RESEARCH REGARDING THE WEAR OF ECOLOGICAL STEELS OBTAINED THROUGH THE CARBURIZING OF IRON METAL POWDERS

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Abstract*:* *The use of moving components is a condition for the good functioning of machines and also for their life cycle. Through proceedings that are specific to powder metallurgy, there can be obtained materials that are resistant to wear. This paper presents the results of wear testing of the parts obtained through the carburizing – sintering proceeding.*

Key words*:* *carburizing – sintering, ecological steel, wear*

1. Introduction

The research in the field of powder metallurgy is very current through their very special results. Thus, an important area is that of obtaining parts that are resistant to wear. A series of research made in the laboratories of the Department of Engineering and Management of the Technological Systems, Drobeta Turnu - Severin, have as objective the obtaining of steels starting from the iron powder which is enriched with carbon coming from the decomposing of methane gas, proceeding which is called 'carburizing of iron metal powders'. Carburizing is accompanied by sintering – phase which is compulsory in powder metallurgy and which leads to the expansion of the contact between the surfaces of the powders particles, the chemical homogenization between the powder and the carbon in gas phase and the densification of the material. The parameters of the carburizing – sintering proceeding are:
- heating in still medium (argon) until the carburizing temperature;
- carburizing took place at the temperature of 850 ºC in methane gas medium, with a flow of 2.5 l/hour, for 6 hours;
- after carburizing the methan gas alimentation was interrupted and the still atmosphere with argon was once again created for sintering;
- heating in argon at the sintering temperature of 1150 ºC for 30 minutes;
- cooling of the carburizing – sintering box in protective argon medium for 120 minutes; gthe cooling took place by opening the cover of the oven.

The total time of carburizing – sintering was of 900 minutes.

The parts that underwent carburizing were obtaining by pressing the iron powder at 400, respectively 600 MPa [2].

The carburizing of metallic iron powders through the contribution of carbon coming from the decomposing of methane gas at the same time with the sintering proceeding has become enviromental friendly by reducing the emissions of polluting gases, the reduction in the degree of water pollution and the reduction in the quantity of waste. These aspects are very important when analyzing the environmental performance of this technology. Also important is the behavior at wear which is dirrectly connected with the life cycle of the parts manufactured through this technique which is specific to powder metallurgy and also with the emissions of metallic powders in the atmospheric medium [1].

2. Materials and methods

In the Research Laboratory for Tribology it was studied **the wear in time** of the samples compactized at 400, respectively 600 MPa. The main characteristics of the parts which underwent this test are density and the friction coefficient.

From the point of view of density, the parts used had an average density of 7.12 g/cm^3, in the case of the ones pressed at 400 MPa and for the ones pressed at 600 MPa the density was of 7.08 g/cm^3. The difference of density is due to the amount of carbon which was more diffused in the parts compactized at 400 MPa in comparison with the ones compactized at 600 MPa.

The friction coefficient was determined with the aid of a modern tribometer made by CSM Instruments – Switzerland, type TRN 01 – 02541 (fig.1).

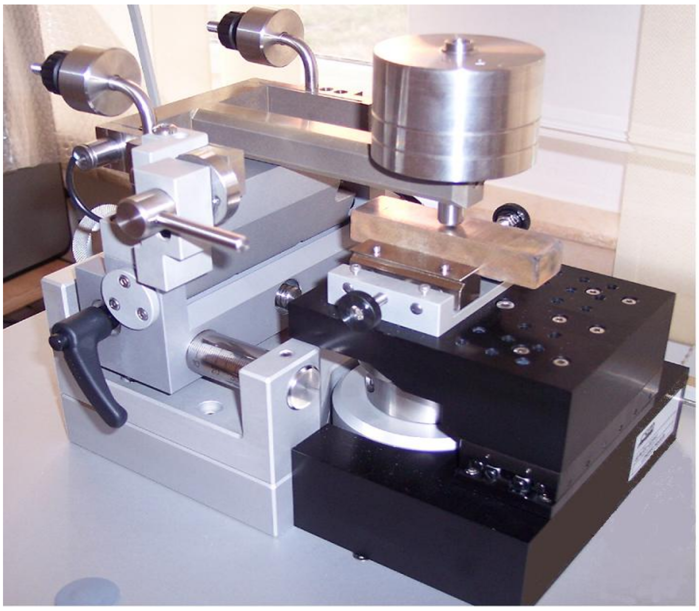

Fig.1. The device for wear testing of parallelepiped parts

The variations of the friction coefficient are shown in fig.2 and fig.3.

