International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

A Review on Friction Stir Welding

Rajmane Sarojini[1], Patil Prerana[2], Devakar Pravin[3], Dombale Sukhadev[4], Jangam Vaibhav [5]

[1,2,3,4,5]Department of Mechanical Engineering, NMCOE Peth (India)

ABSTRACT

Friction stir welding (FSW) is a solid-state joining process. This joining technique is energy efficient, environment friendly, and versatile. The principal advantages are low distortion, absence of melt related defects and high joint strength. In FSW parameters play an important role like tool design and material, tool rotational speed, welding speed and axial force. The paper focuses on process parameters that in required for producing effective friction stir welding joint.

Keywords: Friction Stir welding, 6061 aluminum alloy, tool rotational speed, welding speed, tensile strength.

I.INTRODUCTION

Friction Stir Welding (FSW) is a solid state welding process in which the material that is being welded does not melt and recast. In this process to join materials by generating frictional heat with help of abrasive action between a rotating tool and materials being welded. It was firstly introduced in 1991, The Welding Institute (TWI), Cambridge (U.K.). Since then FSW mostly used in the aerospace, railway and ship building industries especially in the fabrication of aluminum alloys. It is difficult to weld the aluminum alloys, using arc welding, gas welding and other welding processes. Friction Stir Welding on the other hand, can be used to join most Al alloys and it gives the better surface finish.

As the FSW process does not release toxic acids or fumes, it is an environment protective process. No consumable filler material or edge preparation is normally necessary. The distortion is significantly less than that caused by arc fusion welding techniques. By welding Aluminum alloys by fusion welding process there is possibility of cracks, porosity, alloy segregation and hot cracking and the fusion welding process completely alters microstructure and varies the mechanical properties [1].

Friction stir welding process uses a non-consumable rotating tool consisting of a pin extending below a shoulder that is forced into the adjacent mating edges of the work pieces. The heat input, the forging action and the stirring action of the tool induces a plastic flow in the material, forming a solid state weld. During FSW, a welding tool, which consists of a shoulder and a specially designed pin, is plunged into the plates to be welded, while rotating and advancing at a welding speed along the joint line until the plates have been butted together.

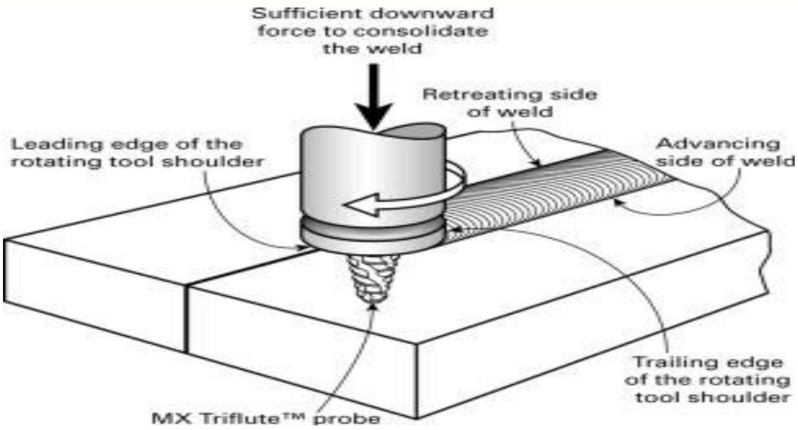

Fig1.Principle of operation [2]

II.LITERATURE SURVEY

2.1 As the FSW process does not release toxic acids or fumes, it is an environment protective process. No consumable filler material or edge preparation is normally necessary. The distortion is significantly less than that caused by arc fusion welding techniques. By welding Aluminum alloys by fusion welding process there is possibility of cracks, porosity, alloy segregation and hot cracking and the fusion welding process completely alters microstructure and varies the mechanical properties By FSW both similar and dissimilar materials can be successfully joined.

