

Chapter 1

Transient Thermal Analysis of FSW Tool With Different Material by Using Computational Testing Method

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ABSTRACT

Friction stir welding (FSW) is a prevalent solid-state joining method. This procedure entails a revolving instrument that comprises a cylindrical pin and a shoulder. The pin infiltrates the material to produce frictional heat, while the shoulder ensures stability and exerts pressure throughout the welding procedure. For more resilient materials, the creation of economical, lasting equipment that can generate robust welds is crucial for the economic feasibility of FSW. The selection of tool material and its design profoundly influence tool efficacy, weld quality, and total expenditure. In this context, structural steel has exhibited superior thermal properties, with the maximum heat flux measured at 81.26 W/mm². This signifies the material's efficacy in conducting heat to the welding plates, attaining the requisite temperature for a successful welding operation. Titanium tools exhibit a heat flux of 31.87 W/mm².

1. INTRODUCTION

Friction stir welding (FSW) is an environmentally sustainable technology that eliminates the need for electrodes, rendering it a cleaner option compared to conventional welding methods. FSW is frequently employed to unite lightweight metals, including copper, aluminum, magnesium, and zinc alloys (Abnar, Kazeminezhad, & Kokabi, 2015; A. Kumar, Liu, & Kumar, 2024). A restriction, however, is that the lifespan of FSW joints often is shorter than that of the original material. Although a relatively recent concept developed in 1991, FSW has demonstrated significant cost-effectiveness (Ahmed, El-Sayed Seleman, Fydrych, & ÇAm, 2023). The efficacy of Friction Stir Welding (FSW) is significantly influenced by the employed tool, which generally comprises a spinning rounded shoulder and a threaded cylindrical pin (Almoussawi, Smith, & Faraji, 2018). This instrument produces heat predominantly via friction and manipulates the softened alloy to create the weld junction (Asl, Mirsalehi, & Dehghani, 2019). In contrast to conventional fusion welding, friction stir welding (FSW) circumvents prevalent problems such as solidification cracking, porosity, and the depletion of alloying elements, as the material remains below its melting temperature (Çam, 2011). These benefits have facilitated its commercial success in welding soft alloys such as aluminum. Welding tougher alloys, such as steel and titanium, presents complications (Anand, Satyarthi, Bharti, Kumar, & Kumar, 2024; Linton & Ripley, 2008). However, Friction stir welding

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