FRICTION STIR WELDING OF ALUMINIUM ALLOY (6063 AND 5052) USING MILLING MACHINE

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ABSTRACT

Friction stir welding (FSW), a solid-state joining technique, is being extensively used in similar as well as dissimilar joining of Al, Mg, Cu, Ti, and their alloys. In the present study, friction stir welding of two aluminium alloys—AA6063 and AA5052—was carried out at various combinations of tool rotation speeds and tool transverse speeds. The transverse cross-section of the weld was used for optical as well as electron microscopy observations. The microstructural studies were used to get an indication of the extent of material mixing both at the macro- and microscales. It was observed that, at the interface region, both materials exhibited similar texture despite the non rigorous mixing of the materials in the nugget. The extent of inter diffusion of alloying elements at the interface was studied using electron probe microanalysis. The tensile testing evaluation of these specimens showed good mechanical properties. The inter diffusion of alloying elements and development of similar orientations in the nugget could have contributed to the better tensile properties of the friction-stir-welded AA5052-AA6063 specimens.

Keyword : *Friction Stir welding, Temperature, Tool Material, Tool geometry*

1.Introduction

Friction stir welding was invented by The Welding Institute (TWI) in December 1991. TWI filed successfully for patents in Europe, the U.S., Japan, and Australia. TWI then established TWI Group-Sponsored Project 5651,"Development of the New Friction Stir Technique for Welding Aluminum," in 1992 to further study this technique .Friction stir welding (FSW) is a relatively new joining process that has been used for high production since 1996. Because melting does not occur and joining takes place below the melting temperature of the material, a high-quality weld is created. This characteristic greatly reduces the ill effects of high heat input, including distortion, and eliminates solidification defects. Friction stir welding also is highly efficient, produces no fumes, and uses no filler material, which make this process environmentally friendly

2.METHODOLOGY OF FSW PROCESS

In this process, a cylindrical-shouldered tool witha profiled threaded/unthreaded pin is rotated at a constantspeed and fed at a constant traverse rate into the joint linebetween two pieces of plate material, which are buttedtogether. The parts to be clamped rigidly onto a backingbar in a manner that prevents the abutting joint faces frombeing forced apart. The length of the pin is slightly lessthan the weld depth required and the tool shoulder shouldbe in intimate contact with the work piece surface. The pinis then moved against the work piece or vice-versa.Frictional heat is generated between the wear resistantwelding tool shoulder and pin, and the material of thework pieces. This heat along with the heat generated bythe mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to softenwithout reaching the melting point. As the pin is moved inthe direction of welding the leading face of the pin,assisted by a special pin profile, forces plasticized materialto the back of the pin whilst applying a substantial forgingforce to consolidate the weld metal. The welding of thematerial is facilitated by severe plastic deformation in thesolid state involving dynamic recrystallization of the basematerial. The welded joints will be sliced using powerhacksaw and then machined to required dimensions,American Society for Testing of Materials (ASTM E8M04)guidelines should be followed for preparing the testspecimens.

3.LITERATURE REVIEW

In this section the detailed literature review of the friction stir welding was done and experimentation of FSW with parametric study of aluminium and its alloy is carried out.M.K. Sued, D. Pons, J. Lavroff, E.H. Wong propose the design features for bobbin friction stir welding tools also explains the features for bobbin friction stir welding tool and developed with linking it with physics of the process of FSW production process for obtaining the effects of bobbin friction stir welding tool having different pin structures were tested effectively. R.S. Mishra and Z.Y. Maworks on worked mainly on the aluminium alloys with some process parameters also gave the main points results that, the mechanisms are responsible For the formation of welds and microstructural refinement and also effect of process parameters on the microstructure of the base metals & joints. Also a lot work had been done on the tool design parameters for FSW. Kudzanayi Chiteka, explains tool material selection is an important task which helps to determine the weld quality produced. The tool material selection affects the tool operational parameters like temperature generation, speed of welding, tool wear property etc. The study gives the analysis of tool materials that can be used successfully for the process . R. Rai, A. De, H.K.D.H. Bhadeshia and T.DebRoyhad given the information about the feasibility of the FSW for harder alloys such as titanium steels etc. Also they explained that the performance of the tools are totally depends on the selection ofmaterial and also the design of the process[4].Y. N. Zhang, X. Cao, S. Larose and P. Wanjara, done the Review of tools for friction stir welding and processing, in this review the FSW/P tools are briefly summarised in terms of the tool types, shapes, dimensions, materials and wear behaviours. Friction stir processing (FSP), a variant of FSW, has been developed to manufacture composites, locally eliminate casting defects, refine microstructure and/or improve the associated mechanical and physical properties including strength, ductility, fatigue, creep, formability and corrosion resistance. The literature review got some points regarding the FSW and the joining the aluminium alloys. So the FSW is selected for joining of aluminium alloys with studying some of experimental parameters. The parameters are selected for the process and also we will experiment it on conventional milling machine for cost reduction and also successful welding operation can be done. The alloy of aluminium selected for the trials is AA5052 and AA6063in the form of plates having thickness of 4 mm and conduct the number of trials.

