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INFLUENCE OF LUBRICANTS ON THE MULTIPHASE IRONING PROCESS

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Abstract

In this paper are presented results of experimental investigations of the type of lubricants influence on the ironing process. The tribological model was adopted, based on sliding of the metal strip between the two contact elements. Variations of the tensile force, contact pressure and the friction coefficient were investigated for each of the applied lubricants, in the three-phase ironing process, at constant sliding velocity. The objective of these investigations was to compare the applied lubricants and to estimate their quality from the aspect of their applicability in the ironing process.

Keywords: *Ironing, Tribological model, Friction coefficient, Contact pressure, Tensile force.*

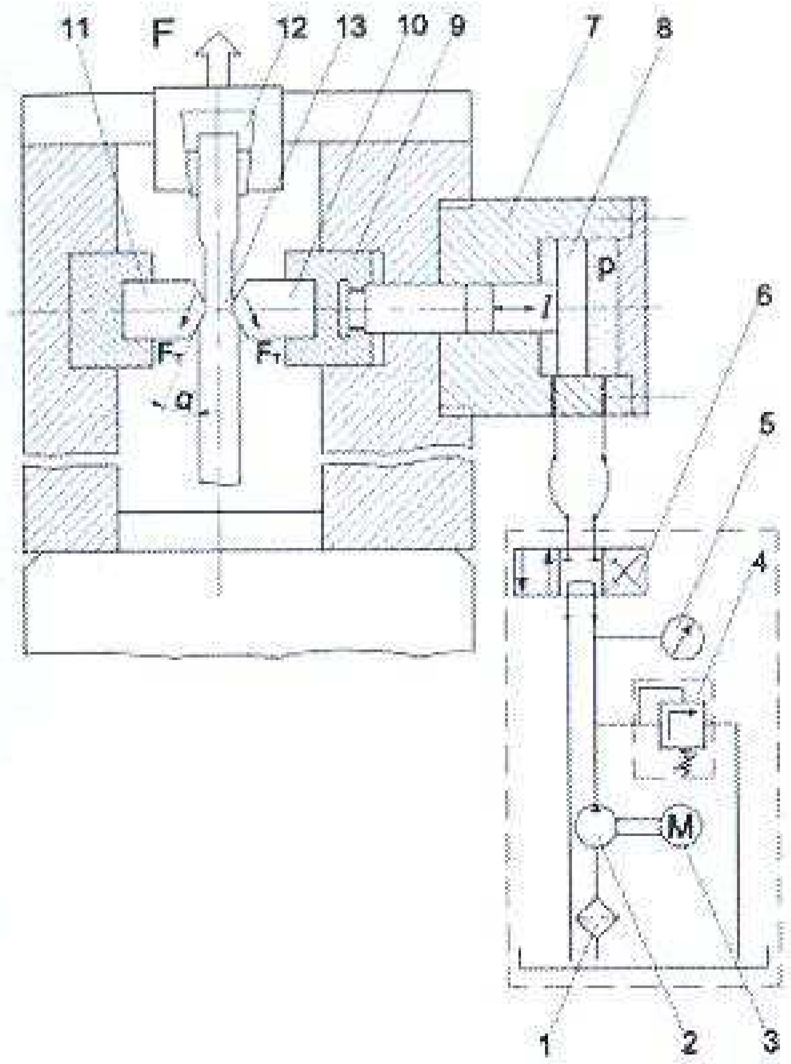
1. Introduction

The ironing process in cold conditions is frequently characterized by high contact pressures and local load of the tool, especially in the case of the multi-phase process. In such conditions, the lubricant has the decisive influence on plastic forming. Absence of lubricant would cause the direct contact of the machined piece and the tool, what would significantly disrupt the stability of the forming process. Lubrication, as a measure of reducing the damaging influence of friction, enables increase of the deformation and deep drawing degree, [1]. Application of lubricants eliminates or decreases the harmful phenomenon of galling, [2], wear of the tool's working surfaces and improves the quality of the machined piece surfaces.

Based on the adopted tribological model [3, 4], the original device was developed, based on sliding of the thin sheet samples between the side elements (die) in three phases. The contact surfaces between the sample and the die were separated by the layer of lubricant. The three types of lubricants were applied: a) lubricant in the form of the zinc phosphate coating with oil, b) lubricating grease based on molibdenum-disuplhate and c) oil for deep drawing. For each type of lubricants and the blank holding force, the measurement of the tensile force was performed.

2. Experimental device and the tribological model

For experimental investigations a device was constructed which models the symmetrical contact of the thin sheet with the die during the ironing process [3, 4] (Fig. 1). The metal strip is being placed into the holding jaw 12. The jaw with the sample is moving from the bottom towards the top, by the mechanical part of the device. The sample is being acted upon by the side elements 10 and 11, which simulate the die and perform the ironing. The moving sliding element 10 is placed into the holder with a T-groove 9, which is moving with piston 8 and hydro-cylinder 7. The sliding element 11 is fixed. During the ironing process the recording of the tensile force is being done at over the total length of the punch travel of approximately 60 mm, by the corresponding measuring chain.