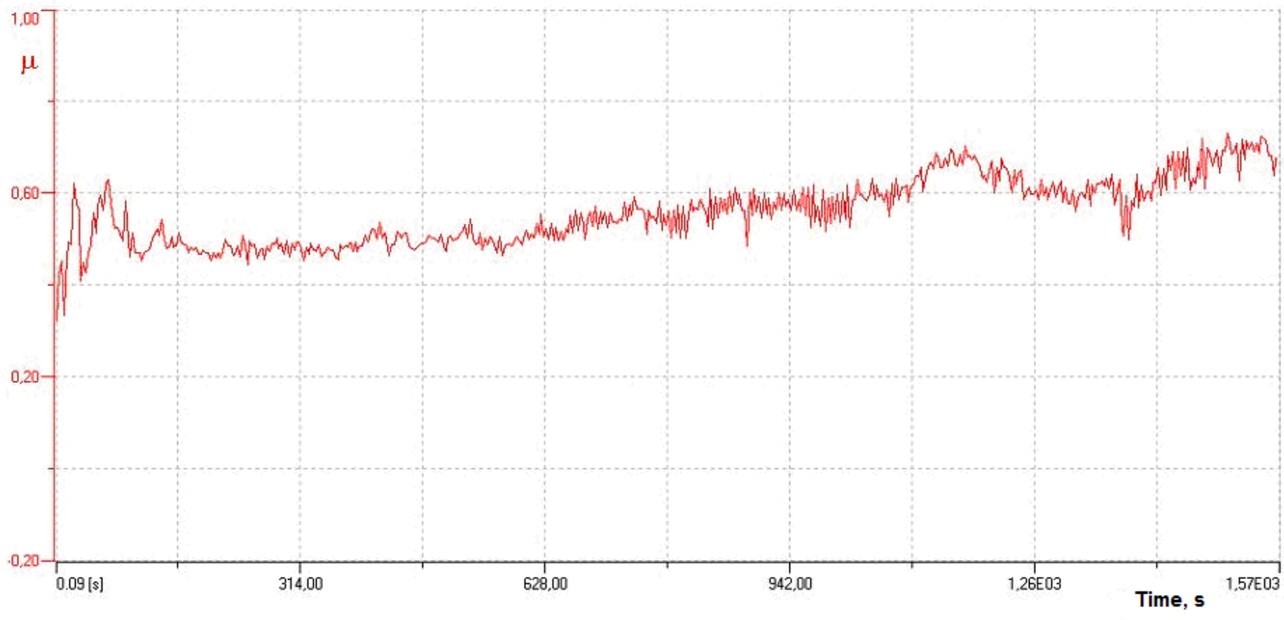

Fig.2. The variation of the friction coefficient for the samples compactized at 400 MPa

The friction coefficient was stabilized at the final value of μ = 0.67 (fig.2). According to the data from specialty literature for values of the dry friction coefficient, the friction coefficient determined by the tribometer corresponds to a steel – on – steel friction couple.

