Friction Stir Welding of Aluminum Alloys

Property Characterization and Relationships

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ABSTRACT

In this report we will look at Friction stir welding process. Friction stir welding (FSW) is a solid state joining process used in aircraft and marine industries. There are various variables of welding such as tool rotation and transverse speed for the welding of 6061 aluminum alloys. The examination for this type of welding will be a tensile test to check how good is the performance of the welding. This joining technique is energy efficient, environment friendly and can operate in all directions. High strength aluminum alloys are widely used for this type of welding.

Friction Stir Welding of Aluminum Alloy 6061
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INTRODUCTION

Friction stir welding (FSW) is a solid-state joining process that uses the heat generated by friction between the rotating tool and the piece material which leads to weld the workpiece. It was invented and experimentally proven by Wayne Thomas and a team of his colleagues at the Welding Institute UK in December 1991.

One of the merits of FSW that it does not required melting or filler materials. Although usually used for the aluminum alloys, FSW was used to join copper, magnesium, and titanium alloys, which are otherwise it is difficult to join by the traditional methods of fusion welding.

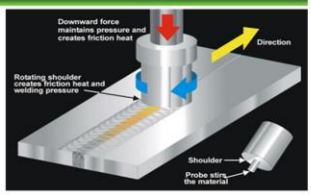
In fact, FSW Process of Al alloys has several merits over fusion welding. These merits include a great weld strength and there is no porosity and crystallization of cracking. FSW has been demonstrated to eliminating defects such as hot cracking in weld-metal, lack of fusion or incomplete penetration and softening of heat-affected zone. Formation of these defects is influenced by a combination of process and metallurgical factor.

PROJECT OBJECTIVES

The present work deals with welding of 6061 Al- alloy by FSW. The main goal is to achieve a high performance welding of 6061 sheet and avoiding all defects that lead to reduce the efficiency of the welding. In addition, The present work also addresses the effect of traverse and rotational speeds on the quality of Al-alloys joints

Principle of Fraction Stir Welding Process

FSW is a simple process (as shown in figure), in which a cylindrical shouldered tool with a profiled pin is inserted into the joint line between two pieces of material. Frictional heat is created between the wear resistant pin and the two workpieces, which are butted together.



PROJECT FRAMEWORK / METHODOLOGY

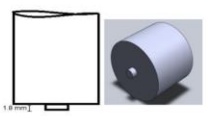
The welding samples were vertically welded parallel to the rolling direction using a manual convention milling machine VHF3. A carbon steel A54 fixture was used to fix the samples on the machine

The tool used was a cylindrical pin tool of shoulder diameter 16 mm, pin diameter 4.5 mm and length of 1.8 mm made of H13 steel.

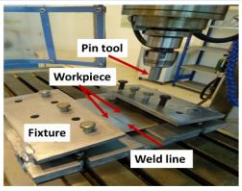
The chemical composition of Al-alloy 6061 sheet

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
0.4-0.8	Max 0.7	0.15-0.4	Max 0.15	0.8-1.2	0.04-0.35	Max 0.25	Max 0.15

Rotational speed (rpm)	Traverse speed (mm/min)
690	32, 45, 69
1130	32, 45, 69
2000	32, 45, 69

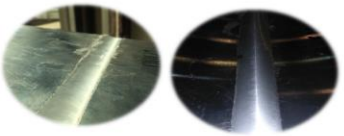


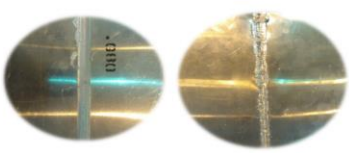
Round

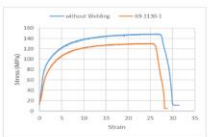


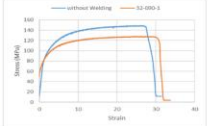
RESULTS

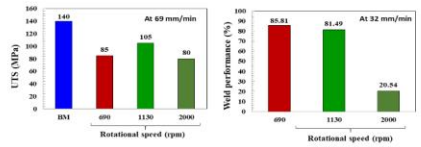
For measuring the performance we use the ultimate tensile strength test, to compare the welded regions with the base metal (BS). And we reach a good performance of 88% compared to the base metal.

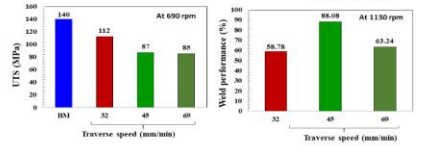












CONCLUSION

I. Welding parameters, including tool rotation rate and traverse speed are critical to produce defects free weld.
II. 6061 Al alloy 2-mm sheet thick was successfully joined using friction stir welding under the optimum conditions ranges of 32 to 69 mm/min of traverse speed with 690 to 2000 rpm of the tool rotational speed.
III. FSW will make some of aluminum welding applications easier, and the product will produced faster with a high efficiency.

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