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Analysis of Micro Vickers Hardness of Friction Stir Welding of Dissimilar Aluminum Alloys (AA6061-T6 and AA6082-T6)

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Abstract

Objectives: Friction Stir Welding method is used to join two metals or alloys with the help of rotating tool along the butt edges of the workpieces. The material reaches recrystallization temperature which leads to formation of high strength weld without the melting of joining materials. In this research, the dissimilar aluminum alloy plates (AA6061 and AA6082) of 6 mm thickness were Friction Stir Welded and mechanical properties were investigated. **Methods/Analysis:** Experiment was performed using Taguchi L9 technique and the different plates were welded with the help of friction at different tool rotational speeds of 800, 1100 and 1400 rpm by shifting the welding speeds i.e. 180, 150 and 120 mm/min and tool profiles (cylindrical threaded and taper threaded). **Findings:** It was concluded from the present study that the average value of hardness was lower compared to base alloy at the zone of nugget. **Novelty/Improvement:** Friction Stir Welding procedure can be economically utilized as a part of welding of different aluminum compounds.

Keywords: Driction Stir Welding

1. Introduction

Friction Stir Welding (FSW) is a framework in welding in which an characteristic tool is used to create frictional warmth at the welding region where metal material will be changed over into solid state[1]. Friction Stir Welding is a moderately new strong state joining process[2]. This joining procedure is energy efficient, environment well disposed, and adaptable[3]. Specifically, it can be utilized to join high-quality aviation aluminum alloys and different composites of metal that are difficult to be welded by traditional combination welding[4]. FSW is thought that it is best method of welding and most significant for the improvement in metal joining. This procedure is principally utilized on aluminum and regularly on substantial pieces, which can't be effortlessly warm treated, post weld to recoup temperature attributes[5]. The Friction Stir Welding is really, another innovation in the high execution aviation and car application. In contrast with conventional welding systems, FSW unequivocally lessens the nearness of contractions[6].

Aluminium alloys are basically used in industry due to its better corrosion resistance, high electrical and thermal conductivity[7]. The welding of the two different Cu alloys cannot be done easily with the help of conventional welding process due to which welding was done by friction stir method. The different alloys such as aluminium, magnesium, copper, ferrous and titanium were welded with the help of friction stir from last few years[8]. The welding process which is done by conventional process suffers from various types of defects such as porosity and in these pores gases entrapped which was not escaped during solidification[9]. The welding in which friction stir was used having non consumed rotating tool also maintained temperatures below melting point of materials being joined. It is difficult in joining materials with vastly different composition of materials with the help of conventional process of fusion welding[10]. The

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selection of appropriate filler material having intermediate properties is critical[10].

2. Experimentation

The material utilized for the trial work was AA6061 and AA6082 plates with measurements (100 mm x 50 mm x 6 mm). The VMC machine was utilized for welding purposes. The installation Figure 1 was utilized for completing test work. The high speed steel tools[11] were utilized for completing the Friction Stir Welding process. In the present study three distinctive instrument pin profiles were taken to examine hardness of welded sample. The distinctive pin profiles utilized as a part of this study are displayed in Figure 2.

The process parameters are rotational speed of tool, feed rate of tool and pin profile of tool[12]. The Taguchi L9 orthogonal array method was used for the different optimization with different inputs. The working parameters as shown in Table 1 implemented in this study are taken after different trials. The three levels are taken for each process parameter. Vickers micro hardness tests were completed on cross area opposite to the weld line, at mid thickness over the weld zone utilizing 100 gf load[13].

Figure 1. Fixture.

Table 1. Working parameters

	process parameters	level 1	level 2	level 3
A	Tool rotational speed(rpm)	800	1100	1400
B	Tool feed rate(mm/min)	120	150	180
C	Tool pin profile	Taper threaded	Cylindrical threaded (tpi-22)	Cylindrical threaded (tpi-14)

3. Analysis of Hardness

Hardness is the measure of resistance which material offers to change in shape. The information about the metallurgical changes caused by welding is provided by hardness measurement test. It was observed that with the increase of rotational speed there is increase in hardness, this is because of the reason that as a result of increased rotational speed more heat was generated due to which at recrystallization fine grains were formed which resulted in increased hardness. There was difference in hardness profiles formed at different tool rotational speeds, tool feed rate and tool pin profiles. From readings shown in the Table 2, the base composite hardness was found more as compared to normal hardness at zone of nugget. The micro hardness values changes in the welded territory and the parent material as microstructure of base alloy and joined zone are different. It was watched that with the expansion of rotational rate the hardness likewise expands, this is a result of the reason that as an after effect of expanded rotational speed more warmth was produced because of which at recrystallization fine grains were framed which brought about expanded hardness.

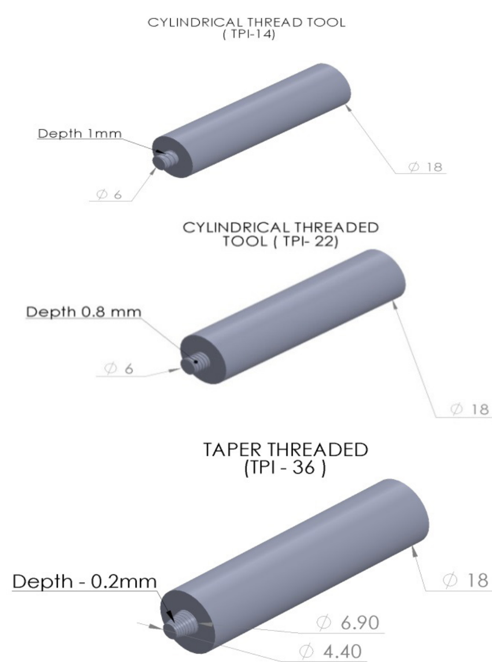

Figure 2. Tools used in the experiment.

Table 2. Microhardness (HV) at different distances from weld centre

Sr. no.	Microhardness (HV)								
	Distance from weld centre(mm) AA6082-T6				Weld Centre	Distance from weld centre(mm) AA6061-T6			
	8	6	4	2	0	2	4	6	8
1	76.3	77.2	64.7	66.4	71.8	75.6	76.8	67.7	64.5
2	73.5	68.2	54.6	69.8	65.9	68.2	59.6	53.9	73.4
3	71.9	74.5	53.4	57.8	66.7	57.5	65.3	77	84.3
4	80.5	76.1	66.1	74.5	76.7	81.6	81	62.5	73.2
5	92.1	81.3	64.9	58.4	78.3	68.1	54.7	64	65.5
6	69.4	67.9	64.4	75	72.5	67.8	68.9	69.3	79.2
7	80.5	67.8	71.1	75.7	78	80.4	68.4	72.1	82.1
8	58.8	72.8	71.3	65.5	70.4	70.2	64.2	63.1	72.6
9	77.6	69.7	69	70.5	68.1	66.7	75.7	58.1	72.2

4. Conclusion

It was concluded from different observations on castings components during experimentation that hardness average value at zone of nugget was lower than the base alloy.

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