Thermal Cycle in FSW of AA 6061-T6: Experimental Measurements

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Abstract

This work analyses the thermal cycle in frictional stir welding of AA6061-T6.sectioning method is adopted to analyses the thermal cycle raised in the practical experiment. This does not consider the conductivity if material and heat transferred between tool and specimen. The experiment conducted in five travel speed and the temperature measured by k-type thermo couple. The effect of travel speed also studied measuring with thermocouple attached at different points at different distance from the welded center line during welding .The effect of travel speed with respect to time also studied measuring with thermocouple .The thermo couple fixed at different points at different distance from the welded center line during the welding process .The temperature value and its variation against distance from center line and max temperature point is calculated from the thermocouple reading and timer is used to calculate the time with respected to the travel distance .In this case of experimental work the temperature increase at those point towards the plates end .For each method the variation of temperature from the centerline and speed vary in different ways this can be due to thermal conductivity of material but it is not effected in the formation of the material.
Keywords: FSW-AA 6061, Welding, Thermal cycle, Micro structural, Speed

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I. Introduction

Since FSW invention at 1991, frictional stir welding (FSW) has been technology of strong development in recent years. FSW has become a major joining process has revolutionized the construction of welded aluminum and ship building among other .The thermal cycle induced in the material during welding is an issue of greater importance because it effect like micro structural evaluation, plastic flow.

In this sense, studies have been made from experimental standard point in order to reach better understanding of the effects of FSW process and its variable on thermal cycle.

In this case plate thickness, tool geometry and effect of tool pins are not considered. Thermal cycle analysis can be approached either by two models purely thermal models or by thermo mechanical coupled ones. These coupled models are used to calculate the temperature generated by the action of travel speed.

II. Objective

The objective of this study was to analyze the thermal cycle produced during welding of AA6061 –T6 plates by FSW, for different travel speeds, by experimental model. In this study the effect of tool stirring is not considered.

III. EXPERIMENTAL PROCEDURE

In order to achieve the proposed objectives, AA6061-T6 plates of 100*50*4 mm butt welded by the FSW machine. In this case rotation seed of 514rpm and tilt angle of 2^0 while travel speed was varied from 51 to 206 mm/min. The frictional stir welding tool used was made of H13 tool steel, presenting a concave shoulder and a tapered pin. Shoulder diameter is 12mm, while the minor and major pin diameters are 3 and 4 mm respectively. Finally, the pin height was 3.7mm. in this experiment k-type thermocouples are used. which are located in the middle length of the specimen in the retreating side. They were placing them in holes with 1mm in diameter and 2mm deep, positioned approximately at 7,13,19 mm from the line.

After welding:

After the frictional stir welding process the specimen cleaned by chipping process. The removal of unwanted metal come out from the specimen during welding process is removed. The specimen shown in below the figure. And it undergoes tensile, hardness, microstructure analyses.