2.2 FSW consistently gives high quality welds , proper use of the process and control of a number of parameter is needed to achieve this .A key factor in ensuring weld quality is the use to appropriate tool and welding motion

2.3 Modern structural application demands reduction in both the weight and as well as cost of the fabrication and production of materials. aluminum alloys are the best choice for the reduction of weight, cost and replacing steels in many applications and Friction Stir Welding (FSW) process efficient and cost effective process. FSW is solid state welding process in which material is not melted during welding process so it overcomes many welding defects compared to conventional fusion welding process which is initially used for low melting materials. This process is initially developed for low melting materials like Aluminum, Magnesium, Zinc but now process is useful for high melting materials like steel and also for composites materials. The present study describes the effect of FSW process involving butt joining of similar Aluminum alloy combinations of AA6351 with AA6351 and dissimilar Aluminum alloy combinations of AA6351 with AA5083 on the tensile, hardness and impact behavior.

2.4 Friction stir welding (FSW) is the latest technology in the area of metal joining and is perhaps the most promising of all the welding processes. A lot of research has been carried out in this area but most of the initial work has been done on low temperature softening materials like aluminum alloys. Friction Stir Welding (FSW) has become a major joining process in the railway, aerospace, auto industries and ship building industries especially in the fabrication of aluminum alloys. The process uses a spinning non-consumable tool to generate frictional heat in the work piece. This paper looks at the review, on friction stir welding process, various welding variables like tool rotation, transverse speed, tool tilt ,plunge depth and tool design, for the welding of aluminum alloys or various dissimilar alloys.

2.5 In FSW the interaction of a non-consumable and rotating tool with the work pieces being welded, creates a welded joint through frictional heating and plastic deformation at temperatures below the melting temperature of the alloys being joined. Based on friction heating at the contacting surfaces of two sheets to be joined, a special tool with a properly designed rotating probe travels down the length of contacting metal plates, producing a highly plastically deformed zone through the associated stirring action.

2.6 Solid state joining technique, in Friction stir welding a third body contact by tool will generate the additional interface surfaces and finally all the surfaces are coalesced with each other by applied pressure and temperature and form solid state weld. This review paper addresses the overview of Friction stir welding which includes the basic concept of the process, microstructure formation, influencing process parameters, typical defects in FSW process and some recent applications.

III.METHODOLOGY

3.1 Work piece material

The composition and mechanical properties of AA6061 aluminum alloys is given in Tables 1a and 1b, respectively.

Table-1a. Chemical composition of aluminum alloy.[1]

Al Alloy	Si	Fe	Cu	Mn	Mg	Cr
6061	0.4-0.8	0.7 max	0.15-0.4	0.2-0.8	0.8-1.2	0.15-0.35

Table-1b. Mechanical properties of base metal.[1]

Tensile strength (MPa)	Yield strength (MPa)	% Elongation	Hardness
283	235	26.4	105

IJARSE
ISSN: 2319-8354

3.2 Tool material

The Friction stir welding required specially designed tool. Tool material will be required harder than work piece material and also high melting point The material of the tool is H11 tool steel. A non consumable high-speed steel tool is used for fsw process.

3.3 Welding Parameters

Welding Parameters For this study following parameters are mainly considered. They are

1. Axial Load (AF)

2. Transverse Speed (TS)

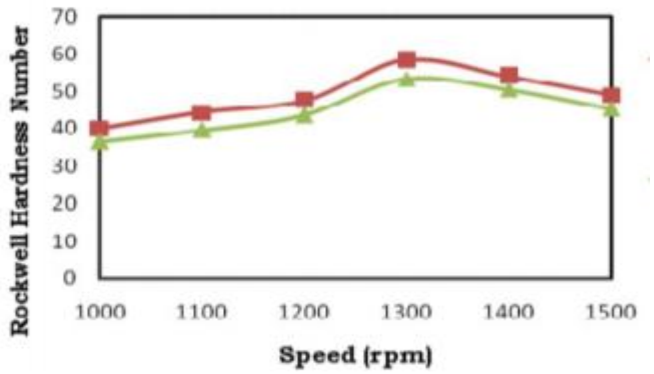

Fig.2. Effect rotational speed of the tool on Rockwell Hardness Number[3].

