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ASPECTS ABOUT THE KINETICS AND THERMODYNAMIC TRANSFORMATION OF A SPECIAL S.G. CAST IRON

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ABSTRACT

The paper presented here belongs to the researches about the influence of the heat treatment's parameters over the micro hardness's variation of a Bainitic S.G. Cast Iron at the end of an wear process. The wear process was influenced by the structural changes of the specimen's surface. It was determinate the micro hardness (HV $_{0,01}$) with an "Akashi MVK - E3" machine, in the 50 μm of the section of the wear specimens and it was determinate the variation of the rapport (δ) between the micro hardness (Δ H) and the distance of the wear surface (Δl).
Keywords: S. G. cast iron, heat treatment, wear

1. INTRODUCTION

At present, very limited information on the abrasive wear properties of austempered ductile iron is available. Wear is one of the major ways by which materials cease to be useful. Process plant and subsidiary processes contend with a much bigger wear problem than in the case of machine parts, although their life is often much shorter. Therefore, it is important to enhance the wear resistance of cast irons [1,2,3].

2. MATERIALS

The studied cast iron had the following composition: 3.70 % C; 2.46 % Si; 0.564 % Mn; 0.038 % P; 0.009 % S; 0.21 % Mo; 0.12 % Ni; 0.17 % Cu; 0.072 % Mg. This cast iron was elaborated in an induction furnace. Nodular changes were obtained with the "In mold" method, with the help of prealloy FeSiCuMg with 10-16% Mg, added into the reaction chamber in a proportion of 1.1% of the treated cast iron. The structure in raw state is perlito-feritic typical for a cast iron with geometrically regular nodular form. The casted raw iron had the following mechanical properties: Rm = 660 [N/mm^2] HB =180; KC = 12 [J/cm^2]; A = 7 [%].

3. HEAT TREATMENTS

The parameters of the heat treatment done were the following: the austenizing temperature, T_A=900 [°C]; the maintained time at austenizing temperature, τ_A=30 [min]; the temperature at isothermal level, T_{iz} = 300, 350 and 400 [°C]; the maintained time at the isothermal level, τ_{iz}= 5, 30, 60, 120, and 180 [min]. All these 3 experiment groups: lot A (t_{iz}=300°C), lot B (t_{iz} = 350°C) and lot C (t_{iz} =400°C), performed at isothermal maintenance in salt-bath (55% KNO_3+ 45% $NaNO_3$), being the cooling after the isothermal maintenance was done in air.

4. EXPERMENTAL PROCEDURE

From this material, 15 typical wear - test specimens (ϕ 20 x 3 mm) was done.
The abrasive wear test were performed by a mechanism with ball-on-plane contact (manganese steel ball was actuated by an electric motor) under 40 N load at room temperature for 1 h. It was determinate the micro hardness (HV $_{0,01}$) with an "Akashi MVK - E3" machine, in the 50 μm of the

section of the wear specimens. An analysis of the transformation in the section of the wear specimens, it was made by calculating a study the variation of the rapport (relation 1) between the micro hardness (ΔH) and the distance of the wear surface (Δl):

$$\delta = \Delta H / \Delta l \qquad ... (1)$$

where:
ΔH - the variation of the micro hardness between the wear surface and some;
δ - distances [$HV_{0,01}$];
Δl - the variation of the distance between the wear surface and some;
δ - distances [μm].

For exemplification:

$$\delta_1 = (HV_5 - HV_2)/(l_5 - l_2) \qquad ... (2)$$

$$\delta_{10} = (HV_{50} - HV_2)/(l_{50} - l_2) \qquad ... (3)$$

where:
HV_{50}, HV_5 -represent the micro hardness for the distance d = 50 μm, and d = 5 μm, from the wear surface (considerate d = 2μm), [$HV_{0,01}$]
HV_2-represent the micro hardness of the wear surface, [$HV_{0,01}$];
l_{50}, l_5 -represent the distance "d" determinate (in section) from the wear surface of the specimen [μm];
l_2 -represent the distance corresponding of the wear surface [μm];

5. RESULTS AND DISCUSSION

The variation of the "δ" rapport function the isothermal temperature (t_{iz}) and different isothermal times (τ_{iz}), is presented in the table 1.

