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WEAR RESISTANCE INCREASING OF BORON SATURATED SURFACE LAYER  
OF STEEL 15 230 AND 17 246

ZVYŠOVANIE OTERUVZDORNOSTI BÓROM NASYCOVANÝCH VRSTIEV  
OCELÍ 15 230 A 17 246

#### Abstract

In presented paper we described studies of resistance of selected material in abrasive wear tests. A surface of tested materials was remelted using TIG method and the layer of borax and B<sub>4</sub>C in water suspension at the surface. Based on tests results, we found out, that the B<sub>4</sub>C as a boron source is more suitable compare to borax when saturating remelting surface layer, with more significant impact on relative abrasive wear resistance of selected steel 15 230 and 17 246.

#### Abstrakt

V našom príspevku popisujeme štúdium odolnosti vybraných materiálov v skúškach abrazívneho opotrebenia. Povrchová vrstva testovaných materiálov bola pretavená metódou TIG s bóraxom a B<sub>4</sub>C vo vodnej suspenzii. Na základe výsledkov skúšok sme zistili, že B<sub>4</sub>C ako zdroj bóru je vhodnejší ako bórax pri nasycovaní pretavovanej vrstvy, s výraznejším vplyvom na pomernú oteruvzdornosť oboch vybraných ocelí 15 230 aj 17 246.

## 1 INTRODUCTION

Industrial practice put a main emphasis on materials of used parts and machines. These materials have to face hard mechanical, physical and chemical factors of environment. Accordingly demands on advanced technologies exploitation and operation efficiency of those machines increase. Improvement of functional machine parts life and consequently improvement of serviceability of machines and systems is a possibility of efficiency improvement.

Selection of efficient system base material – surface layer is appropriate solution of balance of external stress and part strength in section and surface hardness. There are many known methods of wear resistant layers creation today, but not all of them are expedient from technical and economic point of view and each of them has to be reviewed and evaluated separately.

From the economic point of view thermal treatment, thermal-chemical treatment of surfaces and metal deposits applications are appropriate technologies for wear resistant layers creation. These technologies considerably increase material wear resistance, but not at such rate as diffusion saturation processes or material weld-on do.

## 2 MATERIAL AND METHODS

One of potential new method of improvement of functional surfaces tribological properties is alloying in a fusion process using dissociated atmosphere and diffusion processes. The aim is to create chemical compounds of higher mechanical properties and stability (e.g. nitrides, borides) in metalurgical process.

Remelting of surface layers was realized via TIG method using semi-automatic welding machine ALUTIG 200 in gas atmosphere of argon. The borax and B<sub>4</sub>C were used as boron sources. When in powder form, it is difficult to use them along with argon as shielding gas. Suspensions of the

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borax and B<sub>4</sub>C with distilled water were therefore prepared and applied on specimen surface. Current intensity was adjusted to selected appropriate value 110 A.

For experiments we used laboratory device for abrasive wear resistance testing according standard STN 01 5084 – Evaluation of abrasive wear resistance of metal materials on abrasive cloth (see fig.1).

The laboratory device (fig. 1) consists of uniformly rotating plate (1); abrasive cloth (2) is fixed on it. Specimen (3) is held by clamping head (4) and gravity force of weight (5) holds it down to abrasive cloth. Other parts are device allowing radial motion (feed) of specimen (6) and a terminal switch (7).

The specimen is moving from the middle to margin of the abrasive cloth or in reverse direction in test, with a part of its surface continually coming to contact with new (unused) abrasive cloth.

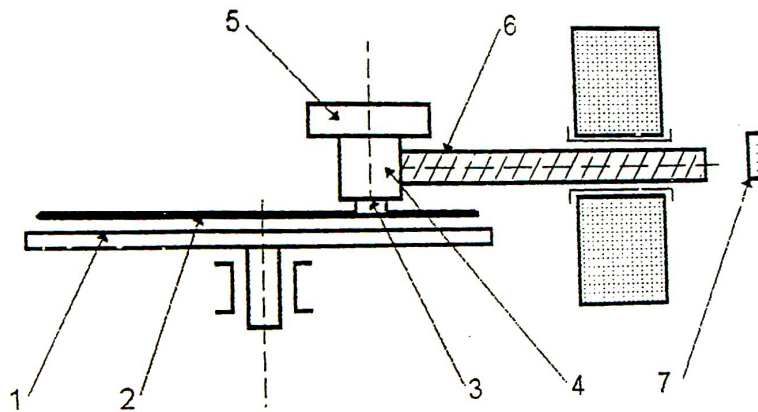
Relative abrasive wear resistance ( $\psi_{abr}$ ) is the main criterion of material valuation in laboratory conditions.

