Numerical model for prediction of tool wear and worn-out pin profile during friction stir welding

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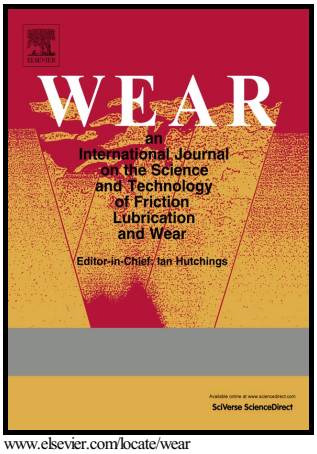

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PII: S0043-1648(17)31731-3
DOI: https://doi.org/10.1016/j.wear.2018.05.007
Reference: WEA102418

To appear in: *Wear*

Received date: 3 December 2017
Revised date: 23 March 2018
Accepted date: 9 May 2018

Cite this article as: Pankaj Sahlot and Amit Arora, Numerical model for prediction of tool wear and worn-out pin profile during friction stir welding, *Wear,* https://doi.org/10.1016/j.wear.2018.05.007

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Abstract

Understanding tool wear during friction stir welding (FSW) is important for joining of high melting point metallic (HMPM) materials. Heat transfer and material flow based models developed in past have improved understanding of the FSW process. However, numerical models to predict tool wear and pin profile during FSW of HMPM materials are not available. Thus, the current research has focused on developing a heat transfer and material flow based model to predict tool wear and worn-out tool pin profile of H13 steel during FSW of Cu-0.8Cr-0.1Zr (CuCrZr) alloy. Temperature evolution and material flow are computed by solving conservation equations of mass, momentum and energy. The model thus developed is validated for thermal cycles and tool pin profile for various process parameters. Tool wear is predicted based on forces and stresses acting on the tool. Modified Archard's wear theory is applied to compute tool wear and worn-out tool pin profile. The wear model successfully predicts the worn-out tool pin profile and self-optimized phenomena for various process parameters. The model is also applied to understand the changes in worn-out pin profile during FSW process.

Keywords: Friction Stir Welding; Numerical modelling; Thermal cycle; Stresses; Wear depth; Tool pin profile