxides with a high melting point that are more challenging to remove using liquid slag. Friction stir welding, on the other hand, is a non-fusion method that removes unwanted and needless metallurgical changes during melting and cooling. While maintaining all other parameters, the project entails welding the specimens AA2024 and AA6061 at two distinct tool rotating rates. Because of its low density and passivation phenomenon, aluminum is a remarkable metal that resists corrosion. Aluminum and its alloys are used to make structural components that are essential to the aircraft sector as well as other transportation and structural material applications. In the present world, welding aluminum alloys is of utmost importance.

II. METHODOLOGY

The following examples show the methods we used for our project on friction stir welding parameter optimization for dissimilar aluminum alloys.

NEED FOR STUDY

Why Friction Stir Welding…...?

- No consumables & no prior surface cleaning are required
- Good mechanical properties are obtained
- Can be done in simple CNC and lathe machine.

Why Optimization…..?

- To find best process parameters to attain high tensile strength in the welded area in friction stir welding.

Why Aluminium alloys…...?

- Most abundant metal.
- High S-W ratio than other materials.

III. MATERIAL SELECTION

Our project uses two different aluminum alloys as its material. The following were the main factors taken into account when choosing the materials: 1. Applications: Determined by the ways in which the item can be applied in the current situation. 2. Tensile strength: To produce novel properties, the materials chosen should have contrasting or differing tensile strengths. 3. Corrosive resistance: The materials are chosen because they may be welded together to create intermediate properties by joining two regular materials.

TOOL SELECTION

The base metal chosen determines which tool is used. The instrument should be more durable and strong than the materials it is made of. In our experiment, three different kinds of tools were tried and tested: Cylindrical Tool: A cylindrical-profiled tool is utilized in the friction stir welding procedure. It is thought to have a straightforward design. Tool with a cylindrical shape and V-thread: this type of tool is utilized in the friction stir welding process. Tapered Threaded tool: the tool used in friction stir welding has a tapered profile. It has a 15-degree taper angle.

IV. FRICTION STIR WELDING PROCESS

The materials and equipment chosen for the procedure are used to complete the welding operation. Tool rotational speed is changed during the operation, but other parameters such as tool profile, load, and transfer speed remain fixed.

A metallic or metallic solid solution compound consisting of two or more elements is called an alloy. Alloys in complete solid solution have a single solid phase microstructure, whereas alloys in partial solution have two or more phases that, depending on the history of thermal heat treatment, may or may not be uniformly distributed. As table 1.1 illustrates, alloys typically have distinct properties from their constituent elements.

Table 4.1: Various types of available alloys

Aluminumalloys	Indium alloys	Potassium alloys
Bismuth alloys	Iron or ferrousalloys	Rare earth alloys
Cobalt alloys	Lead alloys	Silver alloys
Copper alloys	Magnesiumalloys	Tin alloys
Gallium alloys	Mercury alloys	Titanium alloys
Gold alloys	Nickel alloys	Titanium alloys
Zinc alloys	Zirconium alloys	

Any alloy can be welded with any other alloy, which is one of FSW's main benefits. Therefore, ferrous and nickel alloys are used to achieve the necessary goal of welding dissimilar alloys. Aluminum and its alloy versions are the main materials that are welded using this procedure.

ALUMINIUM ALLOYS

Alloys with aluminum (Al) as the main metal are known as aluminum alloys. The elements that are commonly used in alloying are silicon, zinc, manganese, copper, and magnesium. Casting alloys and wrought alloys are the two main types, and both are further separated into heat-treatable and non-heat-treatable alloys. The elastic modulus of aluminum alloys is normally around 70 GPA, which is around one-third that of the majority of steel and steel alloys. Ever since metal-skinned aircraft were introduced, alloys made primarily of aluminum have played a significant role in the aerospace industry.

IJARSCT ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53 Volume 4, Issue 3, October 2024

FRICTION STIR WELD TOOL

For FSW applications, a tool must be able to tolerate high z- and x-axis loads at temperatures between 900 and 1000°C. The tool needs to sustain high abrasion resistance and consistently produce weld characteristics. Localized heating and material flow are the two main purposes of the instrument. The friction between the pin and the work piece is the main cause of the heating during the first stage of tool plunge. Deformation of the material causes some extra heating. The tool is dipped till the work piece is touched by the shoulder. The largest source of warmth is caused by friction between the work piece and the shoulder. The relationship between the pin and shoulder is significant from a thermal perspective. Furthermore, the other design elements are not essential.

