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THE INFLUENCE OF THE THERMAL TREATED SEMI-FINISHED PRODUCTS THICKNESS ON THE TECHNOLOGICAL AND OPERATIONAL CHRACTERISTICS

Isidor PREJBAN, Stefan MAKSAY

Polytechnic University of Timisoara, Faculty of Engineering of Hunedoara

Abstract

The present paper analyzes the influence of the thickness of the thermal treated semi-finished products on the mechanical characteristics of the heat-treatable and case-hardening steels. The thermal treatments that consist of repeated heating and cooling performed under well-ascertained conditions have the highest influence on the steel structure, respectively on their properties.

The steel grades that were chosen for study are OLC45, 40BCr10 and 17MoCrNi14, and the samples for the mechanical tests had dimensions between Ø15mm and Ø60mm.

As a result of the experimental data processing, it was found out that the values of the mechanical characteristics $Rp_{0,2}$ and Rm decrease and the values of the characteristics A_5, Z and KCU increase together with the increasing of the diameter of the thermal treated sample.

Keywords

the thermal treated, mechanical characteristics, semi-finished products thickness

1. INTRODUCTION

The various scopes the steels are used in and the conditions under which the steels work have led to the necessity to ensure properties having the values of the mechanical, physical and chemical characteristics as high as possible. The structure of the steels depends on the treatments the steel was subject to during its subsequent processing (thermal-mechanical treatments, thermal or thermal-chemical treatments). If these treatments were wrongly performed or applied, the steel having the suitable chemical composition, but the defective structure, can show unsuitable properties.

Thermal treatments consisting in heating and cooling performed under well-ascertained conditions have the highest influence on the steel, respectively on its properties.

In order to study the influence of the thickness of the thermal treated specimen on the mechanical characteristics of the heat-treatable and case-hardening steels, three representative steel grades were chosen: OLC45, 40BCr10 and 17MoCrNi14. Two samples per each heat for each steel grade out of fifteen heats, rolled out of □100 mm billet were sampled. Out of a sample per each heat and out of each material there were machined specimens having the dimensions Ø60 mm, and out of the second batch there were machined the other specimens at Ø40 mm and Ø25 mm for the heat-treatable steels, respectively Ø40 mm and Ø15 mm for the case-hardening steels, according to Table 2.

The sampling for the tensile and toughness tests was performed according to Figure 1 and each sample was marked. After sampling, the specimens were metal-cut at the required dimensions.

The thermal treatment conditions applied are shown in Table 1. After performing the thermal treatment, the specimens having different thickness were machined in gauged sample for the tensile and impact bending (toughness) tests.

Thermal treatment conditions applied to the steels Table 1.

Steel grade	Quenching	Cooling agent	Heating time	Annealing	Cooling agent	Heating time
OLC45	850°C	oil	35′	620°C	air	60′
40BCr10	850°C	oil	35′	550 °C	water	60′
17MoCN14	850°C	oil	40′	180 °C	air	120′

Figure 1 shows the schematic representation of the way of sampling the specimens out of the semi-finished products of the three steel grades, and Table 2 shows the number of specimens sampled on each dimension.

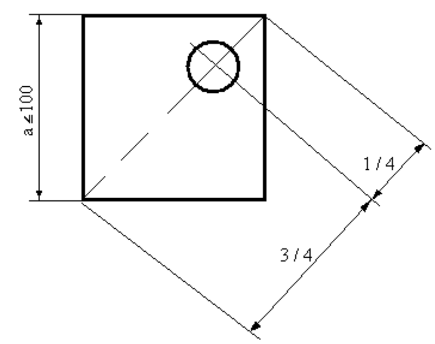

Figure 1. Way of sampling the specimens for the tensile and toughness test

Table 2

Steel grade	Specimen dimension and number of pieces				
	Ø60 mm	Ø40 mm	Ø30 mm	Ø25 mm	Ø15 mm
OLC45	15	20	-	21	-
40BCr10	15	20	-	27	-
17MoCN14	15	-	30	-	27

The results of these tests are centralized as a table, and based on the results achieved experimentally for the same mechanical characteristic, a high dispersion of the values for the same steel grade at the three specimen dimensions that were subjected to the same thermal treatment, has been obtained. This fact shows that the thermal treatment applied under the same conditions has an influence on the mechanical characteristics.