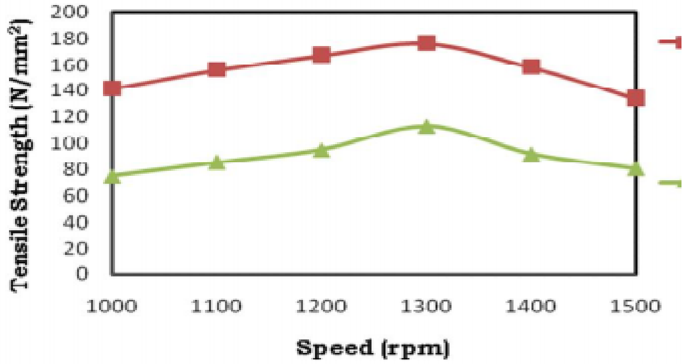

Fig.3. Effect rotational speed of the tool on tensile strength[3]

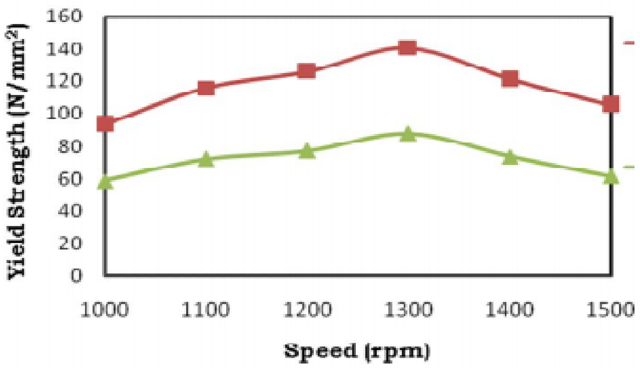

Fig.4. Effect rotational speed of the tool on yield strength.[3]

Table 2: Main process parameters in friction stir welding.[4]

Parameter	Effects
Rotation speed	Frictional heat, “stirring”, oxide layer breaking and mixing of material
Tilting angle	The appearance of the weld, thinning
Welding speed	Appearance, heat control.
Down force	Frictional heat, maintaining contact conditions

IV. EXPERIMENTAL SETUP

4.1Working Setup

We chosen for the project work material is AA 6061 Aluminum Alloy plates (125mm X 50mm X 5mm) in the annealed and solutionized and aged conditions. The Friction stir welding required specially designed tool. The material of the tool is H11 tool steel. A non consumable high-speed steel tool is used for welding 6061 Al alloy having the shoulder diameter of 10 mm and the tool has probe (tool pin). The tool has frustum shaped probe with threads. Probe diameter is varied from 5 mm to 3 mm. The diameter of the shoulder is 10 mm. The FSW tool was subjected to heat treatment to improve its hardness. The hardness of tool after heat treatment is around 54 HRC. The FSW is carried out on a CNC milling machine[1].

The plates are positioned in the fixture, which is prepared for fabricating FSW joints by using mechanical clamps so that the plate will not be separated during welding. To test the mechanical performance of the welding, tensile strength is measured.

The welding parameters will be the increase in tool rotational speed, coarse grain structure is produced, which resulted in low ultimate tensile strength and low impact strength. On the other hand high welding speed results in low heat input which improves the cooling rate, leaving a fine grained structure. This in turn increases ultimate strength and increases impact strength. With the increase in rotational speed, rate of heat input increases, which results in coarse microstructure, which in turn decreases the hardness. But at the same time increase in welding speed lowers the rate of heat input results in higher cooling rate and fine microstructure. Fine microstructure results in increased hardness [5].

