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INFLUENCE OF THE GEOMETRIC FORM OF THE PLATE UPON THE DIRECT EXTRUSION FORCE FOR THE NON-FERROUS METALS

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Abstract: *In the paper there are presented some sorts of parts in lead, aluminum and copper obtained by direct cold extrusion. In the second part of the work is presented by means of tables and diagrams the force of the parts in lead, aluminum and copper obtained by direct extrusion with more sorts of active plates.*

Key words: *force, lead, aluminum, cooper, direct cold extrusion.*

1. GENERAL CONSIDERATION

The geometric form of the active plate, that is the α angle and the rounding radius in the deforming area have a significant influence upon the technological parameters of the extruding process.

Using one set of active plates can get a significant change in the way of the material flow, namely it can be obtained a radial flow, which appear inside the plastic zone.

In case of active plates with radius in the deformation area one can see that this leads to a diminution of the size of the dead zone.

An increase of the α angle leads to a decrease of the dissipated power and of extruded power.

In order to make evident the influence of the geometric form of the active plate upon the deformation force, the experimental researches were directed as follows: the influence of the angle of the active plate and the influence of the radius in the deforming zone.

For the influence of the α angle of the active plate upon the deforming force were used the followings:

- half-finished materials of lead 99.5, aluminum 99.5 and copper 99.9, with the following dimensions:
  - initial diameter: D0 = 24,5mm;
  - final diameter: Df = 15mm; 10mm;
  - length: Ls = 50mm; 30mm;
- one set of active plates with α=120˚; 105˚; 90˚; 60˚; 45˚;
- rounding radius of the plane active plate: r=0; r=2; r=4;
- deforming degree: ε=62,51%; ε=83,34%;
- extruding temperature: 20°C;
- extruding speed: v=100 mm/min;
- the INSTRON 1196 of 250 MN Testing machine and the Hydraulic press of 100 ft.

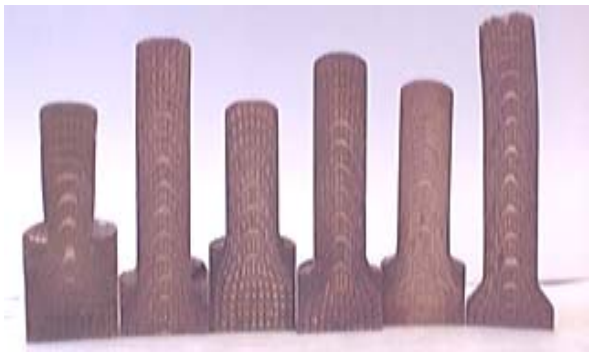
The extruded tests in order to measure the force are presented in figures 1, 2 and 3.

At the combined extrusion the degree of deformation was different ε=83.34% (D_0=24,5mm and D_f=10mm) and ε=62,51% (D_0=24,5mm and D_f=15mm). The active plates, which have been used, have different half angle α: convex active plate (α=120˚; 105˚); plane active plate (α=90˚ and the rounding radius r=0; 2; 4 mm); conic active plate (α=60˚; 45˚).

a **b** **c**

Fig. 1. Parts in aluminium directly extruded with active plates: a-convex; b-plane; c-conic; ε=62,51%

a **b** **c**



a **b** **c**

Fig. 3. Parts in copper directly extruded with active plates: a-convex; b-plane; c-conic;

2. VARIATION OF FORCE NECESSARY FOR DIRECT COLD EXTRUSION OF NON-FERROUS METALS

On the basis of the value obtained and synthesized in the Table 1 there were designed the variation curves of the force depending on the stroke of every angle of the active plate. From Table 1 and Fig. 4 one can see that the size of the force depends on the value of the α angle. The greatest value of the extruding force results for α=90˚ and the smallest values are for the conical active plates with α=45˚ and 60˚.

Table 1

Force for direct extrusion of lead [N], ED Pb 10x50

Stroke mm	Angle of active plate [°]				
	α=45˚	α=60˚	α=90˚	α=105˚	α=120˚
0	0	0	0	0	0
5	1050	1000	3000	1100	1000
10	5250	5450	5550	5350	5400
15	5400	5400	5500	5600	5650
20	5370	5250	5450	5400	5450
25	5180	5150	5300	5300	5350
30	5130	5050	5200	5150	5150
35	5100	4850	5150	5100	5100
40	5000	4700	5100	5000	5050
45	4500	4200	4850	4800	5000
50	5700	5450	6500	6150	5750

For smaller deforming degree ε=62,51%, as one can see in Table 2 and Fig. 5, the size of extrusion force for all metals depends on the α angle, namely the force is smaller for smaller angles.

Table 2

Force for direct extrusion of lead, aluminum and copper [N]

Type of extrusion	Maximum force [N]		
	Lead	Aluminum	Copper
ED 15x120x30	2600	22400	56500
ED 15x105x30	2500	22350	56000
ED 15x90r0x30	2900	22150	55800
ED 15x90r2x30	3150	19625	53000
ED 15x90r4x30	3200	19400	51600
ED 15x60x30	2900	19250	50650
ED 15x45x30	2300	16000	38500

