Numerical Simulation of Temperature Distribution and Material Flow During Friction Stir Welding 2017A Aluminum Alloys

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Abstract. This study describes the use of fluid dynamic code, FLUENT to model the flow of metal in the AA2017A case around the welding tool pin (FSW). A standard threaded tool profile is used for the analysis of phenomena during welding such as heat generation and flow of the material are included. The main objective is to gain a better understanding of the flow of material around a tool. The model showed a large number of phenomena similar to those of the real process. The model has also generated a sufficient amount of heat, which leads to a good estimate of the junction temperature. These results were obtained using a viscosity which is near the solidus softening.

1 Introduction

Friction stir welding (FSW) is recent method of welding in solid state, created and patented by The Welding Institute (TWI) in 1991.

In FSW a cylindrical, shouldered tool with a profiled probe, also called pin, is rotated and slowly plunged into the joint line between two pieces of sheet or plate material, which are butted together. The parts have to be clamped onto a backing bar in a manner that prevents the abutting joint faces from being forced apart. Once the probe has been completely inserted, it is moved with a small tilt angle in the welding direction. The shoulder applies a pressure on the material to constrain the plasticised material around the probe tool. Due to the advancing and rotating effect of the probe and shoulder of the tool along the seam, an advancing side and a retreating side are formed and the softened and heated material flows around the probe to its backside where the material is consolidated to create a high-quality solid-state weld.

2 fluid model

2.1 The Arbitrary Lagrangian–Eulerian (ALE) for fluids problems

Because of its larger capacity, compared to the Eulerian description, of dealing with interfaces between materials and the moving boundaries, the description of the Arbitrary Lagrangian–Eulerian (ALE) is widely used for spatial discretization problems in fluid dynamics and structural. In fact, the method is frequently used in "hydrocodes" to simulate the response of large distortion / deformation of the materials.

The most obvious return of an Arbitrary Lagrangian–Eulerian (ALE) formulation in flow problems is that the convective term must take into account the mesh movement. Also, the grid movement may increase or decrease the effects of convection.

It is important to note that the stress tensor depends on the pressure or on the velocity field according to the viscous or non-viscous flow. This is not the case in solid mechanics. Thus the determination of the stress is not a major concern in the dynamics of Arbitrary Lagrangian–Eulerian (ALE) fluids.

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