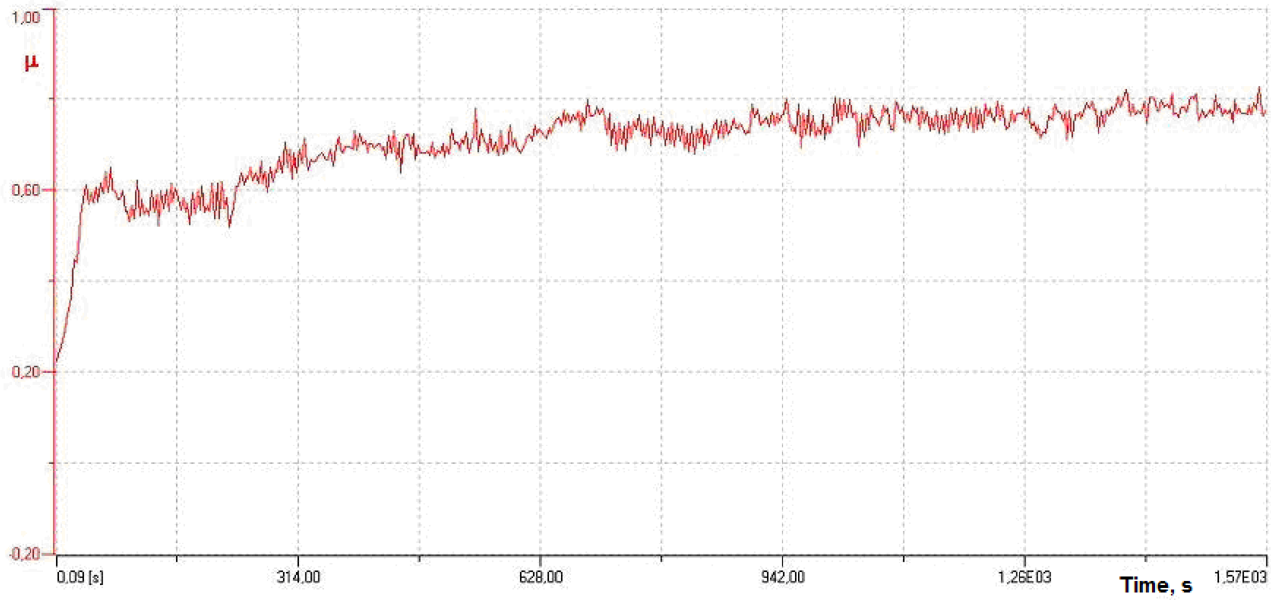

Fig. 3. The variation of the friction coefficient for the samples compactized at 600 MPa

Throughout the analysis, the friction coefficient evolved between 0.225 and 0.828, stabilizing itself at the value of µ = 0.77 which is also in the domain of steel – on – steel friction couples (fig.3).
The mass wear, an expression of resistance to wear in time, was determined using a steel – on – steel friction couple type cylinder on plan (fig. 4). The cylinder is made of 41MoC11 steel heated and rectified, having a hardness of 62 HRC and is fixed on a engine lathe type SNA 125x300 on which the device can also be found, fitted on the cross – slide rest of the lathe, in which the sample to be analyzed is rooted. The lathe was imprinted with a rotation movement of 1500 rot/min. Thus, a dry friction took place.

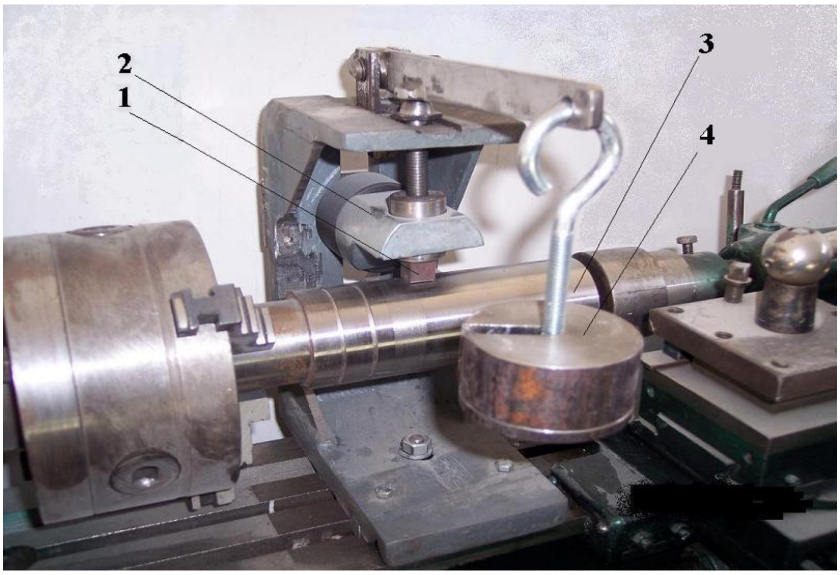

Fig. 4. Device to determine mass wear
1 – sample; 2 – rooting support; 3 – steel cylinder; 4 – pressing force