4.SELECTION OF MATERIAL AND TOOL

In the process of friction stir welding the material selection is basic part. From the literature review, there are large number of materials were used for this process. From the various alloys of aluminium the AA6063 and AA5052 is selected. It is available in the round bars and sheets also. As per the availability of the material in the market, we select the desired aluminium alloy i.e. AA6063 and AA5052 with 4mm thickness. The long strips of AA6063 and AA5052 were bought and cut it as per the various sizes of various dimensions as per the setup requirement.

Also in part of material selection one more selection is important for the process is the tool material selection. It is very important parameter for the process. While selection of the tool material we have to consider the effects observed on the tool during the process. Mainly we have to consider the effect of heat generation and dissipation on the tool material. To produce good quality of weld, it is required that the tool material is to be select properly.

There are various characteristics of the material which can be choosing as the tool material is as:

• Resistance to wear.

• No harmful reactions with the weld material.

• Good strength, dimensional stability& creep resistance.

• Good thermal fatigue strength to resist repeated thermal cycles.

• Low coefficient of thermal expansion.

• Good machine inability.

5.DESIGN OF TOOL

LENGTH OF THE TOOL:75MM

DIAMETER OF THE TOOL:20MM

DEPTH OF CUT:3.8MM

TEST SPECIMEN OF ALUMINIUM ALLOY THICKNESS:4MM

6.**EXPERIMENTAL SETUP**

VERTICAL MILLING MACHINE

SPECIMEN FIXED IN FIXTURES

7.EXPERIMENTAL OUTCOME

SIMILAR ALUMINIUM ALLOY AA5052

SIMILAR ALUMINIUM ALLOY AA6063

DISSIMILAR ALUMINIUM ALLOY AA6063 AND AA5052

8.TESTING OF FSW MATERIAL

ROCKWELL HARDNESS TEST

The Rockwell test is generally easier to perform, and more accurate than other types of hardness testing methods. The Rockwell test method is used on all metals, except in condition where the test metal structure or surface conditions would introduce too much variations; where the indentations would be too large for the application; or where the sample size or sample shape prohibits its use. The Rockwell method measures the permanent depth of indentation produced by a force/load on an indenter. First, a preliminary test force (commonly referred to as preload or minor load) is applied to a sample using a diamond or ball indenter. This preload breaks through the surface to reduce the effects of surface finish. After holding the preliminary test force for a specified dwell time, the baseline depth of indentation is measured.

SUMMARY OF TESTING RESULTS

Parameters	**Sample 1**	**Sample2**	**Sample3**
Total Weld Depth (mm	3.8mm	3.8mm	3.8mm
crack	observed	Not observed	Not observed
Blow holes	Not observed	Not observed	Not observed
Heat affected zone	observed	observed	observed
Tensile strength	28	25	27
Rockwell Hardness	36	28	58

9.RESULT AND DISCUSSION

After this experimentation, various points are come out from the operation of FSW and testing of welded joints.

- The pin diameter and shoulder diameter are increased with the increase in thickness of the plates or specimen undergoing the process of FSW.
- The speed of the tool is one more important parameter to be selected for the process. It is selected as per the thickness of the plates and diameter of the tool. Also suitable higher speed helps to generate higher temperature which is important requirement for the FSW process.
- Also for the effective welding process the suitable higher temperature should be created during the process, so that weld quality is to be increased. The higher speed of the tool give more better quality of the weld aesthetically. As the temperature reaches to its high range the quality of weld increased i.e. quality of weld directly proportional to the temperature created during the process.
- As the tool pin length is more plunge depth of tool in to the workpiece is more. It will take more area of swirling action of material which results in the better mixing of material to each other and weld become stronger. So that when the thickness of the plate increases the tool diameter and length of the tool get increases simultaneously. But it should not exceed the thickness of the plate.
- The clamp and support arrangement acts as a heat sink that dissipates heat. The clamped side may become more hardness value and lower tensile strength.

10.CONCLUSIONS

After the study of Experimentation of friction stir welding of aluminium alloys some of the good points were came out. There are also some other points that also taken in to consideration for the extra work to be done. The some of concluded points regarding this study as:

- The process cost gets minimized automatically as the experimentation is done within the available tools and machines.
- The health hazards are decreased to zero whether the fusion welding has many health hazards affected on operator due to ultraviolet rays, also production of harmful gases during the process.
- With the use of conventional milling machine the FSW can carried out successfully for the materials for those fusion welding is not possible.
- Use of backing plate to specimen gives the support and useful to avoid the movement of the plates during the process. Also it helps to form good weld and also it decreases gap on the back side of the welded plate.
- The speed of the tool should be more as possible higher speed can be achieved on the machine. As the higher speed of the tool causes good weld quality and also increase the strength due good mixing Of material of both the plates.
- The welding joints test shows us that there is good weld penetration in to all four trials. That means the joints get successfully done with heat affected zone is observed at all the joints. And also within the heat affected zone the grain structure viewed as elongated

11.LIMITATIONS

- Heat affected zone is more for this process.
- The tool cost of this process is increases because of one or two time use of the tool for single weld is possible and the tool must be changed for the next weld

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