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MECHANICAL PROCESSING BY PLASTIC DEFORMATION OF NdFeB MAGNET BASED SAMPLES

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Abstract: *Mechanical deformation of materials is defined by modifying the size and geometrical shape under the action of mechanical, technological, thermal, etc stresses. Technological requests can be found in the processes by plastic deformation machining (rolling, forging, extrusion), by cutting (turning, milling, and planning), by heating (melting, casting, and solidification) to afford pieces with shapes and dimensions established by piece design. The article is targeting the reaction to machining of plastic deformation by bending specimens NdFeB based on hydraulic machine model WE60.*
Keywords: *NdFeB magnets, bending test, plastic deformation, hydraulic testing machine.*

1. INTRODUCTION

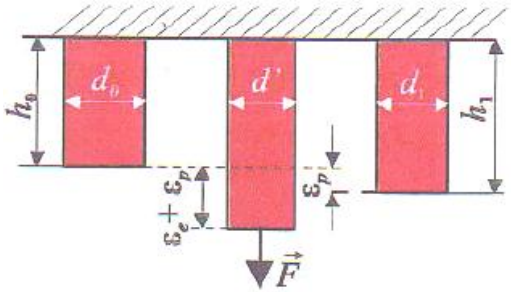
In the current economic climate it is noticed a particular importance increase of the quality problem, determinate by the competitiveness of goods and competition of firms and industrial and commercial companies.
Such preoccupation are favored by the structure of product quality management models, defined by ISO 9000 standards, which focus on improving the relations that occur between manufacturer and customer.
This article discusses the technical manufacture possibilities and behavior of materials used to produce NdFeB permanent magnets based on plastic deformation processing by bending to give the prescribed geometric shape [1-3].

2. PLASTIC DEFORMATION MECHANICAL PROCESSING OF NdFeB MAGNETS MATERIALS

As we know from international standards the mechanical deformation of materials is defined by modifying the size and geometrical shape under the action of mechanical, technological, thermal stresses, etc.
Technological requests can be found in the processes by plastic deformation machining (rolling, forging, extrusion), by cutting (turning, milling, and planning), and by heating (melting, casting, and solidification) to afford pieces with shapes and dimensions established by piece design.
Mechanical deformations depend on:
- material structure;
- physical, mechanical, technological properties of material;
- stresses to which material is subjected.

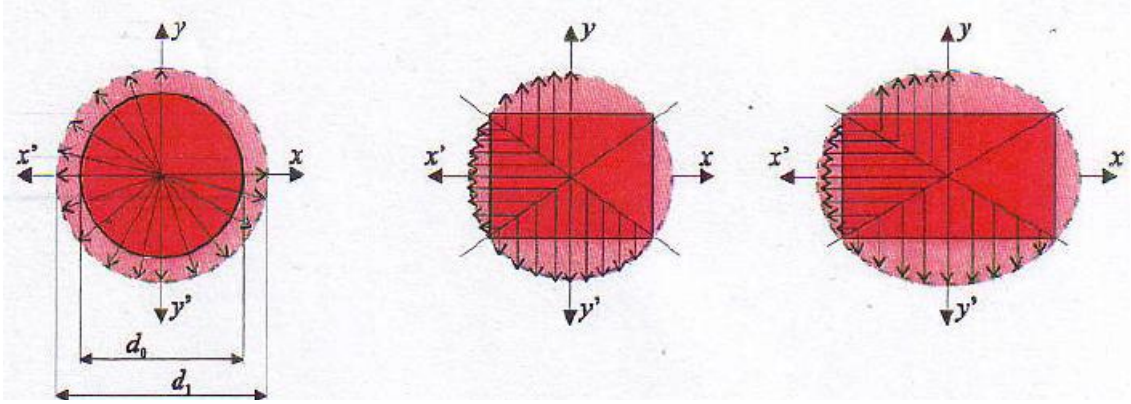
Plastic deformation of metallic materials is governed by the following laws:
- The low of constant volume;
- The law of elastic and plastic deformations coexistence;
- The law of minimal resistance;
- The low of plastic deformation independence energy in relation to changing geometric shape of deformed material and mechanical deformation scheme (criteria of plasticity);
- The low of additional efforts;
- The law of similarity;

- The fundamental law of plastic deformation [4-6].



a) b) c)

Figure 1: Schematic elastic and plastic deformation to elongation of an encased bar
a) initial state; b) elastically and plastic deformed state; c) final state (after removal of the force F)



a) b) c)

Figure 2: Scheme of the law of least resistance explained by the conversion of semi-finished sections as follows: a) from circular cross-section is obtained circular cross-section, b) from square cross-section is obtained circular cross-section; c) rectangular cross-section became oval cross-section after processing

Technological researches have shown that materials are not brittle (fragile) and generally respect Hooke's law, showing that deformable materials subjected to external forces deform elastically to a first threshold value (yield strength) and if the force is removed it returns approximately to its original state, and generally maintain residual deformations.
If the force continues to act, the material enters the plastic zone thus obtaining a piece with a geometric shape and dimensions initially set.
If, however, the force continues to act, the material reaches its yield point and in the end, is destroyed as a result of exceeding the mechanical resistance to breakage. The exceptions from Hooke's law make some material (rubber type), considered nearly perfect elastic [4-8].

3. PLASTIC DEFORMATION MECHANICAL PROCESSING BEHAVIOR ASSESSMENT BY BENDING OF SAMPLES FOR OBTAINING NdFeB PERMANENT MAGNETS USING WE60 HYDRAULIC UNIVERSAL MATERIAL TESTING MACHINE)

Figure 3 shows the bending test on the mold with U geometric configuration of composite experimental NdFeB magnet sample using a hydraulic universal material testing machine model WE60 [9].

