



## CHARACTERISTICS OF FRICTION IN SHEET METAL SLIDING WITH THICKNESS REDUCTION

Đačić Slaviša<sup>1</sup>, Milentije Stefanović<sup>2</sup>, Srbslav Aleksandrović<sup>2</sup>, Dragan Adamović<sup>2</sup>

<sup>1</sup>Coal Mine A.D., Pljevlja, Montenegro, djale@t-com.me

<sup>2</sup>Faculty of Mechanical Engineering Kragujevac, Serbia, stefan@kg.ac.rs; srba@kg.ac.rs; adam@kg.ac.rs

**Abstract:** Presented in the paper are results obtained in investigation of the effects of tribological conditions in cold metal forming. A characteristically tribo-model is strip ironing between angled die surfaces. Investigated were the changes in ironing force, pressure, friction coefficient in single and multi-phase sliding in the conditions of boundary lubrication. The low carbon mild steel sheet, suitable for plastic forming was used. In course of investigation the so called constant low friction has been realized in condition of high contact pressures. Especially significant are the results of multi-phase sliding, which simulates the moving of piece through dies.

**Keywords:** cold forming, 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.

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. TRIBOLOGICAL MODEL DESCRIPTION

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. In researches, the results of which are presented in this paper, the basic ironing model, which imitates zone of contact with die with biaxial symmetry, was used as tribo-model, fig.1. This is a classical model, which enables realisation of high contact pressure and takes into account real geometrical conditions of forming process. It was used in many researches, especially in the area of tribology of stainless steel sheet metals and in Al- alloys forming [1], [2].





