Study the Friction Stir Welding Process Parameters and Its Technical Aspects

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Abstract

Friction stir welding (FSW) is the modern welding process. The friction welding was invented in 1991 in UK at TWI (The welding institute) by the Wayne Thomas. This paper covers all the technical aspects. Friction stir welding is rapidly developing technique different fields of industry. A proper experimental set up can result in high quality welding. So there are different processes parameters are considered for the variation in the outcome and to optimization the welding technique. This paper explains the methodology, basic principle and the other technical aspects. This paper also covers the large advantage of friction stir welding over the earlier welding techniques. This welding uses the non-consuming tool to generate frictional heat between work pieces. This review paper describe about the various welding variables, future aspects and key problems.

Key Words: Friction Stir Welding, Process Parameters, Variables, Technique.

1. INTRODUCTION

The characteristic feature of the FSW is to join materials without reaching their fusion temperature of the materials [1]. This gives the opportunity of new area in welding technology. At starting, FSW operated on alloys of aluminum. Aluminum has relatively low softening temperature so due to this it easily weld. An alloy of magnesium have high strength to weight ratio and low density so this alloys have more significant value to replace aluminum alloys [2]. Friction stir welding is an environment friendly and more energy efficient. It is known as solid state welding process. Friction stir welding open the new areas in welding technique. This welding is mostly used in those areas where high joint accuracy is mandatory. It is widely used in aerospace industry, automobile industry, and medical instruments manufacturing industry etc. This welding is used for joining the different properties materials moreover in this process no shielding gas and no surface cleaning is required. This welding technique has larger advantage than the traditional welding process. This process is carried out with proper tool design and with significant process parameters to achieve a high weld quality. It has main advantage to join all types of metals without reaching its fusion temperature. So friction stir welding is more significant technique in last three decades and it is green technology due to versatility and its energy efficiency [3].

2. LITERATURE

S.No	Author (year)	Material	Parameters	Conclusion
1	Elangovan K. Balasabramanian	AA2229 Aluminum Alloy	Welding speed and tool pin	-Square pin tool profile produced defect free irrespective welding speed. - the joint fabricated at a welding speed of 0.76 mm/s showed higher tensile strength [5] .

2.	Chen thaiping (2009)	AA6061 Aluminum Alloy and SS400 low carbon steel	Rotation speed and transverse speed	Lower transverse and lower rotation speed having high value of charpy impact test.
3	Patil H.S, Soman H.S (2010)	Aluminum 6082- O	Tool pin profile and welding speed	-The effect of tool pin profile and welding speed on the appearance of the weld is presented and no obvious defect was found. - It is found that the joint fabricated using taper screw thread pin Exhibits superior tensile properties compared tri –flute pin profile, irrespective of welding speed.
4	Arora A, Mehta M and Debroy T (2009)	L80 steel and AA7075 alloy	Load bearing capacity of tool pin	A three-dimensional heat transfer and visco-plastic model is used to compute the influence of pin length and diameter on traverse force during FSW. The total traverse force increases significantly with increase in pin length.
5.	Reshad k., Seighalani ,M.K. Givi Beshaeati, Nasiri A.M. and Bahemmat P.,(2009).	Pure titanium	Tool Material Geometry and Tilt Angle.	-Using high-speed steel (HSS) tool for FSW of titanium will result in complete failure of the pin and severe wear of the shoulder nose because of heat generation from friction between the tool and the base metal. -Using brittle WC as a pin material for FSW of the Ti-CP and because of high wear and stress concentrations developing on the root of the pins threads Macro structural analysis of the welded joints [6].
6.	Kulekci Mustafa Kemal & sik Aydin & kaluc Erdinc,(2008)	AA 5754 aluminum alloy plates.	Tool rotation and pin diameter.	-Increasing tool rotation for a fixed tool pin diameter reduces fatigue strength of joints. -Increasing tool pin diameter for a fixed tool rotation, decreases fatigue strength joints [7]. -In FSW lap joints, an optimization between tool pin diameter, tool rotation and tool traverse speed is needed to obtain better fatigue strength.
7.	Arora A.,deb A and DebRoy T..(2011)	AA6061 Aluminum Alloys	Tool shoulder diameter	In order to determine the optimum tool geometry, the two components of the torque are used for various shoulder diameters. As the shoulder diameter increases, the sticking torque, MT, increases, reaches a maximum and then decreases. This behavior can be examined, which shows that two main

				factors affect the value of the sticking torque. First, the strength of the material is decreases with increasing temperature due to an increase in the shoulder diameter. Second, the area over which the torque is applied increases with shoulder diameter [8].
8.	Cao X jahazi M..(2011)	AZ31B-H24 Magnesium Alloy	Tool rotation Speed and probe length.	Tensile shear load initially increases with increasing tool rotational speed but decreases with further increase. Shear strength increases with increasing probe length and penetration depth in to the bottom sheet [9].