The variation diagrams of the mechanical characteristics were drawn depending on the dimensions of the treated specimens shown in Table 3, where $\overline{Rp_{0,2}}$, $\overline{Rm}$, $\overline{A_5}$, $\overline{Z}$, $\overline{KCU\ 300/2}$ represent the arithmetic mean of the mechanical characteristics for each typo-dimension of the studied specimens.

Table 3

Steel grade	Dimension	Arithmetic mean of the values of the mechanical characteristics on each typo-dimension of the studied specimens				
		$\overline{Rp_{0,2}}$ daN/mm^2	$\overline{Rm}$ daN/mm^2	$\overline{A_5}$ daN/mm^2	$\overline{Z}$ daN/mm^2	$\overline{KCU\ 300/2}$ daN/mm^2
OLC45	Ø60	48,266	79,533	20,2	50,6	7,733
	Ø40	50,25	81,7	19,05	49,25	7,02
	Ø25	52,857	84,428	17,958	45,523	6,466
40BCr10	Ø60	73,866	93,8	17,533	60,133	12,106
	Ø40	81,9	99,6	16,25	58,15	11,9
	Ø25	91,851	102,814	14,074	56,407	9,581
17MoCrNi14	Ø60	61,266	86,533	19,066	60,4	17,226
	Ø30	76,933	97,366	15,966	58,066	14,066
	Ø15	93,592	102,259	14,222	54,777	12,348

Figure 2 shows the variation of the $Rp_{0,2}$ characteristic depending on the specimen dimension. It can be noticed that if the dimension of the thermal treated specimen increases, the value of the $Rp_{0,2}$ decreases.

Figure 3 shows the variation of the mechanical characteristic Rm depending on the dimension of the thermal treated specimen. It can be noticed that the value of the maximum tensile load Rm decreases together with the increasing of the dimension of the thermal treated specimen.

Figure 4 shows the variation of the specific elongation A_5 in % depending on the diameter of the thermal treated specimen. For OLC45 the A_5 value is higher than the minimum value specified by the norm. For the steel grades 40BCr10 and 17MoCrN14, the A_5 values are higher than those specified by the norms and it increases together with the increasing of the specimen diameter.

Figure 5 shows the variation of the contraction Z depending on the specimen diameter, where there have been recorded higher values than those specified by the norms for all the analyzed steel grades. The values of the contraction Z recorded for OLC45 are much under the values corresponding to the steel grades 40BCr10 and 17MoCrNi14, the last two being close enough. They increase together with the increasing of the diameter of the thermal treated specimen.

Figure 6 shows the variation of the toughness KCU 300/2 depending on the diameter of the thermal treated specimen. The toughness increases together with the increasing of the specimen diameter. The recorded values of the toughness are higher than those specified in the norms, for all the analyzed steel grades.

It can be summarized that the values of the mechanical characteristics $Rp_{0,2}$ and Rm decrease and the values of the characteristics A_5, Z and KCU increase together with the increasing of the diameter of the thermal treated specimen.

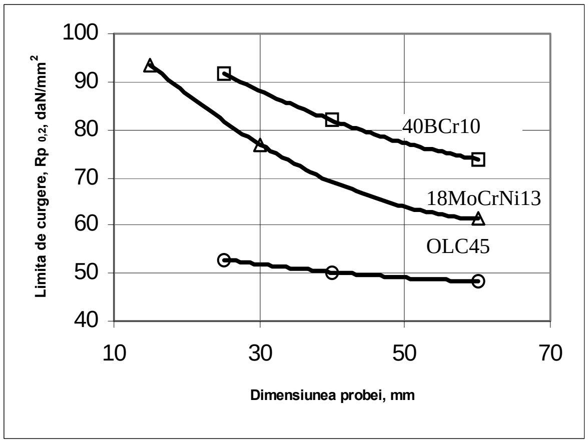

Figure 2.Variation of the characteristic $Rp_{0,2}$ depending on the specimen dimension

