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Probing Torque, Traverse Force and Tool Durability in Friction Stir Welding of Aluminum Alloys

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Abstract

A coupled theoretical and experimental study was undertaken to examine the impact of plate thickness, alloy strength and processing conditions on the susceptibility of tool failure in friction stir welding of AA7075 and AA7039. A three-dimensional steady-state heat transfer model was used to compute the temperature field in tool and workpiece alloy. The torque and traverse force, and the mechanical stresses on the tool were estimated analytically and validated with the corresponding experimentally measured results for a range of processing conditions. The propensity of the tool to failure was assessed by a durability factor, which was estimated as a ratio of tool material strength at the computed peak temperature and the resultant mechanical stress on the tool probe. The results showed that rise in welding speed, alloy strength and plate thickness could lead to increased mechanical stresses on tool probe, reduced durability factor and enhanced susceptibility of tool failure. The overall methodology was used successfully to provide the underlying basis for two reported practical examples of tool failures in friction stir welding.

Keywords: Friction stir welding; AA7075; AA7039; Torque; Traverse force; Tool durability