3. WORKING AND PRINCIPLE OF FRICTION STIR WELDING

The working and principle of friction stir welding shown in figure 1 and figure 2 respectively. In FSW a cylindrical, shouldered tool with a profiled probe is rotated and slowly plunged into the joint line between the two pieces butted together. The heat is generated due to wear resistance between welding tool and work pieces. A welding tool have a shank, shoulder and pin fixed with milling machine and is rotated along its axis. The basic principle of friction stir welding is heating the metal to a temperature below re-crystallization temperature. In this process no shielding gas and filler rod is necessaries. Tool moves along the work pieces contact line. The cooling of material leads to creation of solid phase bound between the clamped wok pieces. In the FSW there is no problem of porosity, cracking and having good mechanical properties. It can be automated and reduces needs for skilled workers.

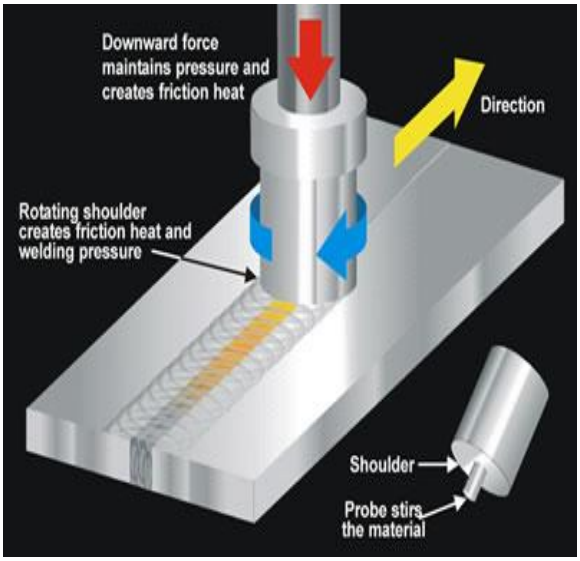

Fig- 1 Principle of Friction Stir Welding

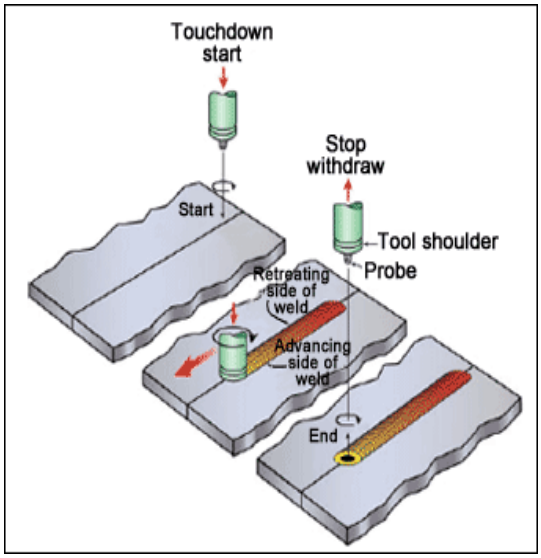

Fig - 2 Schematic of Tool and process of FSW

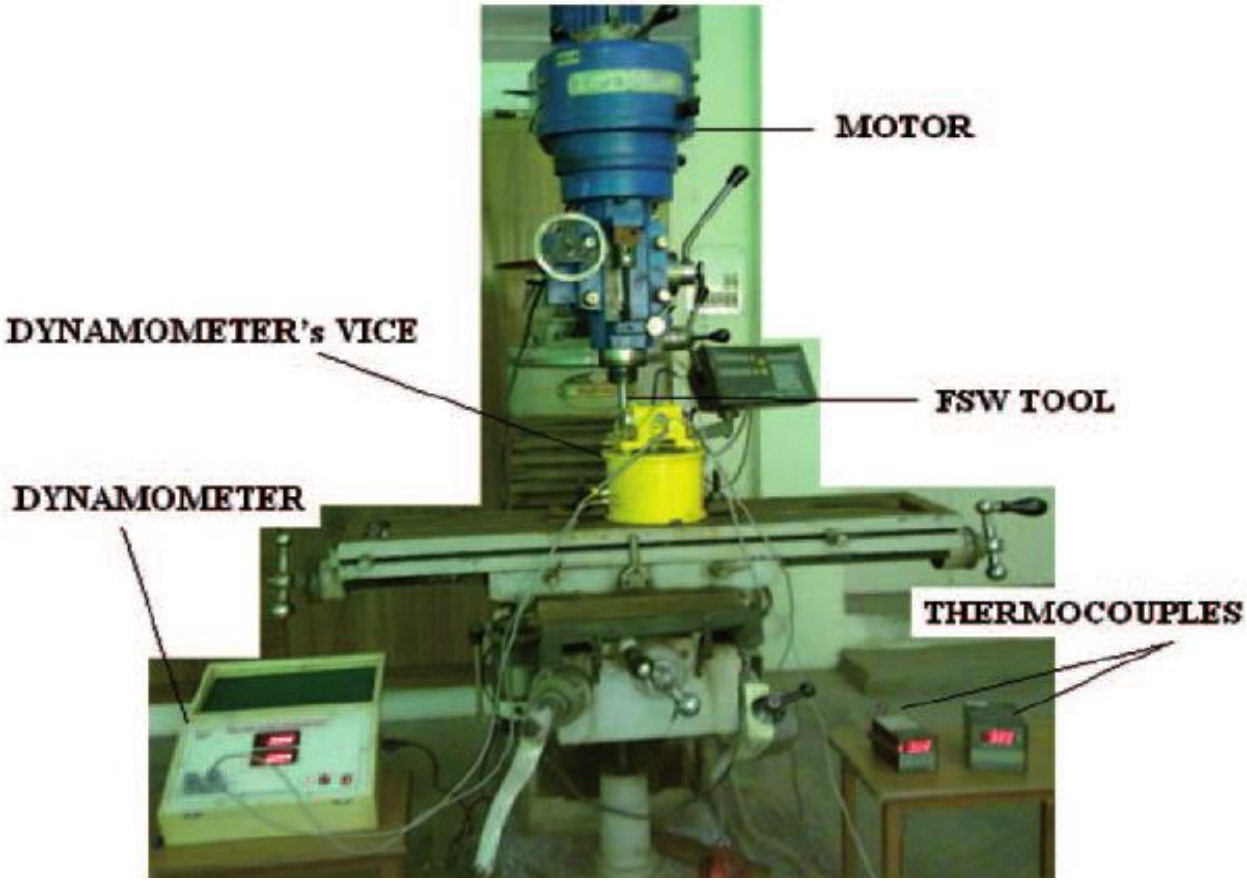

Fig-3 Experimental set up of Friction Stir Welding

4. WELDING VARIABLES

FSW involves complex variables to joining the similar metals and dissimilar metals. Therefore Rotation speed, down force, tilting Angle and welding speed are the variables. In FSW tool rotation and tool speed are very important variables. Tool have a clockwise and anti clock wise direction along the line of joint. The motion of tool generates the heat due to friction on work pieces joining line and this heat help to join the work