A SURVEY ON OPTIMIZATION OF PROCESS PARAMETERS OF AA1100 AND AA5052 USING FSW

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Abstract- The joining of materials is important from the beginning of civilization. Friction stir welding is a solid state welding process invented in 1991. This process is suitable for joining the same or different materials having different mechanical and chemical properties and different material structure of Al and Mg alloys. This research work mainly focus on friction stir welding of two dissimilar metals namely AA1100 and AA5052 using Taguchi method. The geometry of tool, feed rate and tool rotational speed plays important role in the welding process. FSW is nowadays being applied in aerospace, automotive and other industries. FSW technique can be able to produce large welded joints with accuracy as compared to conventional processes.

Keywords - Friction stir welding, Parameters, Dissimilar metals, Mechanical properties.

I. INTRODUCTION

Welding is a technique, which is used for joining of metals. The joining of similar or dissimilar materials is important to obtain a product having properties of both materials. The problems in joining materials with different properties using conventional welding process are known to everyone. During welding the selection of filler material, having different properties, is critical because it changes the properties of the joint. This filler material could degrade the quality of welds, resulting in inferior welds. Solid state welding process like FSW does not need any filler material during welding. In this welding process, welded joint has both parent material properties.

Classification of welding processes:
- Gas welding
- Arc welding
- Radiant energy
- Solid state welding
- Resistance welding
- Thermo chemical welding

Solid state welding:

The solid state welding process is mostly used for the welding of metals and their alloys like aluminium, magnesium, copper, etc.

Friction stir welding:

FSW is a recently developed welding process, invented by The Welding Institute (TWI), UK. This process deals with a non-consumable rotating cylindrical welding tool with a shoulder and a pin which is used to generate frictional heat and plastic deformation of the welding part to form a joint, while the material remains in the solid state.

Figure-1: Diagram of friction stir welding process

A non-consumable rotating cylindrical tool having a constant speed with a tip is transversely fed into a butt joint between clamped pieces of material. The tool tip is a little shorter than the depth of work pieces, when touched the work pieces frictional heat is generated between the welding tool and the work-pieces. By applying more force tool nib inserted in the materials and starts mixing the both materials while the material remaining in the solid state. When constant feed rate given to the work pieces the tool is moved forward resulting in welding of materials. This process of the tool helps the material to re-crystallization of the material surface.
II. FSW PARAMETERS

There are various significant parameters which are included in FSW which are the following:

1. Feed Rate:

In FSW is given at a constant rate during the welding process. The properties of welded joint depend upon the feed rate to the materials.

2. Tool Rotation And Speed:

Rotation and speed are considered in FSW are very important and must be chosen very carefully. Speed of tool, rotating defines the weld quality. Tool speed can be changed while selecting parameters.

3. Design Of Tool:

A good and hard tool can increase both quality of the joint and the maximum possible speed. The tool should have low thermal conductivity with good oxidation.

4. Tilting Angle:

This is the tilt given to the tool helps forging of the material at the rear. Tilting results the lowering the tool at rear portion than front. This will ensure that the downward pressure fully penetrates the weld.

5. Welding Forces:

A number of forces are required during welding via friction stir welding, such as the downward force of the tool, traverse force and torque is required to rotate the tool.

III. ADVANTAGES AND DISADVANTAGES

Few are the advantages and disadvantages of FSW technique are:

Advantages:
- Water proof joint.
- High mechanical properties.
- No harmful gases released during the welding process.
- Consumables and gas shield are not required- A H13 tool is required to weld the material.
- Less training required to operate the machine and lower the setup cost of the machine
- It can be operated in all directions (horizontal, vertical, etc.), because there is no weld pool.
- Good welds surface appearance.
- Continuous welding can be obtained.

Disadvantages:
- Special tools are required to weld the material having different thickness.
- Exit hole left at last when the tool is withdrawn.
- Large forces are required to clamp the plates together.
- Less flexible than conventional processes.
- Non-linear welds cannot be welded easily.

IV. LITERATURE SURVEY

Yan Yong et al., 2010 [2] in their research paper discussed about the combination of two aluminium alloys AA5052 and AZ31 Mg alloy by friction stir welding with the thickness of 6mm. It was observed that best welding between this combination can be get when tool is rotated at 600rpm and welding speed of 40 mm/min. It was also observed that microstructure of weld zone is refined than parent materials.

N.T. Kumbhar and G.K. Dey, 2011 [3] studied their work at BARC on friction stir welding related to micro-structural developments of welded alloy AA5052. They proposed that joining of steels, zirconium, titanium alloys by friction stir welding requires to develop special material/tool design. However, Al5052 alloy provides an in-depth study microstructure and mechanical properties. Their study shows that AA5052 show superior mechanical properties like ductile mode of fracture.

P. Biswas and N. R. Mandal, 2011 [4] In this research they worked on three-dimensional finite element (FE) transient thermal analysis of friction stir welding for different tool geometries and process parameters. In this study, heat generation was assumed to be pure friction between the tool and work piece ( AA1100 type of aluminium alloy with 6mm thickness) interface. It was observed using SS310 tool with AA1100, friction plays an important role in heat generation. Tool geometry with concave shoulder and conical pin shows good result for FSW of AA 1100.