Table 1. The variation of the "δ" values rapport.

t_{iz} [°C]	τ_{iz} [min]	$\delta = \Delta H / \Delta l$, [$HV_{0,01} / \mu m$];									
		δ_1	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7	δ_8	δ_9	δ_{10}
300	5	11,33	8,37	11,38	12,05	10,34	8,5	9,45	7,8	7,26	7,46
	30	35,33	19,87	13,92	10,05	7,86	12,04	10,21	8,87	8,47	7,58
	60	17,66	27,12	22,46	16,94	12,69	10,43	8,85	8,03	6,79	6,35
	120	42	39,62	23,15	16	12,52	11,96	9,82	8,52	7,79	6,98
	180	96	39,12	25,92	18,72	14,65	11,96	10,12	8,82	7,79	6,98
350	5	38,66	23,75	18,53	13,94	10,91	8,96	7,61	6,24	5,84	5,23
	30	15,66	20,5	21,30	16,61	12,04	9,89	9,06	7,29	6,44	6,23
	60	22	23,37	15,46	12,66	12,43	10,21	8,96	7,53	6,88	6,16
	120	39	14,62	13,69	10,66	10	8,21	6,97	6,05	5,60	5,02
	180	7	19,5	19,3	15	12,13	11,74	8,18	7,11	6,48	5,63
400	5	30	16,12	12,61	14	10,95	10,28	9,06	7,66	7,20	6,46
	30	46,66	34,37	24,23	18	14,08	11,89	9,81	8,52	7,74	6,75
	60	1,66	5,12	14,07	10,88	10,47	8,96	7,90	6,60	6,07	5,43
	120	35,33	16,87	12,46	11,61	10,82	9,21	8,09	7,03	6,20	5,38
	180	24	11,5	16,15	11,66	9,47	7,5	6,61	5,73	4,88	4,48

In figures 1, 2 and 3, it was calculated the values presented in the table 1.
From the values presented in table 1 and figures 1 - 3, it can be certainly observed a normal evolution of the values of the δ rapport. For all the values of "δ", the values decrease from δ_1 to δ_{10} and that means a major different between the values of δ for the specimen near to the wear and the specimen far away from the wear process. For all the values of "δ", corresponding to all the t_{iz} temperatures, it is observed the general remark that the values for the rapport δ_1 to δ_6 (corresponding for maximum 30 μm from the wear surface), has a great variation of the values.

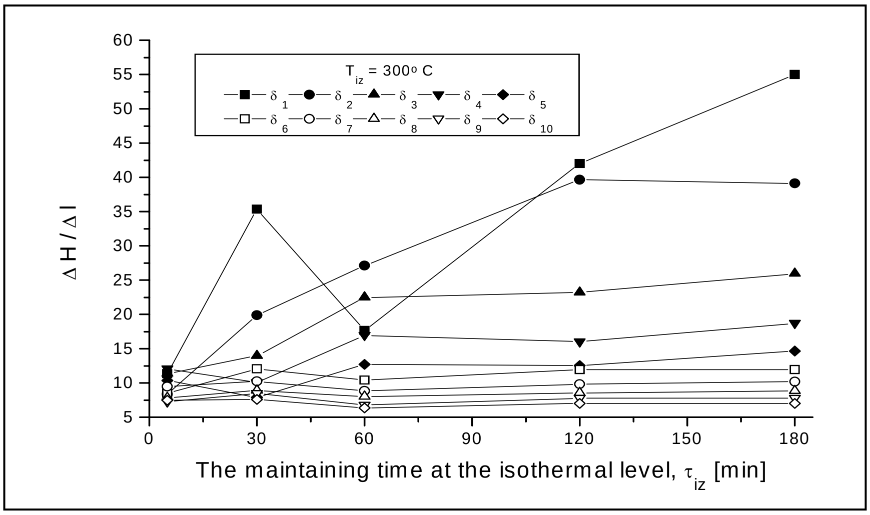

Figure 1. The variation of the ΔH / Δl rapport, function the isothermal temperature t_{iz} = 300 °C and different isothermal maintaining times τ_{iz}.

