The Development of Process Technology for the Friction Stir Welding of Thick Section Aluminium Alloys

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ABSTRACT

The ability to join aluminium alloys by Friction Stir Welding (FSW) for a plate thickness of less than 10mm (typically below 6mm) using a generic FSW tool has meant that FSW is now one of the most rapidly expanding processes used for the joining of aluminium and its alloys in the Northern Hemisphere. Attempts however, to exploit this initial tool design for the purposes of welding thicker section (10mm and above) aluminium have proven not as successful.

The purpose of this study is to demonstrate how the interaction of the welding tool, particularly tool pin form in conjunction with rotational speed, applied force and processing temperature can account for joint formation during FSW. A lack of information concerning how the tool pin form influences weld temperatures, process loads and weld formation, when joining aluminium alloys with a plate thickness greater than 12mm has provided the impetus for this current study.

Fundamentally two welding tool pin designs (pin CT1 – conical threaded and pin CT2 – conical threaded with three flats) have been investigated for the FSW of 12.5 and 25mm thick 5083 H111 and 12.5mm thick 7075 O and T651 aluminium alloys. In order to realise processing temperatures in the region of the weld nugget for 25mm thick plate an instrumented FSW tool was designed containing thermocouples embedded in both the shoulder and pin of the joining tool. Results indicate that process temperatures correlate well between those measured in the workpiece (stir zone) and in the tool.

The conclusions from this study are as follows:

- Process parameters are interchangeable when FSW 12.5mm thick 5083 and 7075 aluminium alloys.
- Changes in tool pin geometry do not significantly affect heat generation between tools used under constant FSW parameters for a given alloy.
- Processing temperatures increase with increasing tool rotation speed.
- Changes in tool pin geometry affect processing loads. By minimising the force in the direction of weld travel this helps prevent weld defect formation.
- Adequate tool shoulder contact with the surface of the workpiece is essential if weld defects are to be avoided.
- Although the present study demonstrates tool CT2 is capable of producing sound welds in up to 25mm thick 5083 H111 alloy, this required the spindle motor of the

welder to operate at its maximum capacity. Hence this material thickness was found to be the limit of the FSW machine.