A BRIEF REVIEW: OUTCOME O F PROCESS PARAMETERS ON FRICTION STIRWELDED ALUMINUM ALLOYS

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Abstract

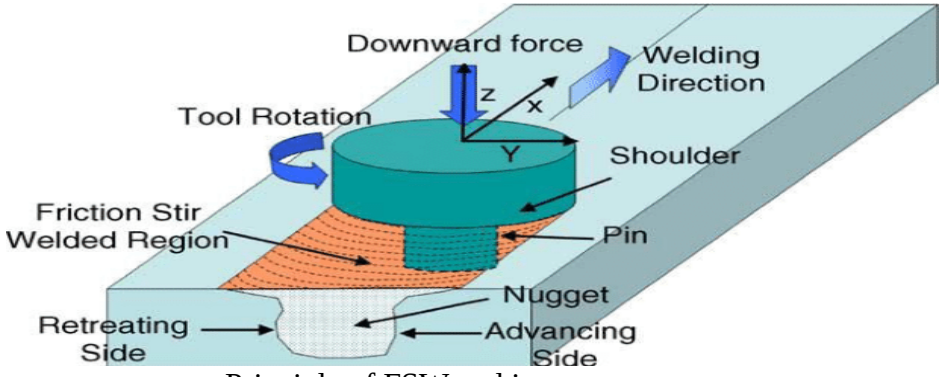
An effort has been worked out to summarise most of the aspects of FSW (friction stir welding) process and the effect of process parameters of this welding technique on mechanical as well as microstructural behaviour of aluminium alloys. The variations in the process parameters discussed in this review paper are: variation of the downward force, rotational speed of the tool, traverse speed and working conditions. The setups used in majority of places consist of vertical milling machines. The value of thermal co-efficient of expansion for the filler metal sheet must lie between the values of the thermal expansion coefficients of the materials of the sheets to be joined.

Keywords: Aluminium Alloys, Friction stir welding, The effect of FSW process parameters, Traverse speed

1. Introduction

Friction stir welding (FSW) is a solid-state welding process that gained much attention in research areas as well as manufacturing industry since its introduction in 1991.For almost 20 years; FSW has been used in high technology applications such as aerospace to automotive till high precision application such as micro welding. Friction Stir Welding is a solid-state thermo-mechanical joining process (a combination of extruding and forging) .FSW is a novel green manufacturing technique due to its energy efficiency and environmental friendliness, in this process a cylindrical tool is rotated and transverse along a square butt to milling technique. The frictionally heated material around the tool pin is plastically deformed and extruded to the back of the pin where it formed and forms the weld

The majority of the heat generated from the friction, i.e., about95%, is transferred into the work piece and only 5% flows into the tool (Ref. 1). The maximum temperature created by the FSW process ranges from 80 to 90% of the melting temperature of the material being welded FSW offers several advantages over conventional fusion welding process due to its low heat input and absence of melting and solidification process.



Principle of FSW and its process parameters

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2. Literature review:

Motalleb-nejad et al.The significance of the word "stir" in friction stir welding is that the probe of a harder material than the specimens to be joined causes a stirring action in the material at the joint and thus highly plasticising the material to a point at which the complete joint is created. [1].

P. Karthikeyan et al. studied the relation between welding and the hardening parameters of friction stir welded aluminium. It has been discussed that how varying the parameters in friction stir welding, the different values of hardness for the joint could be achieved. The verification has been done by universal tensile strength (UTS) testing and the Izod impact testing. A model of least square hardening has been compared with corresponding welding parameters. Further, the relationship has been derived during their investigation. [2]

M. Felix Xavier Muthu et al.deliberated the consequences of the pin profile and the process parameters on the mechanical properties and the microstructure of the friction stir welded aluminium-copper joints. For dissimilar metals with different values of yield strengths, the pin profile plays a very important role. The superior joint properties as desired, shows the attributes such as dispersion strengthening and formation of friction stir zone without any defect[3].

