REVIEWS ON THE EFFECTS OF FRICTION STIR WELDING PARAMETERS ON MECHANICAL PROPERTIES OF DISSIMILAR METAL WELD JOINTS

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ABSTRACT

Friction stir welding is a solid state welding technique which produces high quality welds even in difficult to weld materials such as aluminum, brass, copper and others such material . It was invented in 1991 by the welding institute. This technique produces a very good quality weld joint without actual melting of the materials. The technique is fast, environmentally friendly and simple to perform. In addition, a lot of Industry applications exist for friction stir welded components. The scope of the present investigation is to evaluate the effects of friction stir welding parameters on mechanical properties of dissimilar metal weld joints. From this review it has been found that the welding parameters like Tool Rotation Speed, Feed rate, Tool Tip Shape, Tool Tip Plunge Depth, Tool Tilt Angle, Shoulder Diameter are greatly influence the mechanical properties of friction stir welded joints. Further scope of carrying-out work was also discussed in this review paper.

Keywords: Friction Stir Welding (FSW), Dissimilar Metals, Mechanical Properties, Tool Rotation Speed, Feed Rate, Tool Tip Plunge Depth

I. INTRODUCTION

In recent world a pressure of producing stronger and lighter products while using less energy and doing less environmental harm with lower cost and in short time increased. Many problems associated with traditional fusion welding techniques such as shrinkage, solidification cracking and porosity becomes big obstacle in meeting the standards which leads to more wasting of material, time and money. To overcomes many such problems, a need of new welding technology arise which develops friction stir welding technique. Friction Stir welding technique was invented by Wayne Thomas at The Welding Institute Ltd in 1991. Friction stir welding is a solid state process which produces high quality welds even in difficult to weld materials such as aluminum, brass, copper and others. Friction stir process has received world-wide attention, and today it is used for production in many sectors like aerospace, railway, automotive, shipbuilding, heat exchangers, and nuclear waste containers. In friction stir welding process the

material to be welded is clamped tightly, than the tool is plunged in work piece which is to be welded at certain angle until the tool shoulder touches the surface of the work piece in the centre line. The friction stir welding process consists of pin and the shoulder. The material used as a rotating tool is harder than the material to be welded. Once the tool is plunged in, then it is rotated for certain time without any feed for required heat generation and this time is called indentation time, when required heat is generated the feed is given. Due to raise of temperature the material gets soften and flow towards the tool rotating direction and weld occurs. The critical process parameters which affect the weld joint produced using friction stir welding are Tool Rotation Speed, Travelling Feed/Feed rate, Tool Tip Shape, Tool Tip Plunge Depth, Tool Tilt Angle, Shoulder Diameter [1, 2, 3]. In the current study researches from various authors has been reviewed.

II. LITERATURE REVIEW

Ranjith R., Senthil Kumar B. [2014] investigated joining of two dissimilar aluminium alloys AA2014 T651 and AA6063 T651 using friction stir welding. The experiments were conducted on vertical end milling machine. The friction stir tool is of high speed steel with various pin diameter 5mm, 6mm and 7mm respectively. The friction stir pin length is 5.8mm and diameter of the shoulder is 20mm. The tool has the constant rotational speed of 2000rpm and welding feed of 16mm/min. The tool was rotated in the clock wise direction and tilt angle of the tool was varied between 3 to 5 degrees. Tensile strength, Optical microscope and %Elongation was carried out to evaluate the weld. It is observed that 6 mm pin diameter, 4 degree tilt angle and 0.5 mm offset towards advancing side give the optimum tensile strength of 371 MPa [3].

R. Hariharan, R.J. Golden and Renjith Nimal. [2013] investigated the development of friction stir welded joint of dissimilar aluminum alloys (6061 and 7075) by using Computerized Numerical Control Machine and also compared the effect of tapered pin and cylindrical pin type tools on tensile strength of aluminum alloys (6061 and 7075).The main process parameters considered are rotation speed (1600 and 1250rpm), traverse speed (120mm/min) and tool tilt angle 2^0. The weld joint is evaluated with micro-structure, hardness, and tensile testing. The results demonstrated that the tensile strength of tapered pin sample was around 30% and 15% higher than cylindrical one at 1250rpm and 1600rpm respectively. The maximum tensile strength value (485Mpa) is obtained at rotation speed of 1250 rpm, welding speed of 120 mm/min and tool angle 2 degree tilt. It is also observed that with increase in tool rotation speed the tensile value also increase till critical level and then decline. It is suggested to select taper pin as tool and optimize parameters for a sound welding of dissimilar material [4].

K.Satheesh kumar, G.Rajamurugan, P.Manikkavasagan. [2013] investigated the joining of dissimilar aluminium AA6061 and AA7075 6mm thickness plates by friction stir welding. The process parameters used are rotational speed and transverse feed of 1200, 1400, 1600 rpm and 20, 35, 50 mm/min at constant axial force 5kN. The effect of friction stir welding parameter was evaluated by performing micro-structure, hardness and tensile

testing. The rotational speed of 1600rpm and feed of 35mm/min gives the maximum tensile strength. The lower rotational speed leads decline of tensile strength [5].