1 – F ilter
2 – Pump
3 – Actuator
4 – Irreversible valve
5 – Manometer
6 – Two position distributer
7 – Cylinder
8 – Piston of cylinder 7
9 – Holder with the T-groove
10 and 11 – Sliding elements
12 – Jaw for sample holding
13 – Sample

Fig. 1. Block scheme of the experimental device

Tribological model, used in this experiment, was developed based on an idea presented in [3]. In the large number of cases, the tribological models can not completely simulate real processes [4]. Due to that, the more detailed analysis of the process being modeled is necessary. The applied model enables realization of the high contact pressures (Fig. 2a). The basic idea in realization of this device was to provide for determination of the friction coefficient at the contact surface between the siding element and the sample, based on what the estimate of the lubricant became possible (Fig. 2b). Calculation of the friction coefficient requires analysis of forces that act on the contact surface at certain angle, as well as on the input portion of the side element (Fig. 2b). In that sense, it was proposed, based on observations about the classical approach deficiencies [4], to take into account forces F' and F_{TR}' in the input zone. Then, the inaccuracies were avoided of the friction coefficient values. Caused by simplifications in the basic model [3].

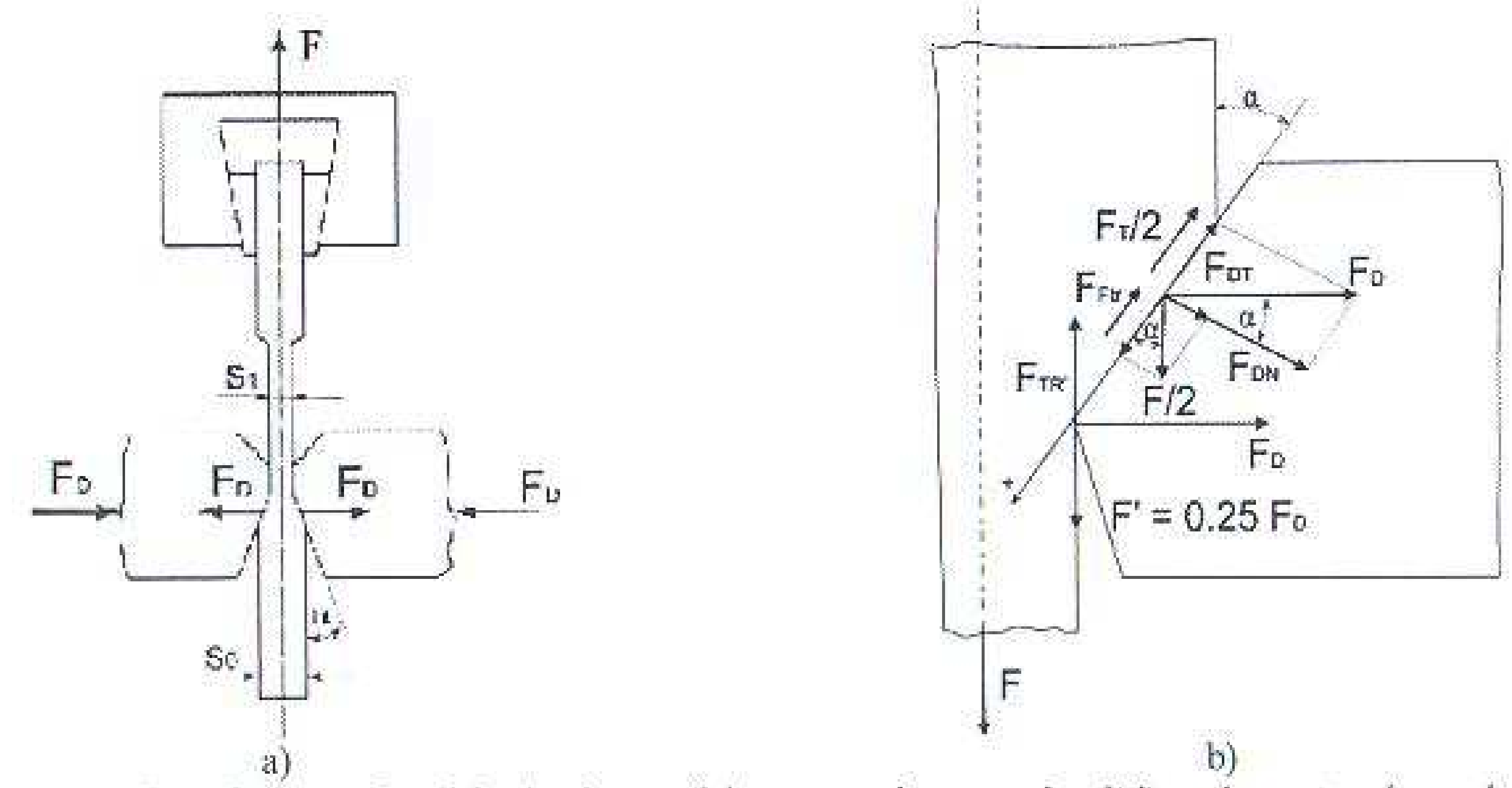


Fig. 2. The tribological model: a) scheme of the contact between the sliding element and samples; b) Scheme of the forces' action.