34th INTERNATIONAL CONFERENCE ON PRODUCTION ENGINEERING
28. - 30. September 2011, Niš, Serbia
University of Niš, Faculty of Mechanical Engineering

IMPORTANCE OF TRIBOLOGICAL CONDITIONS AT MULTI-PHASE IRONING

Milentije STEFANOVIĆ[1], Slaviša ĐAČIĆ[2], Srbislav ALEKSANDROVIĆ[1], Dragan ADAMOVIĆ[1]
[1]Faculty of Mechanical Engineering in Kragujevac, s. Janjic 6, 34000 Kragujevac, Serbia
[2]Coal Mine A.D., Pljevlja, Montenegro,
stefan@kg.ac.rs, djale@t-com.me, srba@kg.ac.rs, adam@kg.ac.rs

***Abstract*:** *The importance of tribological conditions in metal forming is well known and equal to other forming process factors – material, machine and tool. The results obtained in investigation of the effects of tribological conditions in cold metal forming are presented in the paper. A typical tribo-model is strip ironed between angled die surfaces. The changes in pressure, friction coefficient and surface topography in single and multi-phase sliding in the conditions of boundary lubrication were investigated. The low carbon mild steel sheet, suitable for plastic forming, was used. In dependence on conditions in contact, it is possible to realize various friction lows. In course of investigation the so called constant low friction has been realized in condition of high contact pressures. The results of multi-phase sliding, which simulates the moving of piece through dies, are especially significant.*

Key words: *cold forming, multy-phase ironing, friction coefficient, sheet metal*

1. INTRODUCTION

In cold metal forming processes, characterized by high pressures, local tool loads, generating of new piece surfaces etc., realisation of the convenient lubrication regime and elimination of micro-welding are of extreme importance. Distribution and intensity of shearing stresses on piece surface influence the possibility for plastic forming, i.e. the size of active force, energy consumption, tool life, piece surface quality etc. Taking into consideration the complexity of specified factors, tribological investigations in MF processes are extremely important and equal with investigations of other forming system segments - machines, tools and materials.

In the closed system tool-lubricant-material numerous tribological factors are present, most of which are variable during the process and are in a particular interaction, which makes the entire problem extremely complex. These factors can be observed from macro-geometrical, rheological or some other aspect. Some factors which are very important are: properties of tool material and material being formed, thermal problems (temperature, heat transfer, …), micro- and macro-properties of forming process, relation of contact and free surface of the piece, friction properties, lubricant and lubrication method properties, contact surface roughness and its orientation, plasticity, fatigue, adhesion, diffusion, wear, stress and strain distribution, sliding speed, remaining stresses, damages, physical-chemical properties, condition of surface etc [3].

Proper selection of tribological conditions and identification of boundary relations on contact surfaces enables controlled flow in surface layer, whereat this layer has sufficiently lower flow limit than basic material and can be defined without fracture. By combination of main tribo-factors in forming system – speed, load (strain ratio), type of materials in contact (topography, content), preparation of contact surface and lubricant type, it is possible to realise mixed, i.e. boundary friction. In that way, contact between tool and piece material, tearing of softer material particles and rough disruptions of forming conditions are reduced to minimum.

At ironing, pieces of considerable height in relation to diameter are obtained, with bottom thickness larger than wall thickness. In forming, which is most often multi-phase for one stroke, inner diameter slightly changes. Total thinning, i.e. number of rings and geometrical relations of work surfaces of tool elements are important in forming.

2. CHOICE OF TRIBOLOGICAL MODEL

Modelling of tribological conditions at ironing implies satisfying of the minimum of necessary criteria considering the similarity in stress strain properties, temperature-speed conditions, properties of tools surface and material. Classical scheme of ironing is shown in Fig. 1, and different tribo-models of ironing are shown in Fig. 2.

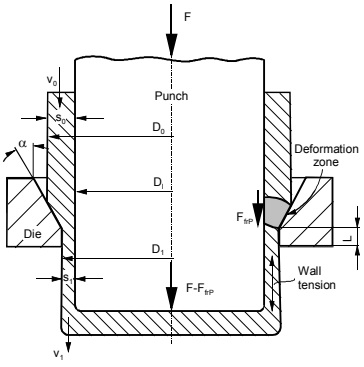

Fig. 1. Scheme of ironing