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AUSTEMPERED DUCTILE IRON

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ABSTRACT

Austempering is a heat treat process that, when applied to ferrous materials, produces components that have properties superior to those processed by conventional treatment. Due to its superior wear resistance and strength-to-weight ratio austempered ductile iron is often used for vehicle and agricultural components. In this work, metallographic properties and tensile strength after austempering of ductile iron samples were presented.

Keywords: austempering, ductile iron, ausferrite, isothermal heat treatment, tensile strength

1. INTRODUCTION

The Austempering process has been employed for the heat treatment of steels since the 1930's. However, it was the "commercialization" of the process in the 1960's that caused it to grow rapidly as an economically viable, high performance heat treatment alternative. New types of equipment and newly found process knowledge lead to increased application of the process, particularly for the heat treatment of light springs and stampings.

Austempered ductile iron was first developed for heavy loaded gear wheels and the production started in Finland in 1973. Soon after that, many wear resistant components such as spring seats, wear plates and rail wheels were produced. Additionally, other high loaded components in the car industry were developed. Some of these applications were of limited use because of safety reasons or production costs. [1] Austempering in ductile iron consists of Austenitizing followed by rapidly quenching to a temperature above the Martensite start temperature, where the material is then transformed isothermally to form Ausferrite, (acicular ferrite in carbon stabilized austenite).[2,4],

2. MATERIAL AND EXPERIMENT

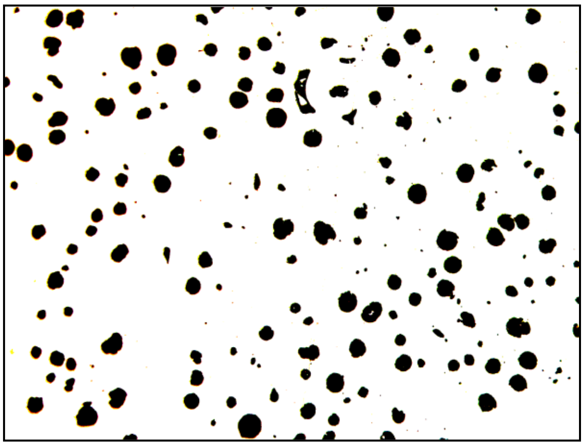
Samples for this investigation were produced in foundry "Novi Život" Zenica. Sample dimensions were as follows: 10x35x200mm. Chemical composition of the tested samples is given in the Table 1.

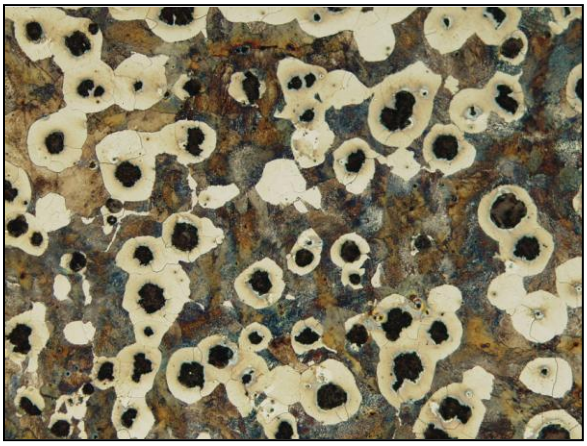
Tabele 1. Chemical compositions of the tested samples, [3]

Composition	C	Si	Mn	S	P	Mg	Cu	Ni	Mo
%	3,29	2,53	0,31	0,013	0,015	0,031	0,51	0,80	0,002

2.1. Metalographic and mechanical properties of the as-cast samples

As cast samples were investigated using Optical microscope and tensile strength machine. Figure 1 gives metallographic properties of the as cast samples before and after etching (3% Nital etching).





a) *b)*

Figure 1. Microstructure of the as cast samples: a) before etching (140 nodules per mm^2) and b) after etching: perlite-ferrite microstructure of metallic matrix (15% of ferrite and 75% of perlite), [3]

Figure 2 presents dimensions of the tensile strength samples and Table 2 gives value of the tensile strength for 4 tested samples.

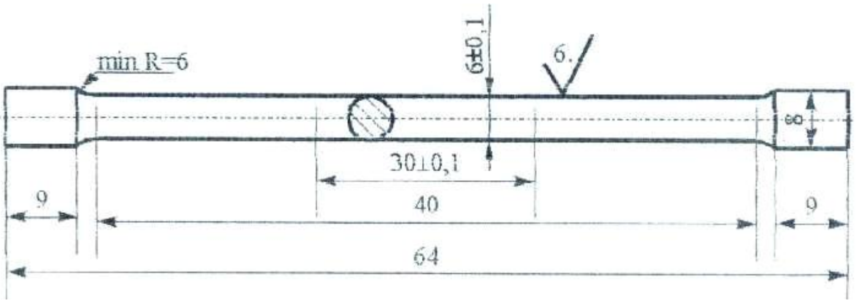


Figure 2. Tensile strength sample, [3]

Tabele 2. Tensile strength properties for 4 tested samples, [3]

No.	Sample		$Rp_{0,2}$ (N/mm^2)	Rm (N/mm^2)	Elongation A (%)
	D (mm)	Area (mm^2)			
1.	6,12	29,42	424	658	7,6
2.	6,10	29,22	425	656	8,0
3.	6,10	29,22	419	644	7,0
4.	6,05	28,75	413	658	7,8

2.2. Heat treatment

Heat treatment parameters are presented in the Table 2 and figure 3. The austempering was carried out using KNO_3 salt bath.

