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A Survey of the Parameters of the Friction Stir Welding Process of Aluminum Alloys 6xxx Series

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Abstract:- Friction stir welding is a modern innovation in the welding processes technology, there are several ways in which this technology has to be investigated in order to refine and make it economically responsible. Aluminum alloys have strong mechanical properties when they are welded by using the Friction Stir welding. Therefore, certain parameters of the welding process need to be examined to achieve the required mechanical properties. In this project, a literature survey has been performed about the friction stir welding process and its parameters for 6xxx series aluminum alloys. The results show that it is possible to fully plan for the comprehensive study in order to evaluate the main, combined, and reactive effects of each of the welding speed, the speed of rotation of the tool, the depth of welded and other variables and factors that affect the mechanical properties of aluminum alloys that have been welded by friction 6xxx. It is easy to forecast the impact of process variables on the friction stir welded aluminum alloy 6xxx series mechanical characteristics through using different experimental design methods like Taguchi Method etc. Also, expensive, Line-consuming, and even insufficient for prediction of material characteristics have been traditional approach of experimentation with several variables as well as reactions. The combined impact of the process variable on mechanical characteristics has been investigated with little effort.

Keywords:- *Friction Stir Welding, Welding Parameters, Welding Process, Aluminum Alloys, 6xxx Series, Welding Speed, and Mechanical Properties.*

I. INTRODUCTION

Aluminum has been used as a commercial metal for 100 years ago. Currently, it is rated second in terms of both global quantity and investment and is obviously the most valuable non-ferrous metal. It has gained prominence in nearly all sectors of the global economy, market sustainability in addition to mechanical machinery.

The engineering importance of aluminum accounts for a variety of special and desirable properties including the light weight, workability, resistance to corrosion as well as both good thermal and electrical conductivity. Furthermore, the specific gravity of Aluminum has is around one-third of the steel weight for an equal length. Cost comparisons are mostly made based on the cost per pound, where aluminum is at a distinct drawback in this case, although there are a variety of uses where a more accurate comparison will be depending on the cost per unit amount. Because a pound of aluminum can generate three times as many pieces of the same size as a steel pound, the cost differential is significantly less.

Perhaps the most significant drawback of aluminum from an engineering viewpoint is it has comparatively poor elasticity modulus, around one-third of the steel's elasticity modulus. Under the same loading conditions, the aluminum element is deflected three times more than the steel element of the same model. Although the elasticity modulus could not be considerably changed by the heat treatment or alloy, the stiffness is typically required to be provided by the design features like corrugations and ribs. These could be integrated relatively easily, though, as aluminum adapts very well to the broad range of production processes. Aluminum alloys have important properties such as good machining, high strength, good conductivity, lightweight, formability, in addition to linear expansion.

II. AIMS AND OBJECTIVES

This study aims to provide a survey of the Parameters of the Friction Stir Welding Process of Aluminum Alloys 6xxx Series, this can be achieved through the following objectives:

- To study the classifications of aluminum alloys.
- To study6xxx Series Aluminum Alloys
- To study the Welding process of aluminum alloys.
- To analyze different studies related to the study topic.

III. METHODOLOGY

➢ *Classification of aluminum alloys*

Aluminum alloys could be classified into two main classes depending on the process of manufacture, which are wrought aluminum alloys as well as Cast aluminum alloys.

➢ Wrought aluminum alloys.

The Wrought aluminum alloys are divided into two main types; the first type involves aluminum alloys that achieve strength by improving the solid solution and cold working in addition to those that are strengthened and improved by the heat treatment Some of the popular wrought aluminum alloys are shown in Table 1, the classification of these wrought aluminum alloys is done by using the four-digit designation system. The first digit is welding velocity equals 1,25 mm/s as well as an axial force equal to 7 had excellent tensile properties relative to the other joints.