Jadeja et al., 2012 [5] Shows the experimental and numerical investigation of friction stir welding on AA6063-T6. The objective of this research is to develop a finite element simulation of friction stir welding of AA6063-T6. He developed trend line equations for thermal conductivity, specific heat and density to know the relationship of these factors with peak temperature. He investigated tensile and hardness values for the welded specimens at different rotational speed and feed. Temperature variations with input parameters were also observed. The simulation model was tested with experimental results. The results of the simulation were in good agreement with that of experimental results.

N. T. Kumbhar and K. Bhanumurthy, 2012 [6] did a feasibility report on friction welding dissimilar materials AA5052 and AA6061. In this paper, it was observed that normal load and spindle torque requires low at higher rotation speeds. The butt joint was successfully welded through the friction welding technique. After the welding process parameters optimization experiments, the optimum work conditions were obtained. The tensile properties were identified and it was found that this combination had better properties than similar friction stir welding of alloys.

Selvam et al., 2013 [8] analyzed the selection of heavy alloy tool for friction stir welding. It was observed that the maximum temperature in the FSW process can be achieved by increasing both welding speed and the rotating speed. When feed rate is maintained at 102mm/min, the tool will be getting deformed. It shows that heat produced due to rotation by shoulder is at a maximum range of 58-59%.
S. Jannet, P.K. Mathews, R. Raja, 2013 [10] made a comparison between friction stir welding and fusion welding. Experiments were performed on AA5083-O and AA6061-T6 aluminium alloys. The tensile properties of welded jointisa5083-O and aa6061-T6 aluminium alloys joints were tested by welding process and post weld aging treatment. It was found that post weld aged joints had attained increase in tensile properties but they were time consuming and costlier.

Sivakumar et al., 2014 [10] discussed about various aluminium alloys, how process parameters affected the weld microstructure and list of mechanical properties that can be achieved. This paper gives information about various aluminium alloys like 5xxx series, 6xxx series and 7xxx series. It was identified a number of areas that are used for further study. For an engineering purpose, there is a need to determine the occurrence and significance of flaws in friction stir welds.

S. Deivanai, Reeta Wattal et al., 2014 [11] performed the experiment on friction stir welding using AA1100 alloy. A model had been developed to check the mechanical properties of friction stir welded aluminium alloy AA1100 joints by in taking various welding parameters and statistical tools such as number of experiments and regression analysis. In this research paper, tensile strength of all the joints are lower than that of the base material, irrespective of the rotational speeds used to fabricate the joints. The rotational speeds which are used to perform the experiment are 8 in numbers. The result shows that AA1100 alloy gives superior tensile properties at a rotational speed of 1200 rpm. At lower rotational speed (800 rpm) tensile strength of the joint is minimum.

Vinayak D. Yadav, S. G. Bhatwadekar, 2015 [12] presents the results of an experimental investigation, done on the friction stir welding using dissimilar aluminium alloys AA1100-AA6101-T6. According to the research paper, tunnel like defects are present at the surface of the joint. It was found that the tensile strength of the dissimilar joint less than the base materials. The tensile strength for dissimilar joint is 153.33 N/mm². The tensile strength of joint is less than stronger base metal alloy AA6101 but very nearer to AA1100 alloy.

Ramachandran et al., 2015 [13] performed the experiment on 3-mm-thick dissimilar aluminium (Al) Alloy AA5052 H32 and HSLA steel IRS M-42 by using FSW technique. The welding carried out at various rotational speeds and tilting angles while other parameter remains constant. The maximum tensile strength was obtained about 94% of Al alloy at 450 rev/min under constant welding speed of 45 mm/min axial load of 7kN and tilting angle of 1.5 deg. These above parameters are appropriate for gaining the maximum tensile strength.

B. Supraja Reddy et al., 2015 [14] this study focusing on dissimilar aluminium alloys to other metals and aluminium based metal matrix composites. This paper presents the study on effect of process parameters on mechanical properties and micro structure. This paper suggests that, various types of tool can be used to get the various strength of the joint. The problems and issues were discussed related to friction stir welding. Further studies was done by considering a number of parameters on dissimilar friction stir welded joints on a wide range of values by using different tool geometries of the aluminium based dissimilar welded joints.

Edwin et al., 2016 [16] performed the experimental analysis of process parameters by FSW technique using AA7075 and AA2024 alloys. The tensile test was performed after the welding of dissimilar materials. It shows that tensile strength is reduced by only about 10% and the percentage elongation reduced half of the base metal. By increasing RPM, the tensile strength also increased. It says, high quality welds could be obtained at the tool rotation speed of 600-1200 rpm.

V. CONCLUSION

In this paper, we focused on friction stir welding of the dissimilar metals (AA1100 and AA5052). It is found that a little work is done on the combination of these dissimilar aluminium alloys using Taguchi method. Friction stir welding is a better option for welding of alloys like aluminium, copper, titanium etc. In the future work, we will do further research in the field of optimization of process parameters of friction stir welding using AA1100 and AA5052 and will check the maximum hardness of the joints.

REFERENCES