pieces. Rotation speed depends upon the joint type, material properties and depth of penetration. After tool rotation and tool speed and rotation tool tilt and angle is also an important. A suitable tilt of the spindle towards trailing direction ensures that the shoulder of the tool holds the stirred material by threaded pin and move material efficiently from the front to the back of the pin [3].

5. APPLICATION

5.1 Ship Building Industry

- Now a day FSW is widely used in shipbuilding industries. In the last decades with the improvements of aluminum alloys are target for the ship manufacturing.

Fig. 4 FSW used in Ship building

This development improves the welding strength due to its corrosive resistive properties.

- Joining of material combinations (e.g. Al/St) and of materials not suitable for fusion welding (e.g. AlCu and AlLi)
- No filler or auxiliary materials required
- Great wall thicknesses weld able in one pass
- Depending on the component geometry, welding with milling machines is possible.

5.2 Aerospace

The FSW is wielding used in aerospace industry. The process is also used for the Space Shuttle external tank, for Ares I and for the Orion Crew Vehicle test article at NASA as well as Falcon 1 and Falcon 9 rockets at Space X [4].

Fig- 5 FSW used in Aerospace industry

6. CONCLUSION

- High and reproducible weld quality (no pores, low inclination to cracking, low distortion and low loss of strength)
- Low susceptibility to defects - high process stability

- With corresponding backing, it is not necessary to re machine the bottom side of the weld; the weld surface may possibly also be left as it is

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