A study has been conducted by Karthikeyan et al. (2011) in order to study the relationship between the process parameters as well as the friction stir processed AA6063-T6 mechanical properties with work piece dimensions 200 mm × 50 mm × 10 mm. The utilized tool in this study was HSS with right hand threaded pin with diameter equals 6 mm, as well as the cylindrical shoulder with diameter, equals 18 mm. Moreover, the length of the pin was 5.7 mm, the rotational velocity of 800, 1000, 1400, and 1600 rpm selected for 22.2, 40.2, and 75 mm/min tool feed for axial forces of 8, 10, and 12 kN. It was found that the weld had a homogenized as well as refined microstructure grain composition. The high mechanical properties could be accomplished with a feed equals 40.2 mm/min, a rotational speed ranges between 1200 and 1400 rpm as well as an axial force equals 10 kN. These properties have been obtained from defect-free welds with a strong microstructure. The overall rise in the UTS equals 46.5 %, ductility equals 133 %, and micro-hardness equals 33.4 % of parent metal. The specimens wherein welding is carried out at a feed rate equals 8 generated process defects.

According to Jayaraman et al. (2014) the roundness (Ø), surface roughness (Ra), as well as material removal rate (MRR) of the AA6063 T6 have been studied. These were evaluated under varying cutting conditions of various machining parameters combinations. The results of this study have been shown that the cutting depth and the rate feed are important factors that affect the aluminum alloy transformation. Also, the results show that the feed rate of 57.365% is the most influential factor in the assessment of various output characteristics or Gray Relational Grade (GRG) accompanied by cutting depth of 25.11 % as well as cutting velocity of 17.35 %. When transforming aluminum alloy with lower cutting velocity equals 119.22 m/min, a medium cutting depth equals 0.15 mm and a reduced feed rate equals 0.05 mm/rev and with an estimated multiple performance characteristics (GRG) equals 0.8084, the optimal multiple performance characteristics were achieved with unbleached carbide inserts. For such a combination of the parameter, the obtained experimental value of GRG equals 0.7717. Inside the 95 % confidence interval of the expected optimum state, the value of multiple output features derived from the validation experiment is 95%.

Elanchezhian et al. (2014) taguchi tested the method in order to achieve an optimum condition of AA8011-6062 aluminium compound for Friction Stir Welding and also reported findings with the ANOVA test. FSW joints manufactured with standardized parameters of rotational velocity equals 1400 r/min, welding velocity equals 75mm/min, axial force equals 7 , shoulder diameter equals 15.54mm, pin diameter equals 5.13mm in addition to tool material stiffness equals 600 HV were found to have an ultimate tensile strength of 153 MPa. The optimal machining conditions for strong impact strength is when the tool rotational velocity of 1200 . . . , a welding velocity equals 100 mm/min, as well as an axial force, equals 5 KN. Rotational velocity equals 1400 . . . , welding speeds equals 75 mm/min, as well as axial force, equals 125.73 are the optimal machining conditions with the high tensile strength. The welding velocity has a marginal effect on the tensile strength.

Bayazid et al. (2015), the strength of the contrast joint 6063-7075 were examined through the use of ANOVA analysis and the Tagus method in which the effect of speed of travel, rotational speed, and platelet position were revealed. The outcomes of the S/N study show that when the rotation speed values, plate locations, and speed of traveling were 1,600rpm, AS-7075 as well as 120 mm/min respectively, the appropriate state of the 6063-7075 divergent joints has been achieved. The joint tensile strength in such a situation has been 143.59 MPa. A study by ANOVA found which the effectiveness of variables of rotational speed, motion velocity as well as plate location on tensile strength of the joint has been 59 percent, 30 percent, and 7 percent, respectively.

According to Fu et al. (2015), FSW conducted utilizing 800 rpm and 50 mm/min by H13 Quenched and Tempered to 50 HRC instrument over different 6061-T6aluminum alloy with AZ31B magnesium alloy. The placement of Mg on the advanced side leads to defect elimination as well as a more homogeneous mixing. A small cavity has been found in the Mg-Al specification when the instrument offset equals zero. The region defects expanded in the Mg-Al specification when the device has been offset to the Al. When the velocity of the tool ranged between 600 and 800 rpm and the traverse velocity ranged between 30 and 60 mm/min, sound weld without defect is received. The analysis of energy Dispersive X-ray of the collected specimen IMCs at 60 mm/min, 700 rpm with Mg on AS, as well as +0.3 mm offset showed the Al presence, Mg material, indicating that Al12Mg17 and Al3Mg2 layers were found in the variety of content. The performance of welding was influenced by two variables: heat input in addition to the heat input level of materials. The heat input was different from the welding velocity and the rate of rotation.