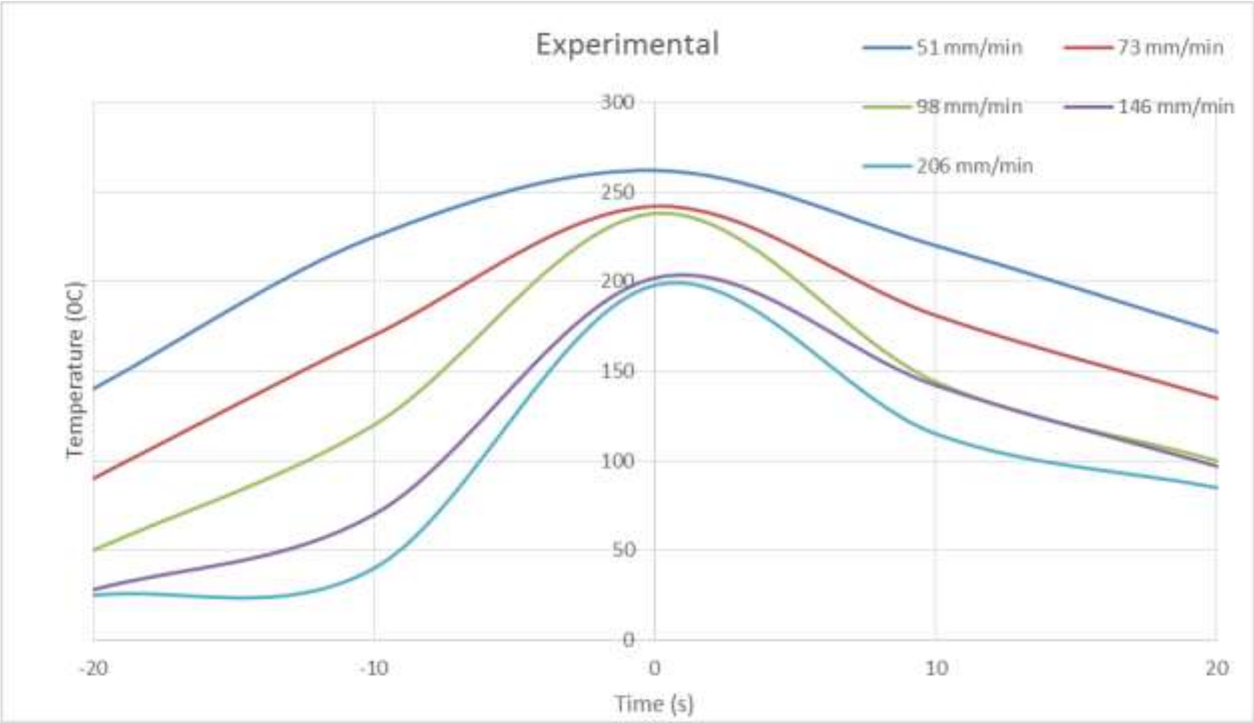
IV. RESULT AND DISCUSSION

Fig (1) is experimental thermal cycle .and those obtained from the difference values of thermal speed. It observed that although the powers were fitted with the thermal model described above, the results are acceptable. The oscillations in the thermal cycles may be due the parabolic nature of the elements .Although the small variation in the location of thermocouple one for each welding condition , the decreasing of the peak temperature and the raising of the cooling rate by increasing the travel speed are observed.

Fig (1) is the plot of temperature values monitored at a point with reference to time for different values of welding speeds. At all speeds the temperature at the point is measured for about 40 seconds. The thermocouple is kept at fixed distance from the weld line in all the 5 work pieces. A common observation is that, as the welding tool approaches the thermocouple position the temperature increases and reaches a maximum when the weld tool is closest to the center point where the thermocouple is kept. As the tool crosses the point temperature reduces because of heat dissipation.

An important observation is that as the welding speed increases from 51 mm/minute to 206 mm/minute the peak temperature values recorded at the specified point decreases from 260 degree Celsius to 200 degree Celsius. It implies that peak temperature of locations away from weld line is lesser at higher speeds. Hence it is a clear indication of the fact that heat affected zone narrows down as the speed of welding increases.

V. Thermal Cycles



The temperature values recorded against different travel speeds are tabulated below:

Sl. no	*Welding speed/travel speed*	*Recorded temperature*
1	*51 mm/min*	*262*
2	*73 mm/min*	*242*
3	*98 mm/min*	*238*
4	*146 mm/min*	*205*
5	*206 mm/min*	*198*

VI. CONCLUSION

In this present work were developed experimental approaches, in order to obtain thermal cycle in FSW process .Thermal cycles obtained by experimental measurements corresponding to the thermocouple for different travel speed. The obtained values at different travel speed have been correlated. The temperatures recorded at higher tool travel speeds are found to be lesser indicating that the heat affected zones at higher speeds will be narrow. Temperature increase at those point towards the plates end.

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