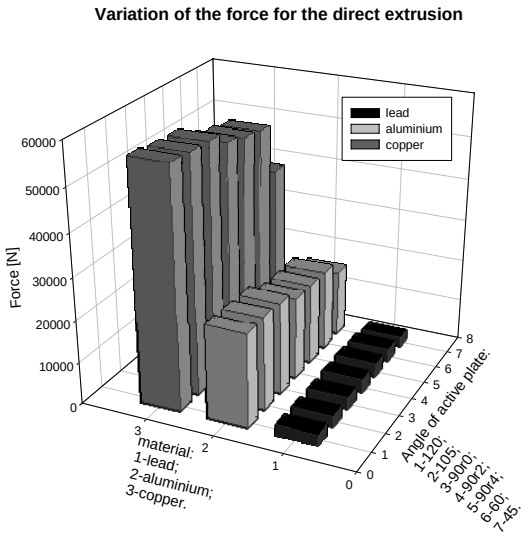


Fig. 5. Variation of the force for the direct extrusion of non-ferrous metals: ε=62,51%

In order to make evident the influence of radius in the deforming area upon the force for

direct extrusion it was used a set of active plates $\alpha = 90^{o}$ with the following connecting radius: r =0; 2; 4 mm. The tests were made for lead, aluminum and copper and part of the results have been summarized in Table 3. In Fig. 6 it is presented the variation of force depending on the stroke of the male die for every type of active plate. From this figure one can see that the smallest extruding force is got for the biggest radius, and the biggest force was registered for the flat active place without radius.

Table 3

Force [N] for the direct extrusion with flat plates

Stroke [mm]	Rounding radius of the active plate		
	r=0mm	r=2mm	r=4mm
0	0	0	0
5	3000	3250	3500
10	5550	5500	5350
15	5500	5500	5350
20	5450	5400	5300
25	5300	5350	5200
30	5200	5200	5050
35	5150	5150	4900
40	5100	5000	4800
45	4850	4800	4700
50	6500	5800	6100

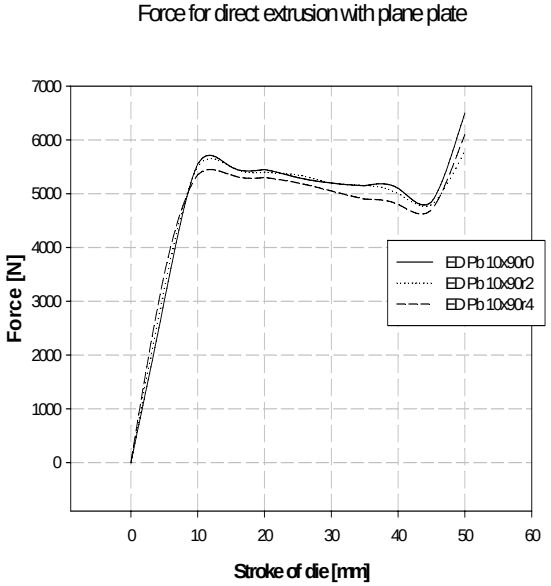


Fig. 6. Variation of the force for the direct extrusion with flat plates [N]

From the experimental researches which were made it was found that the extruding force varies for various deforming degrees, namely the more increased the deforming degree is, the more increased the deforming force is. For the direct extrusion of lead with different deforming degrees the results have been summarized in Table 4 and graphically represented in Fig. 7.

Table 4

Force for direct extrusion of lead with different deforming degrees

Stroke	Force	[N]
[mm]	ε= 62,51%	ε=83,34%
0	0	0
5	1000	1890
10	5450	1900
15	5400	1880
20	5250	1850
25	5150	1820
30	5050	1800
35	4850	1770
40	4700	1740
45	4200	1730
50	5450	1900

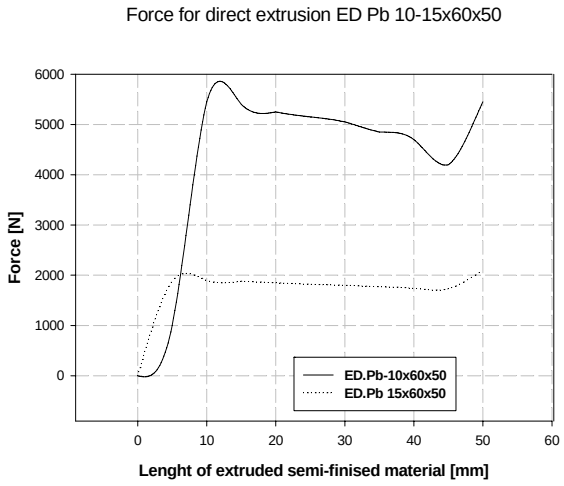


Fig. 7. Variation of the force for direct extrusion of lead with different deforming degrees

3. CONCLUSION

Further to the analysis of the influence factors and of force variation one can draw the following conclusion:

- the size of extruding force both for lead and for aluminium and copper depends on the value of α angle. The greatest value of the extruding force is registered for α=90 and the smallest ones are for the conical active plates with α=45˚ and 60˚;

- the force for the direct extrusion with flat active plates α=90˚ with connecting radius in the deforming area is the smallest for the biggest radius, and the greatest force was registered for the flat active plate without radius;

- the extruding force varies for different deforming degrees, namely the more increased the deforming degree is, the more increased the extruding force is.

4. REFERENCES

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Influenta formei geometrice a placii active asupra fortei la extrudarea directa a metalelor neferoase

Rezumat: În această lucrare sunt prezentate câteva piese din plumb şi aluminiu, obținute prin extrudare directa la rece. În partea a doua a lucrării sunt prezentate tabelar şi în diagrame măsurătorile fortei necesare pentru piesele obținute prin extrudare directa la rece a metalelor neferoase cu diferite tipuri de păci active.

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