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SOME ASPECTS ABOUT THE MECHANICAL PROPERTIES OF A CRYOGENIC S.G. CAST IRON

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ABSTRACT
The paper presents the influence of the temperature and the maintained time at the isothermal level over the structure and properties of a nodular cast iron maintained at some low temperatures. The ADI's behaviour of low temperature is one of the most important study when we want to determinate the phase transformation in solid state of this material and this paper present some aspects of this. The transformation of some austenite percentage into martensite is the resulting of the significant decreasing of the austenite stability at low temperature.
Keywords: S. G. cast iron, heat treatment, low temperature

1. INTRODUCTION
Austempered ductile iron (ADI) describes a range of nodular ductile iron which have been subjected to an isothermal heat treatment to produce an essentially bainitic structure in the material [1]. ADI's have the highest strength in the family of cast irons, the actual properties depending on the metal composition and the heat treatment conditions [2]. The ADI's behaviour of low temperature is one of the most important study when we want to determinate the phase transformation in solid state of this material and this paper present some aspects of this.

2. MATERIALS
The studied cast iron had the following composition: 3.63 % C; 2.88 % Si; 0.45 % Mn; 0.012 % P; 0.006 % S; 0.38 % Ni; 0.41 % Cu; 0.06 % 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.

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 and 400 [°C]; the maintained time at the isothermal level, τ_{iz} = 30; 40; 50, 60, and 70 [min]. The quenching medium temperature was t_r = - 70°C and the time of cooling at low temperature was τ_r = 90 [min]. All these 2 experiment groups: lot A (t_{iz} = 300 °C) and lot B (t_{iz} = 400 °C) were submitted to isothermal hardening, using for every one, separately, the parameters of the heat treatment presented before. For all the groups, cooling after isothermal maintenance was made in air.

4. EXPERMENTAL RESULTS
After the heat treating there was used 20 samples (V- notched specimens): for determining the resistance of the material to the crack propagation (KCV) at room temperature (+ 20 °C) and at low temperature (-70 °C) and also for determining the harness of material (HB) at room temperature

(+20°C). The influence of heat treating over the mechanical properties of A.D.I (results of the tests) is presented in figures 1 to 3.

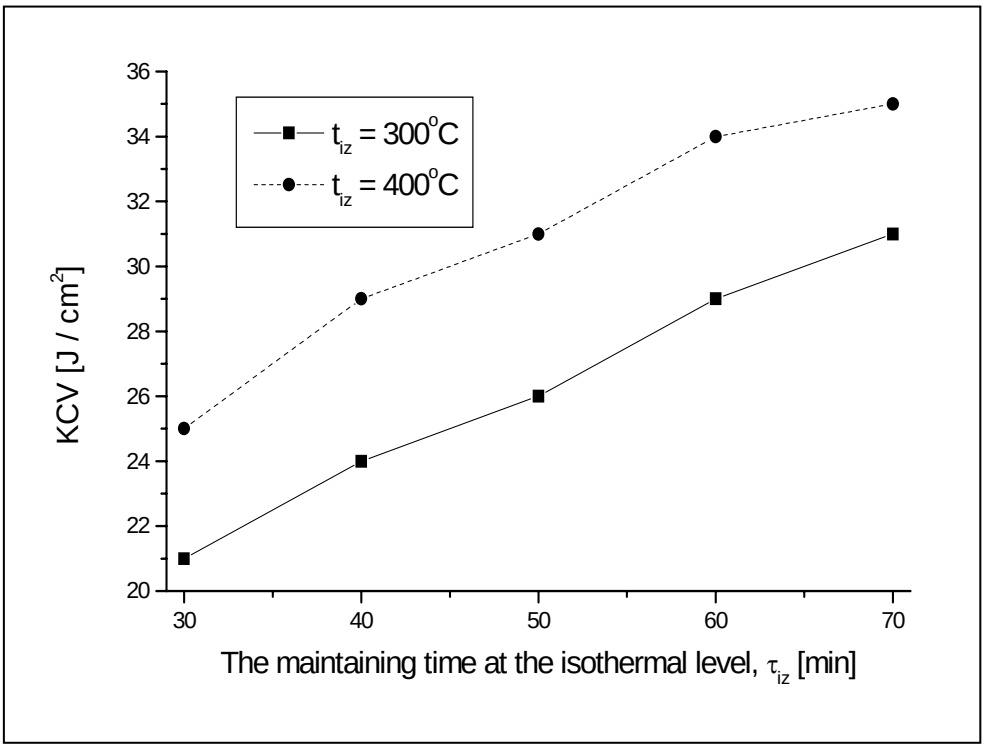

Figure1. Influence of the heat treatment over the impact strength properties of A.D.I. at the room temperature (+ 20℃)

