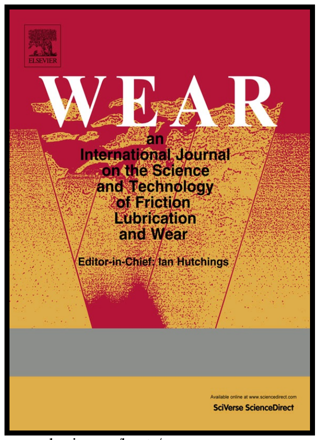

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Prediction of tool wear in the blanking process using updated geometry

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Abstract

Predicting the die and tool replacement time in the blanking process is very important in terms of product quality and cost efficiency. In order to predict tool life, tool wear must be observed constantly and the product defect rate must be analyzed. In this study, a procedure to predict tool life during the blanking process is proposed. Tool wear is represented with the modified Archard wear model and the Lemaitre damage model for ductile fracture. These models express abrasive and fatigue wear, respectively. The surface geometry of a tool is updated based on the computed amount of wear to describe the phenomenon of realistic wear. Through the blanking process, the amount of wear that is measured and calculated is compared. The difference was found to be 7.2%. Using the calculated wear result, the tool replacement time was predicted and the wear prediction procedure was validated by performing a series of procedures using other process conditions.

Keywords: Tool wear; Smart die system; Archard wear model; Blanking process; Lemaitre damage model

1. Introduction

When tool wear occurs, it is difficult to manufacture an accurate product because the dimension of the tool is slightly changed by the wear. This also increases the defect rate of the product, which leads to decreased cost efficiency. While it is important to replace the tool within a proper time frame, it is difficult to measure tool wear in real time and determine the tool replacement time on the basis of tool wear. Recently, a smart die system, which optimizes the process conditions through a process simulator and measures the tool wear in real time, is being researched. However, that system is not yet at a level that can be commercialized and it has limitations in that initial investment is required. In this present study, tool wear was quantitatively predicted and a wear prediction model that could be applied to a smart die system was developed. Tool replacement time was also determined on the basis of tool wear.

Many studies have been conducted to understand tool wear. Most of those studies have investigated the influence of tool wear on product formability based on experimental or empirical information [1-4]. Several studies have predicted tool wear using a numerical analysis model applied in two dimensions [5-8]. However, the calculations obtained from a two dimensional model cannot fully describe the real phenomena that occur in the actual field. Recent studies have been performed in three dimensions using numerical analysis. Attanasi et al. [9] predicted tool wear based on cutting time and velocity in the metal cutting process using a 3D simulation model. Hoffmann et al. [10] simulated the deep drawing process by applying the Geometry-Update-Scheme (GUS) in order to calculate the die wear. Behrens [11] used the hardness model dependent on heat to calculate the die wear in the hot casting process. Tugrul Özel [12] proposed a simulation model to predict microscale cutting tool wear. However, these studies did not consider the cycle of the process, which