Figure 3: Bending test of experimental samples composite experimental NdFeB magnet sample using a hydraulic universal material testing machine model WE60.

In order to achieve the experiments were used different types of samples acquired by the company Arch Hobber Chemicool Ltd., with the following dimensions:

- length: 80 - 100 mm;
- height: 30 - 40 mm;
- thickness: 5 - 10 mm.

The values of bending test angles has been set at $\alpha=160^0$, $\alpha=180^0$.
The table 1 shows bending test results of experimental samples NdFeB based magnets. Test has done on a hydraulic universal material testing machine, model WE60.

Table 1: bending test results of experimental samples NdFeB based magnets, on WE60 hydraulic universal material testing machine

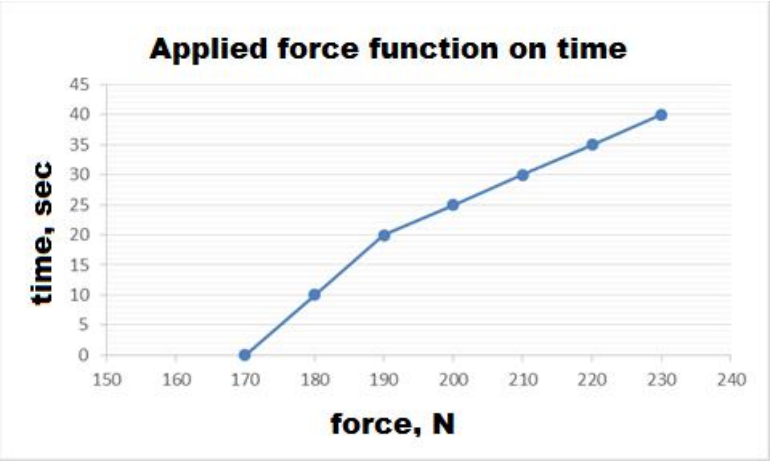
Bending angle (^{0})	Experimental test samples							
	W4	W6	W8	W8H	W10	W10H	W12	W12D
160	fractured	fractured	fractured	fractured	accepted	accepted	accepted	accepted
180	fractured	fractured	fractured	fractured	fractured	fractured	accepted	accepted
Recovery angle (^{0})	-	-	-	0.3	0.2	0.2	0.1	0.1

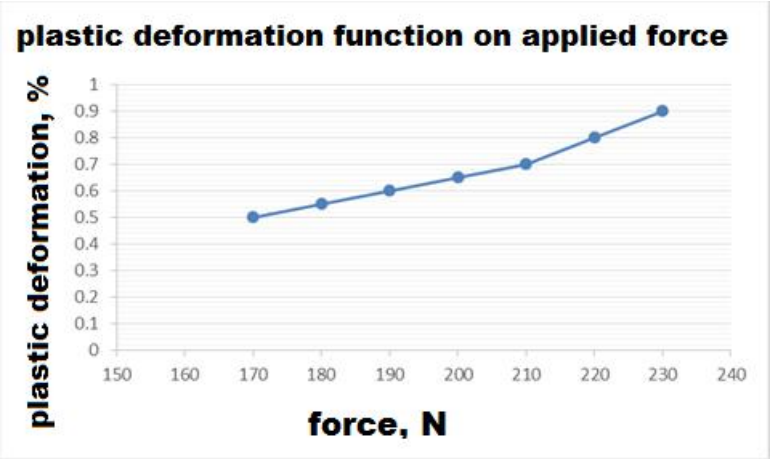
During bending test same parameters vary funtion of initial set up. This selected parameters are:

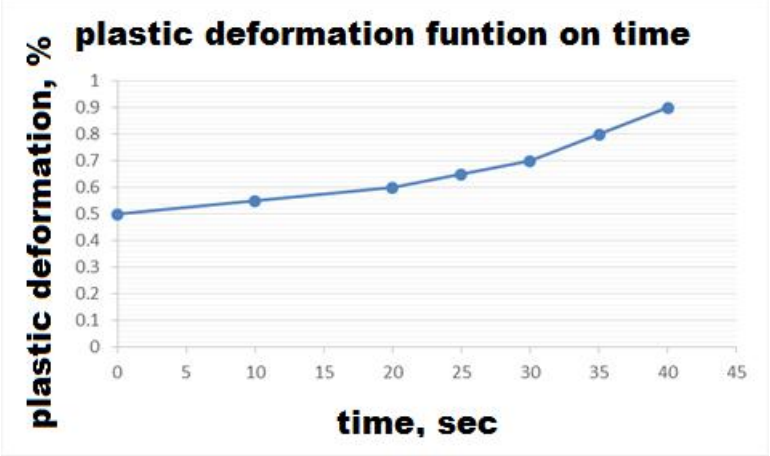
- pressing force F that vary in the range 170 N to 230 N;
- pressing time t, that vary in the range 10 sec – 40 sec;
- specific plastic deformation ε, that vary in the range 0.5 - 0.9%.

All the data are processed using a software pack ECEII. So obtained data's are represented as function graphs: F=F(t); F=F(ε); ε = ε (t);

Figures 4 – 6 present each one of the three function studied F=F(t); ε=ε(ε); ε = ε (F); All data are represented measurements made on hydraulic universal material testing machine WE 60 [10-11].







4. CONCLUSION

This article show the different behavior of materials designed for permanent magnets, based on rare NdFeB earths, subjected to a bending mechanical processing.
For experiments were used materials different from geometric dimensions and shape point of view, that were bent with a hydraulic testing machine.
Function on shape and geometry, samples has different bending behavior, some of them were fissured and checked.
The cold plastic mechanical deformation by bending technology is difficult to be achieved, so at samples with small thickness (up to 8 mm) low angle free bending tests cause to fissures and cracks.

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