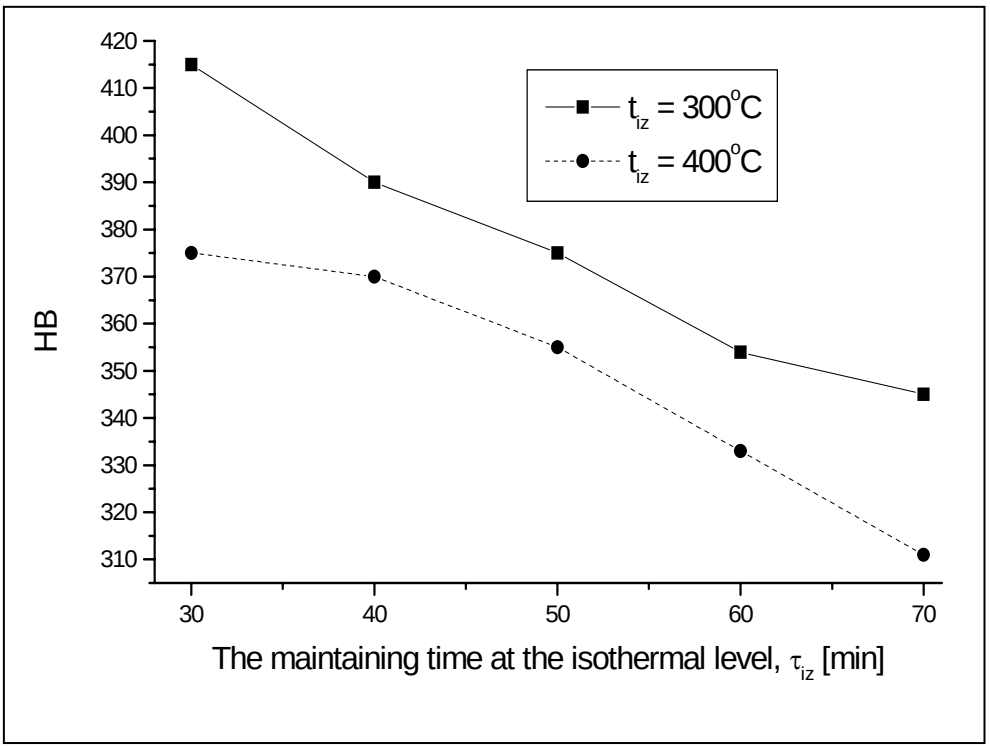

Figure 2. Influence of the heat treatment over the hardness (HB) properties of A.D.I. at the room temperature (+ 20℃)

It can be certainly observed a normal evolution of the values for mechanical characteristics [3,4]. When the heat treating parameters are changing and the temperature is growing for isothermal maintenance than the hardness (HB) are decreasing and the impact strength (KCV) are increasing. When maintaining time at the same temperature of the isothermal level is increasing then the hardness (HB) is decreasing and the impact strength (KCV) are increasing. This evolution of the mechanical properties is determined by the structural changes reported to the parameters of the heat treating. In the case of lot A structure can be constituted of inferior bainite, residual austenite and martensite. These constituents are determining high values for hardness (HB), and less high for the impact strength (KCV).