Muhamad Tehyo, Prapas Muangjunburee, Abdul Binraheem, Somchai Chuchom and Nisida Utamarat. [2012] investigated the effect of friction stir welding parameters on the microstructure and mechanical properties friction stir welded butt joints of dissimilar aluminum alloy sheets between Semi-Solid Metal (SSM) 356-T6 and AA6061-T651 using computerized numerical control machine. The two main parameters considered are tool rotation speeds (1,750 and 2,000 rpm) and six welding speeds (20, 50, 80, 120, 160, and 200 mm/min). The results are evaluated with help of microstructure, hardness and tensile testing. The maximum tensile strength of 206.3 MPa was derived from a welded specimen produced at the tool rotation speed of 2,000 rpm associated with the welding speed of 80 mm/min. As the tool rotation speed and welded speed increases the tensile result improve till it reach maximum value, further increase leads in fall of tensile strength[6].

R.Madhusudhan, M.M.M.Sarcar, N.Ramanaiah, K.Prasada Rao. [2012] investigated the effect of friction stir welding parameters on mechanical and micro structural properties of friction stir weld joint of dissimilar aluminium alloy (AA 6262-T6 and AA 7075-T6). The main parameters varied are Tool Rotational Speed(1000,1200, 1400 rpm), Weld Speed(0.4,0.6, 0.8 mm/sec), Axial Force (8,9,10 kN), Tool shoulder diameter (18 mm), Tool Pin swept diameter (6 mm), Pin Length (5.8 mm). The weld joint is evaluated by optical microscopy, hardness and tensile strength testing. The better mechanical properties (hardness and tensile strength) were obtained at joint fabricated with 1200 rpm tool rotational speed, 0.6 mm/sec weld speed and 9kN axial force compared to all other conditions [7].

R. Palanivel, P. Koshy Mathews. [2011] investigated the tensile behaviour of friction-stir- welded dissimilar aluminium alloys (AA6351-T6 to AA5083-H111). The five different tool pin profiles were used welding, such as Tapered Square, Straight Square, Straight Hexagon, Tapered Octagon and Straight octagon in addition with three different welding speeds (50 mm/min, 63 mm/min and 75 mm/min). The tensile test was performed to evaluate the joint and it was observed that the highest tensile strength value was obtained with straight square tool pin at 75mm/min welding speed. The increase in welding speed leads to an increase in the tensile strength up to a maximum value, while a further increase results in a decrease of the tensile strength [8].

Yan Yong, Zhang Da-Tong, Qiu Cheng, Zhang Wen. [2010] investigated the dissimilar friction stir welding between 5052 Al alloy and AZ31 Mg alloy with the plate thickness of 6 mm. The best results were observed at rotation speed of 600 r/min and welding speed of 40 mm/min. As compared with the micro-structure of base materials, the microstructure of the stir zone is greatly refined. Complex flow pattern characterized by intercalation lamellae is formed in the stir zone. Micro-hardness value presents an uneven distribution due to the complicated micro-structure at the weld joint, and is twice higher than that of the base materials. The tensile fracture position

locates at the aluminum side where the hardness value of weld joint shows a sharp decrease from the stir zone to 5052 base material [9].

Z. Barlas, H. Uzun. [2008] investigated Microstructure and mechanical properties of friction stir butt welded dissimilar Copper and brass sheets. The commercial pure copper (Cu) and brass (CuZn30) sheets which have dimension 150 mm length, 100 mm width and 3 mm thickness were friction stir welded. The main process parameters considered are tool rotational speed with the clockwise (800 rpm), travel speed (22 mm/min) and the tool axis was tilted at 3^0. In order to evaluate the joint performance and the weld zone characteristics, the microstructure, micro-hardness, tensile and bending tests are conducted. : The tensile strength of joints was found to be about same and 46% lower than that of Cu parent metal and CuZn30 respectively. It is demonstrated that commercial pure copper can be successfully joined to dissimilar CuZn30 alloy using friction stir welding [10].

III. Conclusions

Following points can be concluded from the literature review.

- The Friction stir welding is a successful technique to join dissimilar alloy like aluminum, copper and brass.
- A higher tool rotation speed resulted in a higher tensile strength till the maximum value, further increase results in decline in tensile value.
- Optimum friction stir welding parameters should be properly selected for good results.
- The heat input increases as the tool rotational speed increases
- No addition material or fillers are required for welding.
- It is the environment friendly welding technique as no harmful emissions from the process.
- The increase in welding speed results in increase in tensile strength up to a maximum value, further increase results in a decrease of the tensile strength

IV. FUTURE SCOPE

As majority of the research studies on Friction Stir Welding has been done by taking one or two factor at a time which provides results by involves hit and trial methodology. So the combined effect of various parameters like tool rotation speed, tool profile, tool tilt angle, welding speed etc can be investigated for different materials which will give more accurate and detailed results.

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