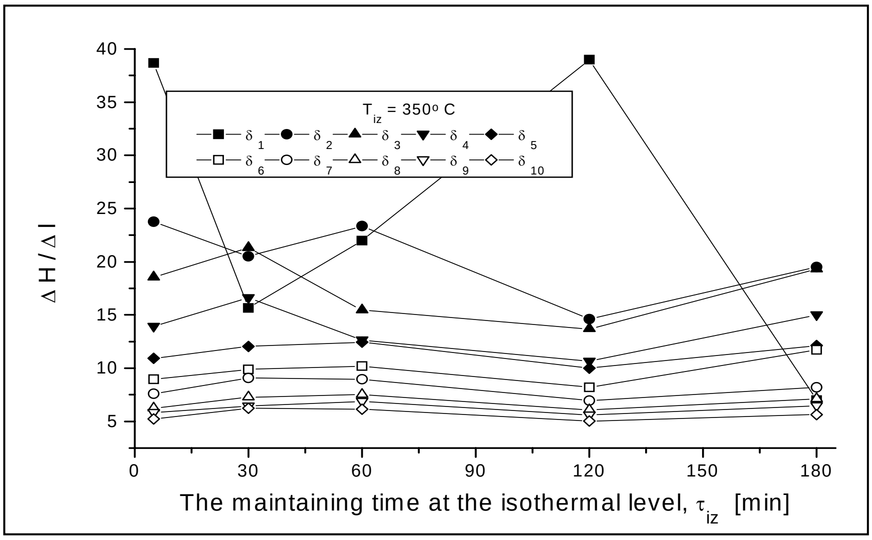

Figure 2. The variation of the ΔH / Δl rapport, function the isothermal temperature t_{iz} = 350 °C and different isothermal maintaining times τ_{iz}.

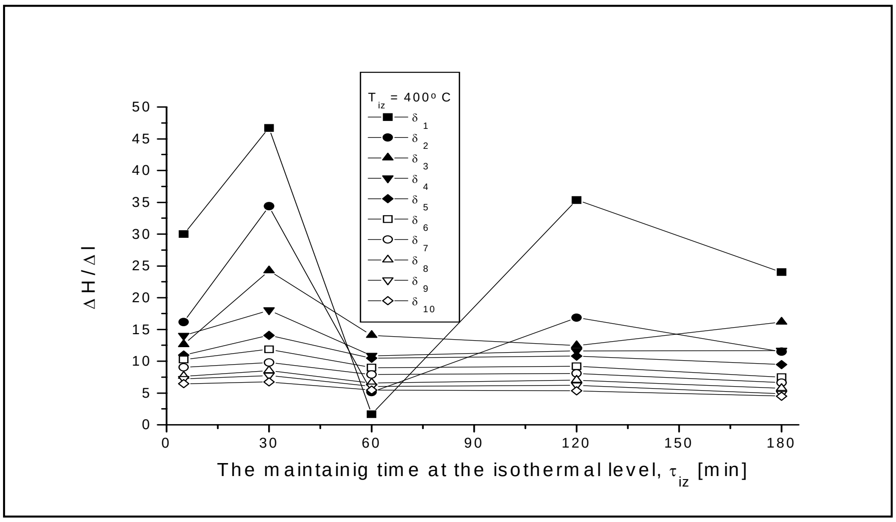

Figure 3. The variation of the ΔH / Δl rapport, function the isothermal temperature t_{iz} = 400 °C and different isothermal maintaining times τ_{iz}.

That means that the wear process is more active near the wear surface. The values for the δ_6 to δ_{10} rapport's, has a small constant variation, and that means that the wear process influence in a small way the structural changes.

6. CONCLUSION

The wear process was influenced by the structural changes of the specimen's surface. The micro hardness of the nears surface of specimens from the wear surface has a superior value and that values decrease with the increasing of the distance from the wear surface. A general observation it is observed that the values of "δ", decrease from δ_1 to δ_{10} and that means a major different between the values of δ for the specimen near to the wear and the specimen far away from the wear process.

7. REFERENCES

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