TOOL DESIGN

The tool's design is crucial since a well-made tool can increase the maximum welding speed as well as the quality of the weld. At the welding temperature, the tool material should be strong, durable, and hard-wearing enough. In order to reduce heat loss and thermal damage to the machinery further up the drive train, it should also have a low thermal conductivity and good oxidation resistance. The most important factor in process development is tool geometry. The traverse rate at which FSW may be performed is determined by the tool shape, which is crucial to material flow.

The standard dimensions of the tool are,

Shoulder diameter : 18 mm

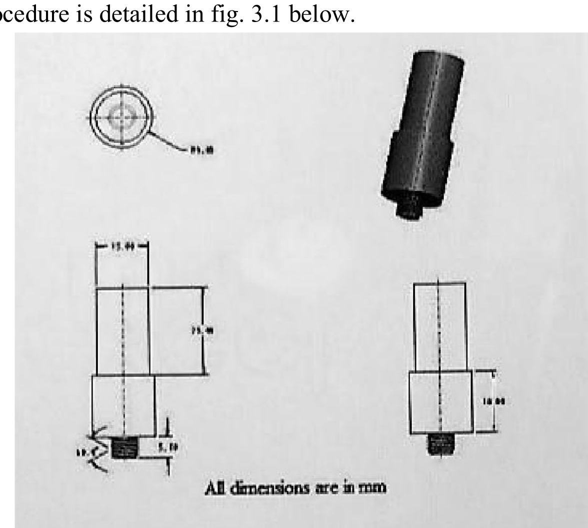
Shoulder length : 18 mm

Pin diameter : 6 mm

Pin length : 5.7 mm

WELDING EXPERIMENTATION PROCESS

Cutting the aluminum work pieces to the proper proportions is the first step in the friction welding experimentation procedure. Following cutting, each piece from each aluminum alloy is chosen, and welding is completed. The specific procedure is detailed in fig. 3.1 below.



Cutting the aluminum work pieces to the proper proportions is the first step in the friction welding experimentation procedure. Following cutting, each piece from each aluminum alloy is chosen, and welding is completed.

PROCESS DETAILED :-

1. The work piece of dimensions 100*50*6mm is cut on AA2024 and AA6061 Using power axe saw.
2. Then the work piece is milled to the tolerance limits.
3. Then the work piece is milled to the tolerance limits.
4. Then the work piece is milled to the tolerance limits.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, October 2024

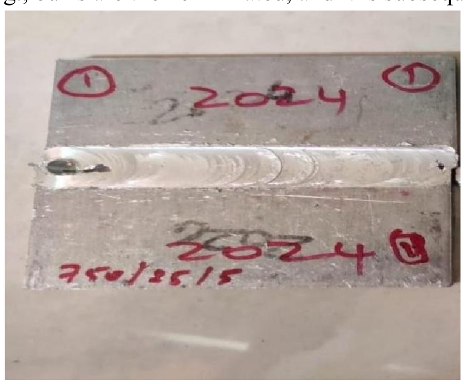
5. The work piece is mounted firmly on the bed and checked for flatness.
6. The CNC program is fed into the control panel of the machine.
7. The suitable collect size is chosen for the tool.it is then fitted to the CNC spindle.

