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Investigation of the lubrication influence on single-phase and multi-phase ironing processes

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Abstract

The ironing process in the cold conditions is frequently accompanied by the high contact pressures and local loading of tools, especially in the multi-phase processes. In such conditions, lubrication has a decisive influence on the successful forming. Absence of lubricant would lead to direct contact of the thin sheet and the tool (die) what would consequently cause the disturbance of the forming process stability; frequently the process would be hindered. Lubrication, as a measure for decreasing the harmful influence of friction at the contact surfaces, enables increase of the deformation and drawing degree. In that sense, experimental investigations were conducted of influence of various types of lubricants on the single-phase and multi-phase ironing processes. The corresponding tribological model was adopted, which is based on sliding of the thin sheet strip between the two side contact elements, which are ironing it. The tribological model was realized according to original experimental device. The variation of the drawing (tensile) force, contact pressures and the friction coefficient were monitored for each type of lubricants, in the single-phase and the three-phase ironing conditions, at the constant sliding speed. In that way, the estimates of each individual lubricant was done. The objective of this research was to compare the tested lubricants from the aspect of their quality and applicability in the ironing processes.

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Keywords: Ironing, tribological model; contact pressure; friction coefficient; tensile force;

1. Introduction

The friction coefficient was selected as a main criterion for assessing the performance of lubricants in the ironing process. It was calculated according to research results given in [1, 2]. The objective of this paper was to compare behavior of three conventional lubricants during the process with contact pressure of medium-intensity, such as the single-phase and multi-phase strip-ironing test. An original experimental apparatus was designed using a methodology based on monitoring the friction coefficient during the process [3, 4]. It is based on sliding the samples made of thin sheets between the side elements (die). The contact surfaces of the sample and the sliding elements were separated by the lubricant's layer. The three types of lubricants were tested: (I) the lubricant in the form of the zinc-phosphate coating (denoted as lubricant L1); (II) lubricating grease based on the molybdenum – disulphide (denoted as lubricant L2); (III) mineral oil for deep drawing (denoted as lubricant L3). The friction coefficient values were calculated, for each type of lubricant and each ironing phase, in terms of the holding force and registered drawing force.

Numerous researchers were dealing with studying the lubricants performance during the ironing process, [5-11]. The specimen material in [9] was an AKDQ 1008 steel sheet. A cup-shaped thin sheets specimen was used in [12] and [13] to

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