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ScienceDirect
Procedia Technology 12 (2014) 433 – 438
Procedia Technology

The 7th International Conference Interdisciplinarity in Engineering (INTER-ENG 2013)

An analysis regarding the variation of necessary force by the indirect extrusion processes

Teodor Socaciu[a,] *

[a]Petru Maior University, Tîrgu Mureş, Romania

Abstract

In comparison with other working procedures of hollow parts, indirect extrusion is characterized by high precision and productivity. Efficiency of the process imposed intense theoretical and experimental research over the years, resulting in widening the range of products manufactured [2, 4, 5, 6, 16]. To exploit these advantages, it is necessary to continue studying the issues arising from this process. Thus, the flow of the material can be unsatisfactory due to the strong friction arising between it and the working parts of the die, friction caused by the breakdown of the lubricant film at high pressure and temperature conditions existing during processing. Also, the forces and pressures that occur at high indirect extrusion worse than energy parameters of the process and considerably reduces tooling durability [1, 3, 8, 9, 17].
This paper presents an analysis of the indirect extrusion force needed depending on the size of the workpiece, friction conditions and proposes solutions to optimize energy consumption in the process of processing.

Keywords: indirect extrusion; friction; force; energetic parameters;

* Corresponding author. Tel.: +40-0265-233212
*E-mail address:*teodor.socaciu@ing.upm.ro

doi:10.1016/j.protcy.2013.12.510

1. The calculus of the necessary extrusion force

The necessary extrusion force by indirect extrusion (figure1) is constituted of the following components [10, 14, 15]:

- F_m- the friction force between the workpiece and the extrusion plate;
- F_p- the friction force between the workpiece and the stamp;
- F_r- the compression force that works on the part of the workpiece situated under the stamp;
- F_{def}- the deformation force.

The necessary extrusion force can be written as the sum of forces presented above:

$$F = F_m + F_p + F_r + F_{def} \tag{1}$$

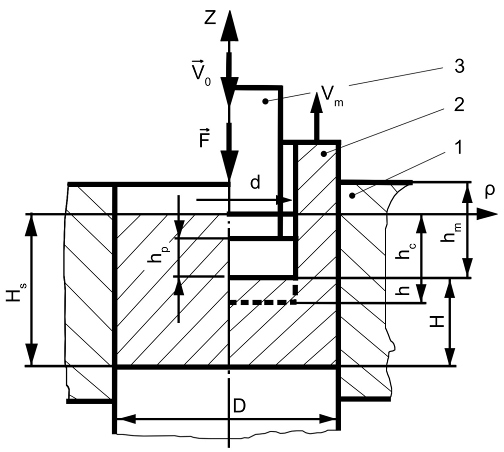

Fig.1. The scheme of indirect extrusion

Notations in figure 1 have the following meanings:

1 - extrusion plate;
2 - workpiece;
3 - stamp;
H_s - the height of the rough workpiece 2 (before deformation);
D - diameter of the rough workpiece;
h_p - height of the stamp head;
d - diameter of the stamp head;
H - height of the non deformed part of workpiece;
h_c - height of the extruded part of the workpiece;
h_m- distance between the upper side of extrusion plate;

It is considered the same coefficient of friction μ between workpice 2, punch 3 and working piece 2 - extrusion plate 1. Resistance to deformation of the material is denoted by k.

Using these, the analytical expressions of the components of the global extrusion force are [7, 8, 13]:

$$F_m = 8\mu\ k \cdot \frac{D\left(h_m + \frac{h}{2}\right)}{D^2 - d^2} \cdot \frac{D^2}{d^2} \cdot \frac{\pi d^2}{4} \tag{2}$$