Abraham et al. (2016), said that by using FSP, Quartz AMCs AA6063 could be produced effectively. Using scanning, photography, as well as transmission electron microscopy, the micro hardness, microstructure, as well as sliding wear actions have been researched and found that the particles of quartz improved the composite's micro hardness. At 0 vol. percent as well as 135 HV at 18 vol. percent, the hardness of micro has been estimated to be 62 HV. The particles of quartz increased the composite's wear resistance. The rate of wear has been reduced as the particle volume fraction of quartz has been increased. In addition to the wear debris morphology, the rate of wear has been observed to be 583 * 10−5 mm3/m about 0 vol. percent as well as 258 * 10−5 mm3/m about 18 vol. percent of the particles of quartz that are affected by the wear mode. The raised particle volume fraction of quartz modified the wear phase from binding to brusque. The debris of wear shifted at 0 vol.

alloy", Science and technology of welding and joining, Vol.8, pp.50- 54.

[5]. Minton, T. and Mynors, D. J. (2006) "Utilization of engineering workshop equipment for friction stir welding", Journals of Materials processing Technology, Vol.177, pp.336- 339.

[6]. Lakshminarayanan A. K., Balasubramanian V., (2008) "Process parameters optimization for friction stir welding of RDE-40 aluminium alloy using Taguchi technique", Transactions of Nonferrous Metals Society of China, Vol. 18, pp. 548-554.

[7]. Elangovan, K., Balasubramanian, V. and Babu, S. (2009) "Predicting tensile strength of friction stir welded AA6061 aluminium alloy joints by a mathematical model", Materials and Design", Vol.30, pp.188-193.

[8]. L Karthikeyan and V.S. Senthil Kumar, (2011) "Relationship between Process Parameters and Mechanical Properties of Friction Stir Processed AA6063-T6 Aluminum Alloy", Materials and Design, Vol. 32, pp. 3085-3091

[9]. P. Jayaraman, L. Mahesh kumar (2014) "Multiresponse Optimization of Machining Parameters of Turning AA6063 T6 Aluminium Alloy using Grey Relational Analysis in Taguchi Method"Procedia Engineering, Volume 97, Pages 197-204

[10]. C.Elanchezhian, B. Vijaya Ramnath, P. Venkatesan, S. Sathish, T. Vignesh, R.V. Siddharth, B. Vinay, K. Gopinath(2014) "Parameter Optimization of Friction Stir Welding Of AA8011-6062 Using Mathematical Method" Procedia Engineering, Volume 97, Pages 775-782.

[11]. S.M. Bayazid, H. Farhangi, A. Ghahramani (2015) "Investigation of Friction Stir Welding Parameters of 6063-7075 Aluminum Alloys by Taguchi Method". Procedia Materials Science, Volume 11, , Pages 6-11.

[12]. Fu B., Guoliang Qin, Fei Li, Xiangmeng Meng, Jianzhong Zhang, Chuansong Wu. (2015) "Friction stir welding process of dissimilar metals of 6061-T6 aluminum alloy to AZ31B magnesium alloy", Journal of Materials Processing Technology, vol. 218, pp 38-47. [14] S. Joyson Abraham, S. Chandra Rao Madane, I. Dinaharan, L. John Baruch (2016)"Development of quartz particulate reinforced AA6063 aluminum matrix composites via friction stir processing".Journal of Asian Ceramic Societies, Volume 4, Issue 4, December 2016, Pages 381-389 .

[13]. Heena K. Sharma, Kamlesh Bhatt, Krunal Shah, Unnati Joshi (2016) " Experimental Analysis of Friction Stir Welding of Dissimilar Alloys AA6061 and Mg AZ31Using Circular Butt Joint Geometry" ,Procedia Technology, Volume 23, Pages 566-572.