V.C. Sinha et al.[8] made an attempt to compare the microstructure as well as the mechanical characteristics of the friction stir welded joints between the two cases. The first case being the joint created between the two samples of similar metal and the other one being the joint created between the two dissimilar metals. The three pairs of joints created by the combination of Aluminium Alloy (AlA) . The rotation speeds were varied between 150 rpm to 900 rpm and in the steps of 150 rpm at 60 mm/min travel speed at a constant angle of 2°, in order to obtain enough experimental results. Through SEM, the microstructure was determined.. Also, the corresponding values of grain size were obtained against the different step-values of heat input[4].

Prakash Kumar Sahu et aldiscussed various parameters for the AL/CU FSW such as tool offset position, tool rotational speed and more significantly the influence of the plate position on the microstructure as well as the macrostructure of the joint.. Moreover, it has also been observed that joint prepared with these dissimilar materials displays the tensile strength to be 95 % of that of aluminium and the bending angle as 65°[5].

Venkateshkanan M et al. considered the dissimilar weld joint of AA2024 and AA5052. The two dissimilar aluminium alloys were friction stir welded and the joint was analysed for the microstructural and macro-structural properties. The main parameter considered in their experimentation was the tool geometry. As discussed in the paper, newly developed steeped tool pin profile makes better joint than the other commonly used tool profiles for friction stir welding. Minute discontinuities could be observed in the cylindrical and tapered tool profiles while in the other tool profiles, there was no such thing[6].

3.Materials and Methods

As per the end application of the finished product, the materials are chosen to be joined by friction stir welding. Generally those metals which have lower carbon content are readily wieldable and soft alu0minium alloys . Also, as per the size and assembly of the end product, we choose the suitable equipment. The types of joint also play a significant role in the methods that follow.

4.Types of FSW Joints

One of the most beneficial factors that can be noticed in FSW is that it doesn't add any mass to the joint since there is no involvement of the filler material in the general use. For the very same reason, it has found industrial applications in the space equipment industry and the automobile industry where the volume to weight ratio matters a lot. Another advantage that the concerned process carries is that it can effectively join the sum up thickness of up-to 5 mm, depending upon the properties of material and the temperature conditions.

The types of joints that can be formed by friction stir welding are the lap joint and the butt joint. For a fixed setup it is not convenient to make any other kind of joints in the

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specimens for trials

5.Macro-structure testing

The tensile testing has been carried out by using UTM (Universal Testing Machine) under the ASTM (AmericanSociety for Testing & Materials) specifications.

6.Micro-structure testing

The micro-structures of the specimens have been tested by the following devices: optical microscope, scanningelectron microscope, X-ray diffraction and EDS (Energy-dispersive X-ray spectroscopy are preferable

7.Discussions

7.1 Effect of traverse speed

It has been observed from literature study for the welding of aluminium alloys 6xxxx series , the traverse speed of ranging from 140 to 160 mm/min was much defect free and had higher strength at constant rotation of speed

7.2 Effect of tool rotation direction

It is also advised from feedback the welding with minimum defects took place only in case of the clockwise tool rotation whereas there was no proper welding observed when the tool rotation was in the counter-clockwise direction and there were many defects.

7.3 Effect of depth of cut:

- Increase in plunge depth increases the possibilities of defects such as excessive flash, voids.
- Depth almost match with the properties of the base material. Tensile properties decrease with increase in plunge depth.
- Irrespective of the plunge depth, the hardness value at the weld zone is inferior to the base material.
- Increase in plunge dept decreases the hardness value

8. Conclusions:

1. FSW for aluminum alloys are observes the following outcomes
2. FSW is preferable for soft Aluminum alloys with low melting temperatures
3. At constant trial speeds with clockwise rotation
4. Minimum plunge depth is preferable
5. Traverse speed is below 150mm/min is advisable

9. References:

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