3. Results and discussions

The sample was weighted using a balance with precision of three decimal places, initially and then at intervals of two, respectively five minutes. The mass difference between weighing is the result of the wear of the sample.
The forces with which we worked are of 25.5 N and of 39 N. There were two series of results:

a) The variation of the mass wear of the sample under the action of the force F = 25.5 N (table 1 and table 2)

Table 1. The variation of the wear of the sample under the action of the force F = 25.5 N for the parts compactized at 400 MPa

Compacting pressure	400 MPa							
Time,min	0	2	4	6	8	10	15	20
Mass,g	45,830	45,828	45,826	45,824	45,823	45,823	45,823	45,822
Difference,mg	0	2	4	6	7	7	7	8

Table 2. The variation of the wear of the sample under the action of the force F = 25.5 N for the parts compactized at 600 MPa

Compacting pressure	600MPa							
Time,min	0	2	4	6	8	10	15	20
Mass,g	43,170	43,167	43,165	43,163	43,161	43,160	43,160	43,159
Difference,mg	0	3	5	7	9	10	10	11

The graphic reprezentation of the evolution in time of mass wear is shown in fig.5:

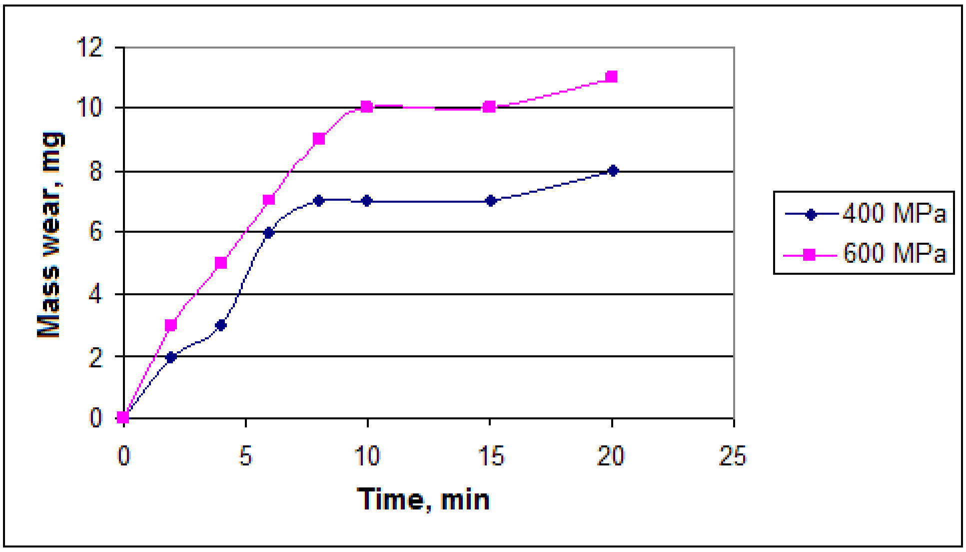

Fig. 5. The variation of the mass wear under the action of the force of 25.5 N

b) The variation of the wear of the sampple under the action of the force F = 39 N
1) For the compacting pressure of 400 MPa (table 3)
Table 3. The variation of the wear of the sample under the action of the force F = 39 N for the parts compactized at 400 MPa

Time, min	0	2	4	6	8	10	15	20
Mass, g	46,590	46,580	46,575	46,570	46,565	46,560	46,559	46,551
Difference, mg	0	10	15	20	25	30	31	39

2) For the compacting pressure of 600 MPa (table 4)

Table 4. The variation of the wear of the sample under the action of the force F= 25.5 N for the parts compactized at 600 MPa

Time, min	0	2	4	6	8	10	15	20
Mass, g	31,800	31,790	31,784	31,778	31,772	31,766	31,766	31,756
Difference, mg	0	10	16	22	28	34	34	44

The graphic reprezentation of the variation in time of mass wear is presented in figure 6.

