Joining of Aluminum Alloys with Friction Stir Welding Method

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1. Introduction

Friction stir welding is a solid phase welding method which takes place in non-traditional welding techniques and the industrial applications of this method intensify in recent years. In this method, parts in various geometries can be joined in solid state and not using extra metal.

Friction Welding (FW), which is older, forms the basis of this method. This joining method was appeared with the aim of joining non-ferrous metals which are difficult and expensive especially with traditional methods and brings material and energy saving together. Friction stir welding that has limited and very little usage in our country at industrial meaning are heavily used in aerospace, automotive and marine industry and supplies advantage for same and different material joining with low distortion after welding process according to the other special welding methods.

Friction Stir Welding (FSW) was invented and experimentally proven at The Welding Institute (TWI) in December 1991 and TWI holds a number of patents on the process. FSW uses a rotating and traversing non consumable tool to generate frictional heat and cause mechanical deformation at the joint. A constantly rotated cylindrical-shouldered tool with a profiled nib is traversely fed at a constant rate into a butt joint between two clamped pieces of butted material.

The process has numerous advantages over other joining technologies and can be used to weld numerous materials including, but not limited to aluminum, bronze, copper, titanium, steel, magnesium, and plastic.

Frictional heat is generated between the wear-resistant welding components and the work pieces. This heat, along with that generated by the mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to soften without melting. As the pin is moved forward a special profile on its leading face forces plasticized material to the rear where clamping force assists in a forged consolidation the weld. This process of the tool traversing along the weld line in a plasticized tubular shaft of metal results in severe solid state deformation involving dynamic recrystallization of the base material.

2. Materials and methods

FSW is a solid-state process, which means that the base materials to be joined do not melt during the joining process. Alloys from 2xxx and 7xxx series, which have traditionally been non-weldable can now be joined with FSW with speed and quality. The rotation action and the specific geometry of the FSW tool generates friction and mechanical working of the material which in turn generate the heat and the mixing necessary to transport material from one side of the joint line to the other. In FSW, a cylindrical shouldered tool with a profiled pin is rotated and plunged into the joining area between two pieces of sheet or plate material. The parts have to be securely clamped in a manner that prevents the joint faces from being forced apart.

Frictional heat between the wear resistant welding tool and the work pieces causes the latter to soften without reaching the melting point and allows traversing of the tool along the weld line. The plasticized material is transferred to the trailing edge of the tool pin and is forged by the intimate contact of the tool shoulder and the pin profile. On cooling down, it leaves a solid phase bond between the two pieces.

In this study, joining of 5083 aluminum alloys, obtaining optimum parameters, determining of mechanical properties of joined parts were experimentally investigated.

A milling machine, was designed as FSW experimental set-up for this study. In FSW method a non-consumable rotating tool, moves along a joint line between two components to produce high quality butt or lap welds, is used. For butt welding, the length of the pin is similar to the thickness of the work piece, so that the tool penetrates almost completely through the joint line.

The FSW tool consists of a profiled pin, which is contained in a shoulder of larger diameter than that of the pin. The pin for FSW experiments was given in Fig. 4. Subsequently, the pin depth, rotating speed and forward speed for pin which are the parameters for FSW were designed and FSW experiments were made.

The optimum parameters were designed according to literature studies and FSW pre-experiments.

3. Conclusion

The different research issues that can occur during friction welding of dissimilar materials were described in this paper. The structural effects during welding, mechanical properties of joints, and different configurations of the process in order to obtain high-quality welds were analyzed.

References:

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Welding in Space Conditions

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Introduction to the history

The first idea of the necessity to work on welding and cutting in space was stated by S.P. Korolev in 1965. The main differences between the space environment and the earthly environment are a deep vacuum with virtually unlimited speed of gas diffusion from the welding zone, a wide range of temperatures at which the products are to be welded, and weightlessness. Moreover, there are a number of secondary factors: limited abilities of the astronaut-operator in the spacesuit, high safety requirements, etc. Undoubtedly, all these affect the quality of welding. The first welding experiments in space were held in October 16, 1969 on the spaceship “Soyuz-6” by G.S. Shonin and V.N. Kubasov using the installation “Volcano”. The installation enabled automatical arc welding, plasma and electron beam welding.

Objectives of welding in space

It is known that welding in space will be used for the following purposes:

a) repair of spaceships, space stations and various metal equipment which are in outer space, on the moon and other planets;

b) assembly and installation of steel structures that are in orbital flight or on the surface of the moon and other planets.