Comparing Numerical and Experimental Solutions of Friction Stir Welding of a Aluminium Plate

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Contents

1 Introduction

2 Experimental measurement

3 Numerical simulation by SYSWELD

4 Conclusions
Introduction

Friction stir welding (FSW) is a relatively new joining technology which was developed and patented in 1991 by The Welding Institute (TWI), United Kingdom [1].

This is a solid state welding process providing good quality of butt and lap joints.

The FSW process has been provided to be ideal for creating high quality welds in a number of materials including those which are extremely difficult to weld by conventional fusion welding.

Schematic of friction stir welding process is illustrated in Fig. 1.

Figure 1: Schematic diagram of FSW.
Experimental measurement

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Experimental measurement

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Experimental measurement
Numerical solution by SYSWELD

Example is presented in this section. The thermal properties for sheet and backing plate are described in Tab. 1, friction coefficient is 0.238, linear welding velocity is 1.67 mm/s, tool rotation velocity 41.89 rad/s, room temperature 15°C and heat exchange coefficient for convection 19 W/(m².K). In Fig. 3 is presented finite element model of sheet and backing plate. In Fig. 4 is shown finite element model of tool. In fig. 5 and 6 are presented the result of solution from program SYSWELD.
Material properties of sheet and backing plate.

<table>
<thead>
<tr>
<th>T(°C)</th>
<th>SHEET (Aluminum alloy)</th>
<th>BACKING PLATE (Steel)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$k\left(\frac{W}{mm\cdot ^\circ C}\right)$</td>
<td>$\rho.10^{-6}\left(\frac{kg}{mm^3}\right)$</td>
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<tr>
<td>20</td>
<td>0.130</td>
<td>2.750</td>
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<tr>
<td>120</td>
<td>2.730</td>
<td>951.0</td>
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<td>220</td>
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<td>320</td>
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<td>420</td>
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<td>2447</td>
<td>2.230</td>
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</table>
Figure 3: FEM model of sheet and backing plate.
Figure 4: FEM model of tool.
Figure 5: Temperature profile.
Figure 6: Velocity field.
Comparison FEA and Experimental data

- Measurement vs. SYSWELD (FEM)

Temperature (°C) vs. Weld length (mm)

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Conclusion

In this paper, a 3D finite element procedure is presented to model the thermofluid flow in FSW for the stationary step in SYSWELD. For the computation of the example proposed in section 3, the mesh is composed of 13457 nodes and 69111 elements.

In Fig. 5 is presented the temperature field from SYSWELD.

In Fig. 6 is shown the velocity field from SYSWELD.

The numerical results was compared with experimental measurement by thermo-camera and thermocouples, which will be presented in presentation on conference.
References


Acknowledgments

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THANK YOU FOR YOUR ATTENTION !