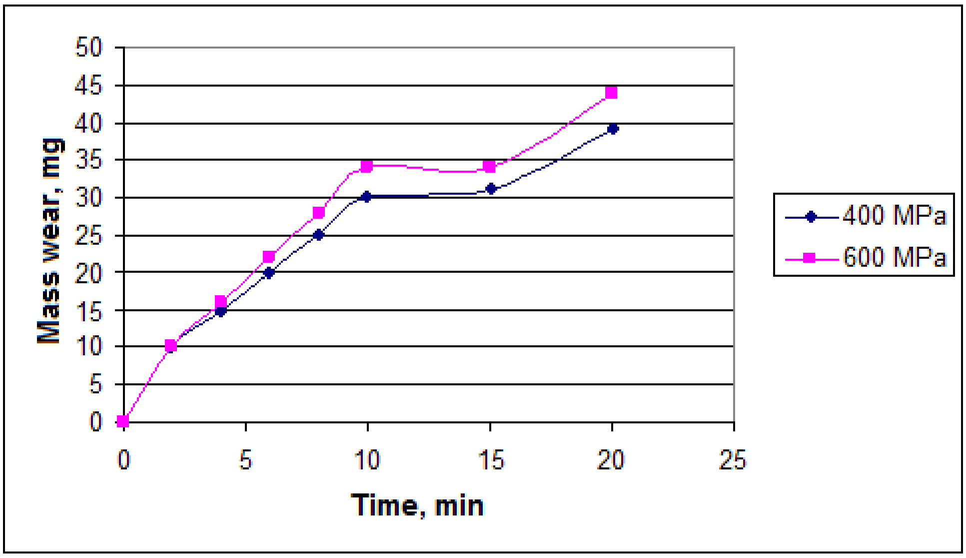

Fig. 6. The variation of the mass wear in time under the action of the force of 39 N.

The graphic interpretation confirms the fact that carburized and sintered samples through the proceeding of carburizing at the same time with sintering are resistant to wear in time. The mass losses at the samples compactized at 400 MPa are lower than in the case of those compactized at 600 MPa and this is why the former are considered to be of better use in practice.
The research regarding the reduction of wear for these steels have as aims either the introduction of alloying elements or finding lubricants adapted to the steel – on – steel fricton couple in which the parts are used. Other authors have studied in their papers mathematic relations on alloyed and micro alloyed steels [3, 4].

4. Conclusions

The loss of mass in time, due to dry friction, under the action of a constant pressing force, grows at the same time with the time of maintaining the sample under the action of the force, being recorded a minimum mass difference of 39 mg in the case of the samples compactized at 400 MPa with the

content of 1.6% C, carburized for 6 hours, sintered at 1150 ^{o}C. This mass difference grows at the value of 44 mg for the sintered steel with 1% C compactized at 600 MPa, carburized and sintered in the same conditions.
There can be seen a good behavior at mass wear in time of the samples compactized at 400 MPa, carburized and sintered in comparison with the samples compactized at 600 MPa and carburized and sintered in the same conditions.

5. References

[1] O. Ghermec, C. Ghermec, T. Popescu, “A new technology to obtain ecological steel”, Proc. 5th Int. Conf. on Environmental Engineering and Management, ICEEM/05, 15-19, September 2009, Tulcea, Romania, Environmental Engineering and Management Journal, ISSN: 1582-9596, vol. 8, no. 5, pp. 1141 – 1144.
[2] M. Mangra, T. Popescu, C. Ghermec, G. Deliu, “Sintered carbon steel and its obtaining proceeding through carbon diffusion”, Patent CBI A 2007/00337 OSIM Bucharest.
[3] C. O. Rusănescu, M. Rusănescu, T. Iordănescu, F. V. Anghelina, “Mathematical relation ships between alloying elements and technological deformability indexes”, Journal of optoelectronics and advanced materials , Vol. 15, No. 7-8, July - August 2013, pp. 718 – 723.
[4] C. O. Rusănescu, M. Rusănescu, F. V. Anghelina, “Study of the hot deformability of micro alloyed steels using torsion tests”, Journal of optoelectronics and advanced materials, Vol. 15, No. 7-8, July - August 2013, pp. 724 – 729; ISSN: PRINT: 1454 – 4164; ON-LINE: 1841 – 7132.