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Study of severe plastic deformation process based on E-fast sensitivity analysis to optimize parameters

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KEYWORDS

Sensitivity Analysis,
E-fast Statistical Method,
Design of Experiment,
Extreme plastic deformation,
Extrusion in angled channels.

ABSTRACT

In this paper, the optimization of effective parameters on the process of severe plastic extrusion deformation in the torsional angular channels of the plate is investigated. Initially, the process test was designed using the response procedure method, and four main and influential input variables on the process, torsion angle, radius, channel angle, and coefficient of friction, were extracted, and the regression equations of each for the mechanical properties of the samples produced by this method. Using sensitivity analysis, which is very useful in the production of parts and industry today, and by using it, the quality of manufactured parts can be greatly improved and production costs can be reduced to a large extent, the effect of input variables on plastic strain Parts checked. In this paper, the mean and maximum strain and maximum force, which are defined under the influence of these input variables, have been investigated and analyzed using the e-Fast statistical sensitivity analysis method. The results of the analysis show that the mean strain is affected only by the values of torsional and channel angles, but the maximum strain is affected by the coefficient of friction and has a direct linear relationship with its changes. The maximum force is also in a balanced state from the effect of the variables. Also, the quantitative effect of torsion angle of 52% and channel angle of 48% on mean strain and coefficient of friction with 86% and torsion angle with 42% had the greatest effect on strain and maximum force.

1. Introduction

Sensitivity analysis is the study of the influence of output variables on the input variables of a statistical model. In other words, there is a way to change the inputs of a statistical model in an organized way that can predict the effects of these changes on the output of the model. Experimental design method is one of the statistical methods of quality improvement. Sensitivity analysis increases the accuracy and validity of validation, optimization, and risk-taking in model simulation analysis. Analysis methods are classified into two categories: classical and modern. The classical method has been inflexible for experiments, but in the modern method, which is programmed based on regression models [1]. Sensitivity analysis is an important tool commonly used to confirm the achievement of an optimal set. The obtained parameters are analyzed by regression. Minimizing the amount of objective function based on the sum of the predicted errors and empirical squares is one of the solutions to optimize the sensitivity analysis [2]. Experimental design is a valuable and powerful tool in identifying critical parameters, optimizing chemical processes, and identifying efficient areas for performing critical operations in processes. Despite the advantages of experimental experiments, the experimental design method, like any other new technology, has met with resistance [3]. E-Fast statistical sensitivity analysis method analyzes the effect of input factors on output factors. This method, which is very accurate and fast, has been used by Taheri to investigate the effect of dimensional factors on the force and critical time of nanomanipulation. Nanomanipulation is one of the most up-to-date processes in the world of nanotechnology that has many applications in the world of industry and medicine. Manipulation means displacement, and in this process, particles at the nano/microscale are displaced using an atomic force microscope to create new material [4].

2. Modeling

In this paper, modeling consists of two parts:

A) Design of experiments using the response method

B) Evaluation of statistical sensitivity analysis of e-fast.

One of the best optimization techniques is to use the response procedure method. This method has also been used to describe different types of processes in the industry. This method is a summary of the rules and instructions of statistical and mathematical sciences that are used to model and predict the results of input variables on output factors under the influence of optimization. The response method also makes a good connection between feedback and controllable input factors.

3. Conclusions

Severe plastic deformation, like any other process in the world of industry and technology, requires increased quality and improved optimization. The extrusion process in angular torsional channel plates is a new method for the production of parts from the fabrication and production subset of parts by the method of severe plastic deformation. Four input variables including: torsion angle, radius, channel angle and coefficient of friction as

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input factors affecting two important mechanical factors of parts including: mean and maximum strain and maximum force have been investigated using the sensitivity analysis method of E-Fast. For strain, the mean values of torsion angle and channel had the greatest effect, but the effect of radius and coefficient of friction had no effect on the trend of changes in mean strain. Also, for maximum strain, the coefficient of friction had the greatest effect in terms of quantity and quality, and the variables of torsion angle and channel angle were in the next order of effect. The maximum force is also affected by an equilibrium state of the input variables, in terms of quantity, channel angle, coefficient of friction and torsion angle, respectively, have played a role in determining the maximum force. The input variable of radius was also completely ineffective for maximum strain and had very little effect for maximum force.

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