MECHANICAL TESTING OF SINTERED MATERIALS

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Abstract: *Alloying elements have an important affect upon the mechanical properties of the Sintered Materials. Compression tests show that the cupper based material obtains high results in cryogenic environments.Tests reveal the weak resistance of materials that contain 0,8% C, due to a poor classification and a inhomogenous metallographycal structure.*

Keywords: sintered material, mechanical properties, compresion test.

1.Introduction

The metallic materials sintered are the materials obtained through the new technologies and exactly the metallurgy of dusts. The metallurgy development was determined by the scientific and technical progress that needs products with special properties that cannot be elaborated through other procedures. The metallurgy of dusts may enter successfully among the classical technologies by the varieties of pieces obtained through this procedure.

In the last years the major of countries strongly industrialized MP concur successfully the conventional technologies. As it may be observed, through a classical method of deformation, the sintered material does not behave at a mechanic request as the compact material. In the structure of a MS the presence of pores influence the behavior at the mechanic request, after it ahs been concluded also in the case of the mechanic trial of compression. The trial to compression is a static request and consists in the appliance of some axial charges of compression of a cylindrical test piece until breakage or to the apparition of a fissure.

These testing are made with low speed of deformation, applying the charge progressively and without shocks that is why deformation is realized slowly. The material characteristics submitted to testing are mentioned in table 1.

Table 1. *Characteristics of material testing*

Material	Compoziție				Densitate g/cm^3 min.	Alungire % min.	Rezistența la tracțiune daN/mm^2	Fără tratament termic HB	Duritate după TT
	C %	Fe%	Cu%	Altele %					
FC 40	0,4	t	-	Max.2	6,95	3	18	50	
FC 80	0,8	Rest	-	Max.2	6,95	2			
F50U3	0,5	Rest	3	Max.2	6,95	2	35	105	320
F80U3	0,8	Rest	3	Max.2	6,95	0,5	35	105	HF 320

The direction of application in the case of compression test can be represented as in Figure 2. Track parameters for testing are:

• initial diameter, do, before the test piece diameter, [mm]
• final diameter, du, diameter at appearance cracking; [mm]
• Initial width (initial thickness) of the specimen, h 0; [mm]
• width (thickness) of the specimen end, hu, [mm]

• shortening of the specimen, Sc,;[%]

$$S_c = \frac{h_o \cdot h_u}{h_u} \times 100 \qquad [\%] \qquad (1)$$

• Crush resistance achieved, K. [10]. [$10^3 MPa$]

$$k = \frac{F_m \cdot (D - f)}{h_u \cdot f^2} \qquad [\text{MPa}] \qquad (2)$$

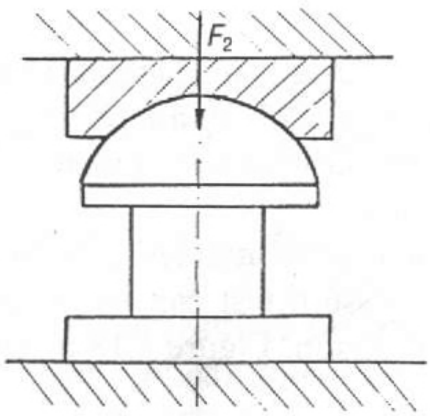

***Fig. 2**. Test of compression*

Test environment influences structure.

2.The experimental part

The test of compression at low temperatures is made between 130-150 K and are respected the conditions foreseen by the technical norms of execution of the performed trials at low temperatures.

The test at compression at low temperatures consists, as in the case of the environment, in applying the compression charge until the apparition of the first fissure.

During the compression trial it is followed the shortage and crowning of the test piece.

The first operation before performing the test of compression is the visual control of the cylindrical test pieces that follow to be submitted to the trial, after which the test piece is introduced in the cooling environment, liquid azotes. Choosing the liquid azotes as a cooling agent is due to the critical point inferior to the trial temperature, the trial temperature minimum corresponds to the value of 77K. The cooling installation is a shaft with liquid azotes due to the small dimensions of the compression tests.

The test pieces were introduced in the shaft with liquid azotes and after five minutes from the violent boiling of the azotes, at the temperature of 77K, are taken out the test pieces with the help of pliers and are positioned in the trial machine.

The positioning is made correctly, so that the test piece to be in the centre of the trial zone, not to create in the test piece another tensions but the compression one.

After the positioning, it is measured, with the help of a thermometer, the temperature directly on the test to have correct data upon the measurements

3.Results and discussions

There are visible the material deformations through the test pieces tightness and flattening, figure 3. The test pieces structures are submitted to the compression strictures at low temperatures.

Fig. 3 *The cylindrical specimens*

The test pieces structures submitted to the compression trials at low temperatures are pointed out through the micrographics 3.a, b, c, and result from the tests processed and their submission to a metallographic attack with Nital.