Two experiments are conducted by altering the tool's rotational speed at two distinct levels. The four experiments and the assessed parameters are listed below:

SI. NO	MATERIAL	SPEED (rpm)	FEED (mm/min)
1	2024	750	25
2	2024	1250	25

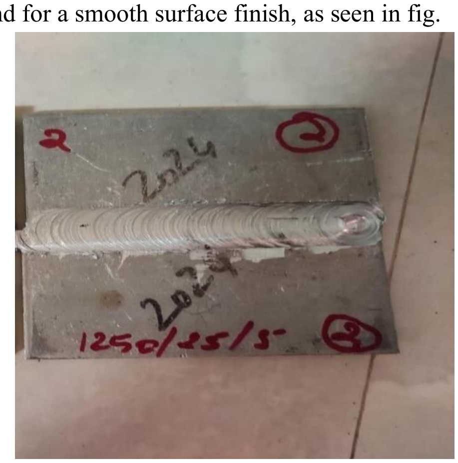
EXPERIMENT 1 (2024, 750rpm, 25 mm/min, CYLINDER THREADED (CT) TOOL)

The feed is chosen at 25 mm/min, and the speed is set at 750 rpm.The cylindrical threaded type of tool was selected for this experiment. The tool is moved along the connecting axis of the two aluminum alloys for the necessary parameters to complete the process. As seen in fig., burrs are then eliminated, and it is subsequently ground for a smooth surface.



EXPERIMENT 2 (2024, 1250 rpm, 25 mm/min, Cylindrical Threaded (CT) Tool):-

The feed is chosen to be 25 mm/min, and the speed is set at 1250 rpm. The cylindrical threaded type of tool was selected for this experiment. The tool is moved along the connecting axis of the two aluminum alloys to complete the process. For the necessary conditions, friction welding is thus performed in the aluminum alloys. Following the physical removal of burrs, it is ground for a smooth surface finish, as seen in fig.



IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 3, October 2024

V. CONCLUSION

1. Thus, friction stir welding process has been successfully carried out on dissimilar aluminum alloys of AA2024 and AA6061.
2. The welding and mechanical properties of these dissimilaralloys are examined.
3. The best parameters for the speed, feed and tool profile are chosen among 3 levels. It is found out using Taguchi method.
4. For the best hardness nature of the welded area, the suitable parameters are 1400rpm, 20mm/min and cylindrical threaded tool profile.
5. The percentage contribution of speed is 50%, feed rate is 44.5% and tool profile is 46.8% for the hardness property using ANOVA.
6. For the best tensile nature of the welded area, the suitable parameters are, the suitable parameters are 1000rpm, 20mm/min and square tool profile.
7. The percentage contribution of speed is 76.8%, feed rate is 77.3% and tool profile is 31% for the hardness property using ANOVA.
8. From the experiment carried out, we conclude that speed is the major factor influencing the mechanical properties like tensile strength and hardness.
9. The best parameters are given by experiment and theoretical work. This can applied for friction stir welding of AA5052 and AA6061 in aerospace and marine applications.

REFERENCES

[1] R.S. Mishra (2005), ‘Friction stir welding and processing’ acentres for friction stir processing, department of materials science and engineering,university of Missouri.

[2] Z.Y. ma (2005), ‘friction stir welding process’ department of material science, Missouri, US.

[3] Alexander goloborodko and Tsutomu Ito (2004), ‘friction stir welding of a commercial 7075-T6 aluminium alloy’ research centre for super plasticity, faculty of engineering, Ibaraki University, Japan.

[4] Meilinger and Imre Torok (2012), ‘The Importance of friction stir welding tool’ Department of mechanical Technology, University of Miskolc.

[5] Wayne Thomas (2006), ‘Advances in tooling materials for friction stir welding’ journal of welding technologies, TWI Cambridge.

[6] Ahmed Khalid Husain, Syed Azam Pasha Quadri (2010), ‘evaluations of parameters of friction stir welding for aluminium AA6351 alloy’.

[7] R. Madhusudhan, M.M. Sarcar, N. Ramanaiah (2013), ‘An experimental study on mechanical and microstructural properties of dissimilar aluminium alloy friction stir welds’.

[8] A. Pradeep, S. Muthukumaran (2013), ‘An analysis to optimize the process parameters of friction stir welded low alloy steel plates’.

[9] Mr. A. Gopi Chand and John Buyan.V (2013), ‘Application of Taguchi technique for friction stir welding of Aluminium alloy AA6061’, International journal of engineering and technology.

[10] Sato, Y., Urata, M., Kokawa, H., Ikeda, K., 2003. Hall–Petch relationship in friction stir welds of equal channel angular-pressed aluminium alloys, Material Science and Engineering 354 (1–2), p. 298–305