Table 2. Heat treatment parameters, [3]

Austenitization temperature	Austenitization time	Austempering temperature	Austempering time
T_a	t_a	T_{ip}	t_{ip}
850°C	60min	370°C	90min

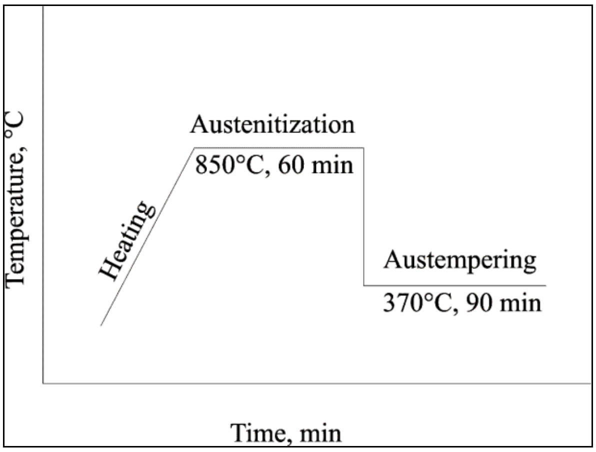
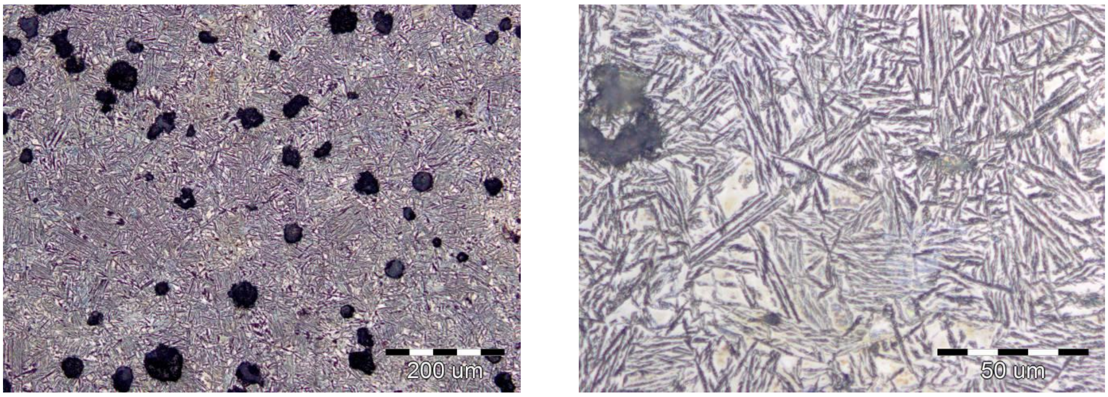


Figure 3. Diagram of the heat treatment

After heat treatment microstructure and tensile strength of the tested samples were investigated. Figure 4 presents ausferrite microstructure after heat treatment



a) 100x *b) 500x*

Figure 4: Ausferrite microstructure of the tested sample [3]

Tensile strength after heat treatment is presented in the Table 3.

Table 3. Tensile strength after heat treatment, [3]

No.	Sample D (mm)	Sample Area (mm^2)	$Rp_{0,2}$ (N/mm^2)	Rm (N/mm^2)	Elongation A (%)
1.	6,11	29,44	615	916	6,1
2.	6,12	29,21	638	922	10,2
3.	6,08	29,20	610	932	7,0
4.	6,05	28,90	635	903	8,2

3. CONCLUSIONS

Summarizing all experimental results ant theoretical background of the Ductile Iron Austempering process following conclusions can be made:

- Two steps heat treatment of the Ductile Iron produces quite new microstructure of the metallic matrix (ausferrite microstructure)
- Amount of the retained austenite in ausferrite microstructure of the metallic matrix range between 40 to 45%
- After heat treatment process tensile strength increases from 40 to 50% comparing to tensile strength of the as-cast samples
- The parameters of the heat treatment which proved to be the most suitable for the chemical composition of samples and laboratory conditions in which the experiments were conducted: $T_a = 850\ °C$, $t_a = 60$ min $T_{ip} = 370\ °C$ and $t_{ip} = 90$ min.

4. REFERENCES

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