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PII: S0924-0136(17)30220-0
DOI: http://dx.doi.org/doi:10.1016/j.jmatprotec.2017.06.001
Reference: PROTEC 15254

To appear in: *Journal of Materials Processing Technology*

Received date: 12-3-2017
Revised date: 28-5-2017
Accepted date: 2-6-2017

Please cite this article as: Hu, Chengliang, Yin, Qiang, Zhao, Zhen, A novel method for determining friction in cold forging of complex parts using a steady combined forward and backward extrusion test.Journal of Materials Processing Technology http://dx.doi.org/10.1016/j.jmatprotec.2017.06.001

A novel method for determining friction in cold forging of complex parts using a steady combined forward and backward extrusion test

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Abstract: Forward and backward extrusion are used extensively in the forging industry, and combined forward and backward extrusion occurs during the forging of complex parts. To determine the friction factors in a complex cold forging process, a new method is proposed based on a steady combined forward and backward extrusion test. During this test, extruded specimens without dead zones were obtained, decreasing the required ductility of the testing materials. Consistently obtaining a stable final shape, including the forward rod and the backward cup, is beneficial for standardizing the subsequent measurements. To improve the sensitivity to friction, key parameters that describe the deformation degree of the forward and backward extrusion and the geometry of the punch and die were optimized based on finite-element simulations. After the steady analysis, an improved scheme based on the optimal scheme was obtained as the final design of the steady combined forward and backward extrusion test. From the simulation results, two groups of calibration curves were constructed for different ranges of friction factors. Experiments were carried out to validate the steady combined forward and backward extrusion test. The test procedure was introduced and friction factors were measured for five different lubricants and for dry friction in the cold extrusion of steel. The results from the conventional ring compression test were used in the comparative analysis.

Keywords: Friction factor; Forward extrusion; Backward extrusion; Calibration curve; Sensitivity; Cold forging

1. Introduction

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