Fig5. Machine setup

4.2 FSW Tool Design

FSW tool is considered as a heart of the welding process which has two primary parts namely shoulder and pin, which heats the work piece material by friction. Shoulder part of the tool frictionally heats the portion of the work piece and induces the axial downward force for welding consolidation. Three types of shoulder end surfaces are normally used, flat, convex, concave shoulder end. Shoulder end surfaces can also have features like scrolls, ridges, knurling, grooves and concentric circles in order to increase the weld quality and material mixing . Probe is the part of the tool which is inserted in to the work piece by axial force which shears the material in front of the tool and moves the same behind the tool . Probe end shape may be made as a flat (or) domed surface. Flat surface increases forge force during plunging, whereas domed one reduces the forge force. Probe outer shape may be made as cylindrical and tapered with or without threads, flutes[6].

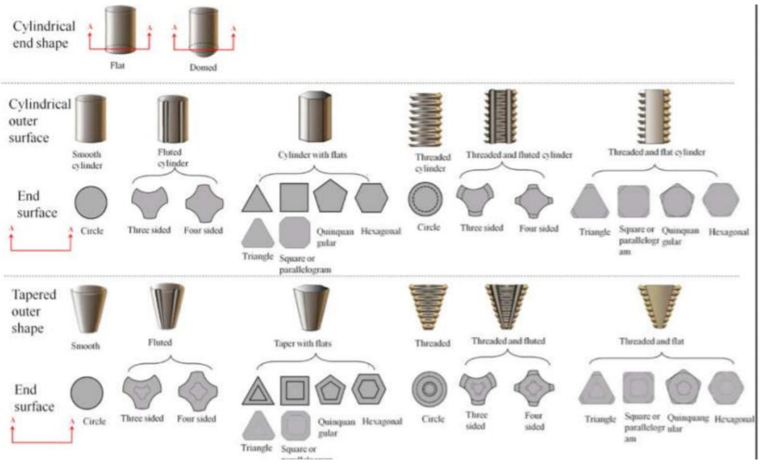

Fig. 6.The different shapes of the probe [5]

V.CONCLUSION

So it can be conclude that it friction stir welding has been used as a successful welding technique for joining all hard materials as well as metal matrix composites in addition to aluminum. This is possible because, joining is established by means grain crystalline microstructure achieved which will also lead to increase in mechanical properties. The number of parameters required to control is less and which can be easily controlled in joining. Machine controllable parameters are having direct proportional relation with mechanical properties except welding speed.

REFERENCES

[1] Indira Rani M, Marpu R.N.and A.C.S.Kumar "A Study of process parameters of friction stir welding AA6061 AL alloy in o and T6 condition. " ARPN journal of engg. and applied science. Vol.6, No.2, February 2011, Page No 61-66.

[2] Wayne M. Thomas, Keith I. Johnson, Christoph S. Wiesner."Fristion Stir Welding – Recent development in tool& process Technologies" Advanced Engineering Materials 2003.

[3] G.Gopala Krishna , P.Ram Reddy, M.Manzoor Hussain. "Mechanical Behaviour of Friction Stir Welding Joints of Aluminium alloy of AA6351 with AA6351 and AA6351 with AA5083." International Journal of Engineering Trends and Technology (IJETT) – Volume 10 Number 4 - Apr 2014

[4] G.C.Jadhav1, R.S.Dalu2." Friction Stir Welding – Process Parameters and its Variables: A review" International Journal Of Engineering And Computer Science ISSN: 2319-7242 Volume 3 Issue 6 June, 2014 Page No. 6325-6328

[5] Avtar Singh, Preet mohiner sandhu, Gurvinder Singh, Bharat kumar Girdhar " Effect of rotational speed on tensile strength and micro hardness of friction stir welding AL2014 and AL5083 AL alloy. " Internation journal of advance research in science and engineering Ijares, Vol.No.-9,A September 2013

[6] A.Suresh Babu, C. Devanathan. "An Overview of Friction Stir Welding." InternatIonal Journal of research In MechanIcal engIneerIng & technology , Vol. 3, May - 2013