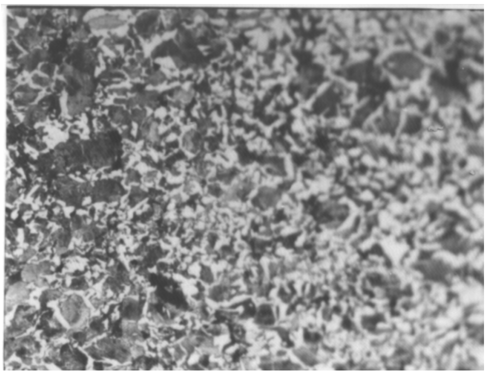

Fig.3.a. *The structural analyze of the material FC 40*

The structural analyze of the material FC 40 submitted to compression at low temperatures. After requesting the compression of the test pieces from FC 40 at low temperatures it is observed the same ferito-perlitical structure with a large dimensional heterogeneity. So, it is also accentuated a large amount of freckles. The structural constituents loose their aspect of deformation observed in the structure of the requested test at the environment temperature.

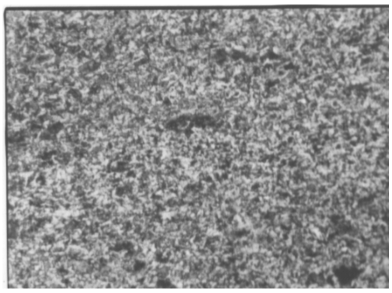

***Fig.3.b**. The structural analyze of the material FC 80*

The requested tests at compressions at low temperatures from the material with 0, 8% carbon, FC 80, presents the same constituents, protected and pearled with a non-homogenate repartition in the field. The constitutuents granulation is getting smaller and looses its aspect of practical deformation. The structure is much more homogeneousness as a result of the request in the cryogenically environment, and the freckles are better accentuated.

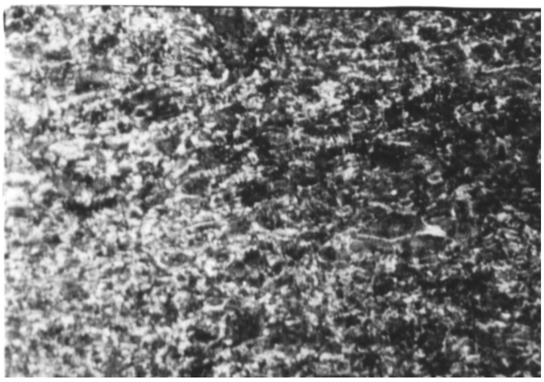

***Fig.3.c**. The structural analyze of the material FC 50U3*

The compression test at low temperatures presents a homogeneousness structure towards other tests submitted to the cryogenic environment and also towards the tests submitted to the request in the environment. The constituent's granulation is more delicate, the deformation aspect is less favorable and the freckles network is more evident.

If there is made a comparison of the compression results at low temperatures with the achieved results from the environment, we can say that the resulted values at low temperatures are superior, I illustrate this comparison through the representation of the compression force with the materials of cylindrical test pieces in figure 4.

Fig.4. *The influence of materials upon the compression force*

Figure 4 shows that the best behavior but also the weakest, respectively the material with 0,5% carbon and 3% copper, FC 50U3 and the material with 0,8% carbon. The material with 0, 4 % carbon keeps the proportion had in the case of the environment.

Another important parameter of the composition influence of the material in the answer to the mechanic request of compression is the visualization between the two averages in figure 5.

Fig. 5. *Mechanics request of compression*

Analyzes show that an intensification of the material densification in the case of low temperatures that leads to an increased resistance in the case of mechanic requests, large deformation tensions being accepted.

For the materials sintered by the chosen composition for the type of test pieces submitted to the trial at environmental temperature, the corresponding breakage the obtained porosity may be a ductile breakage.

4.Conclusions

Among the experimental data corresponding to compression from the calculated data we have considered the following observations upon the behavior of materials at request:

- The compression of the sintered materials is different from the compact materials ones because plasticity is not based on the law of constant volume;
- The biggest value of the compression force is accepted by the material with 0,5% carbon and 3% carbon, FC50U3; at the same time we may say that the test piece from the FC50U3 material at a force value of 60N;
- Also, the material FC50U3, is behaving good at deforming because the test piece flattening is realized at bigger charges than for the other two materials and the value of the agreed force is much bigger than the other two materials, the agreed force is 353 KN;
- The weakest behavior is presented by FC 80 through the acceptance of a small resistance;
- The breakage is not preceded as in the case of compact materials by the test splitting but only for its deformation through flattening and crowning, and for the maximum value of the test piece deforming force is transformed in slag;

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