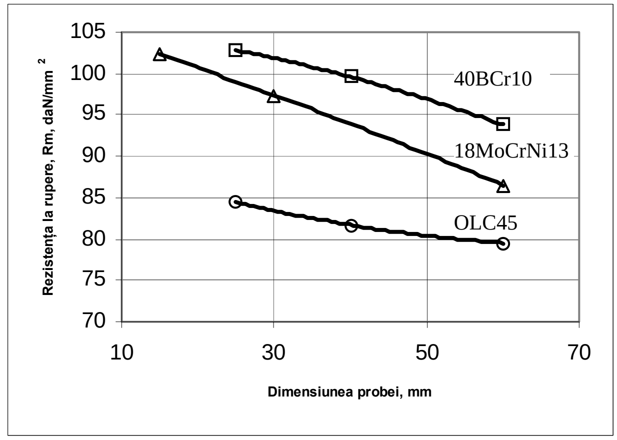

Figure 3.Variation of the characteristic Rm depending on the specimen dimension

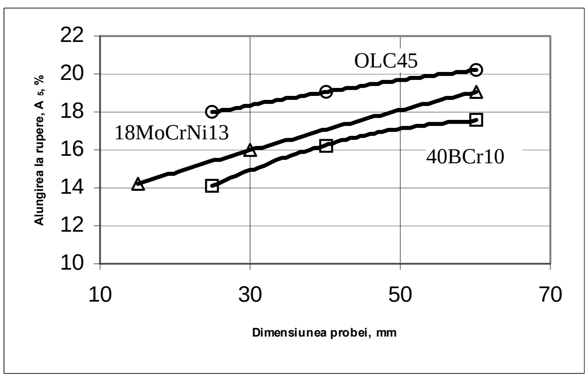

Figure 4.Variation of the A_5 characteristic depending on the specimen dimension

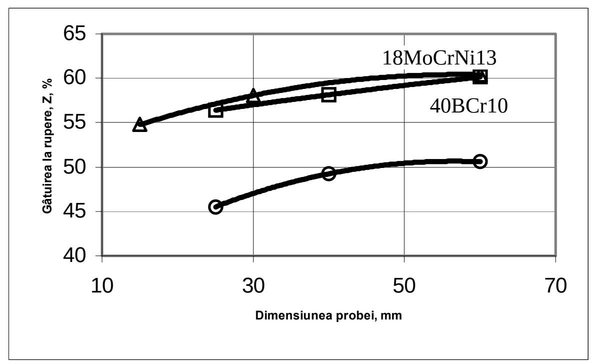

Figure 5.Variation of the characteristic Z depending on the specimen dimension

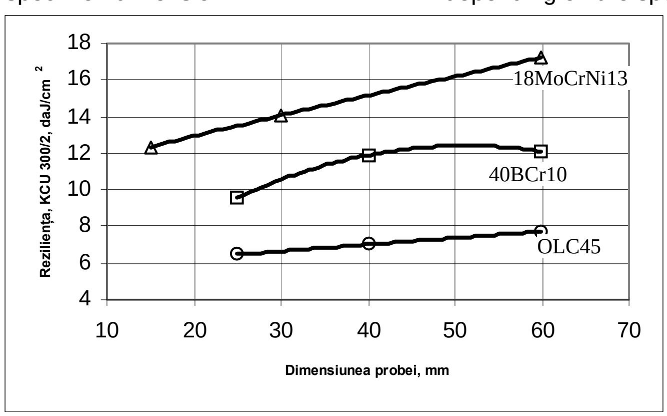

Figure 6.Variation of the characteristic KCU300/2 depending on the specimen dimension

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