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DIFFERENT WAYS OF FRICTION COEFFICIENT DETERMINATION IN STRIPE IRONING TEST

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Abstract: *The sheet metal stripe ironing laboratory test has been developed to study tribological appearances and performance of lubricants in ironing process. Most common way for friction coefficient determination in the test is use of different formulas which gives relation between active forces and reactive friction forces. In application of such formulas some difficulties occurs because of improper friction coefficient values, especially at small intensities of tensile or drawing forces. In this paper for literature approaches were analyzed and after that defining of new formula were proposed. New formula was tested numerically and experimentally. Obtained results indicated that the suggested improvements give much more acceptable values of friction coefficient. That fact is particularly significant in lubricant evaluation process.*

Keywords: *Thick sheet metal, stripe ironing test, friction coefficient*

1. INTRODUCTION

Ironing is technological process which combine characteristics of sheet metal forming and bulk forming. Thinnig strain reach over 25%, and contact pressure over 1000 MPa [1]. Most often applies in manufacture of cylindrical geometry pieces whose depth is much bigger than diameter, and bottom thickness is bigger than wall thickness.

Ironing is normally applied following deep drawing (or extrusion) when forming high, thin walled cans. Such cans are used for beverages, cartridge cases, high pressure cylinders, housings for pumps and shock absorbers etc. World annual production (especially for beverage cans) are more than billion pieces [2].

Of the sheet metal forming processes, ironing is one of the tribologically most severe, owing to the high surface expansion and normal pressure at the tool-workpiece interface. This is particularly significant in the case of forming of pour fomability materials such as stainless steel, high strength steel, etc. [3]. Because of that, use of proper performace lubricants is very significant. In order to quantify the performance of the individual lubricants, a different simulative test methods has been developed. All the tests are modelling the process conditions in ironing. It is a very convenient to use coefficient of friction at contact surfaces change as a criterion for lubricants evaluation.

For this study one of classic stripe ironing tests was chosen [4]. By analysis of acting of drawing force, side forces and friction forces well known formula was determined. This particular formula established the connection between tool geometry, forces and coefficient of friction. The formula was used in different researches, [4, 5, 6, 7, 8] in genuin or modified form.

However, by more accurate measurements of the drawing force was shown that formula gives negative friction coefficient values in range of force smaller intensities. That fact was indicated yet in article [5]. That was motive for making analysis of several approaches with goal to obtain more convenient formula appropriate for above mentioned strip reduction test.

2. DEFINING OF FRICTION COEFFICIENT

Figure 1 shows scheme of the stripe ironing test tooling which models the symmetrical contact of the sheet with the die during the ironing process. The metal strip is being placed into the holding jaw. 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