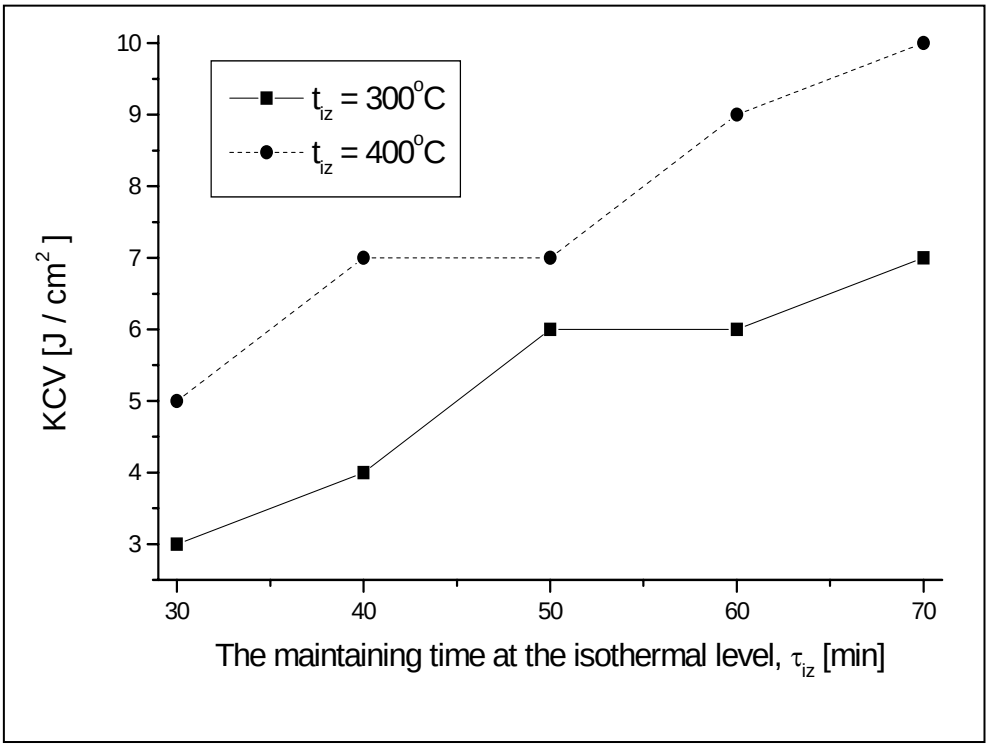

Figure 3. Influence of the heat treatment over the impact strength properties of A.D.I. at low temperature (- 70 ℃).

Together with increasing the level of the isothermal maintenance temperature inside the structure will appear the superior bainite and the martensite will disappear. In the same time there can be observed a general characteristic about the studied lots: less maintaining time for the isothermal variation provides higher values of the hardness (HB) but lower for the impact strength (KCV). This can be explained by the time of the isothermal level maintenance, followed by air cooling at the room temperature, is increasing the proportion of martensite, a constituent which is determining higher values for HB and lower KCV in the structure of the lots. In the case of the samples for determining the impact strength characteristics at low temperature (fig. 3) and the variation of the austenite proportion, it can be ascertained that the impact strength (KCV) are decreasing in lot B compared to lot A. This can be explained by the significant decreasing of the austenite stability, its transformation into martensite resulting in the variation of the values for the impact strength characteristics.

5. CONCLUSION

The increasing of the level temperature for the isothermal maintenance from 300°C to 400°C is leading to an increase of the values for the impact strength (KCV) and a decrease of values of the hardness (HB). The increasing of the maintaining time at the same temperature of the isothermal level is producing a decrease of values for the hardness (HB) and an increase of values for the impact strength (KCV). The transformation of some austenite percentage into martensite is the resulting of the significant decreasing of the austenite stability at low temperature.

6. REFERENCES

[1] Simon D.: ADI- a new material for the automotive engineer, Foundry Trade J., 2 p. 66; 1996.,

[2] Dorazil E.: High Strength Austempered Ductile Cast Iron . Ed. Ellis Horwood Metals Associated Materials, 1991.,

[3] Milosan, I.: Theoretical and experimental researches regarding the obtaining of the A.D.I., Ph.D. Thesis, "Transilvania" University of Brasov, 1998.,

[4] Milosan, I.: The influence of the heat treatment parameters over the microstructures and properties of a S.G. cast iron with special properties, Proceeding of the Romanian Aviation Academy, 2, p. 116; 1998.,