The weight of the specimen and reference etalon was measured before experiment and after that. Material relative wear values regarding etalon in abrasive wear were calculated using formula.

$$\psi_{abr} = \frac{W_{he}}{W_{hv}} \cdot 100, \quad (1)$$

where:  $W_{he}$  – average weight loss of etalon, [g],

$W_{hv}$  – average weight loss of specimen, [g].



**Fig. 1** Design of testing device for abrasive wear tests on abrasive cloth.

### 3 RESULTS

Steel used in experiment were selected following their properties, based on knowledge of their chemical structure and expected reactions.

#### Steel STN 15 230

Steel is suitable for hardening, well formable at higher temperatures, with good machinability. It can be used for parts and products that should resist wear, like machine, household, table, pocket knives. Not suitable for welding. Corrosion resistant.

**Table 1** Measured and computed values for 15 230 steel specimens

Specimen	Mixture	Specimen weight before test (g)	Specimen weight after test (g)	Weight loss (g)	Specific weight (g.cm <sup>-3</sup> )	Average weight loss $\Delta m$ (g)	Total relative resistance $\Psi_{abr}$
15 230	Borax	14,0280	13,8517	0,1763	7,85	0,1929	1,2417
		13,8517	13,6693	0,1824			
		13,6693	13,4857	0,1836			
		13,4857	13,2821	0,2036			
		13,2821	13,0636	0,2185			
	B <sub>4</sub> C	13,8623	13,7080	0,1543		0,1616	1,4817
		13,7080	13,5494	0,1586			
		13,5494	13,3909	0,1585			
		13,3909	13,2277	0,1632			
		13,2277	13,0541	0,1736			
12 014 etalon		10,4864	10,2466	0,2398	7,85	0,2395	1
		0,2466	9,9990	0,2476			
		9,9990	9,7706	0,2284			
		9,7706	9,5285	0,2421			

**Table 2** Measured and computed values for 17 246 steel specimens

Specimen	Mixture	Specimen weight before test (g)	Specimen weight after test (g)	Weight loss (g)	Specific weight (g.cm <sup>-3</sup> )	Average weight loss $\Delta m$ (g)	Total relative resistance $\Psi_{abr}$
17 246	Borax	14,9286	14,7661	0,1625	7,85	0,1732	1,3828
		14,7661	14,6033	0,1628			
		14,6033	14,4401	0,1632			
		14,4401	14,2558	0,1843			
		12558	14,0626	0,1932			
	B <sub>4</sub> C	14,3827	14,2389	0,1439		0,1546	1,5492
		14,2389	14,0897	0,1492			
		14,0897	13,9422	0,1475			
		13,9422	13,7799	0,1623			
		13,7799	13,6097	0,1702			
12 014 etalon		10,4864	10,2466	0,2398	7,85	0,2395	1
		0,2466	9,9990	0,2476			
		9,9990	9,7706	0,2284			
		9,7706	9,5285	0,2421			

**Steel STN 12 014 – etalon**

Magnetically soft steel with guaranteed values of magnetic properties. Suitable for galvanic metallization and cold forming. Weldability guaranteed. Chemical composition shows table 2.

**Table 3** Chemical composition of steel grade 12 014, in %

C	Mn	Si	P	S
0,06	0,45	0,15	0,020	0,020

Figure 2 shows dependence of wear resistance for steel 15 230 remelted using arc process with borax and B<sub>4</sub>C as boron sources.

The values of relative wear resistance of steel 17 246 remelted using arc process with borax and B<sub>4</sub>C as boron sources shows table 2 and they are plotted in figure 3.

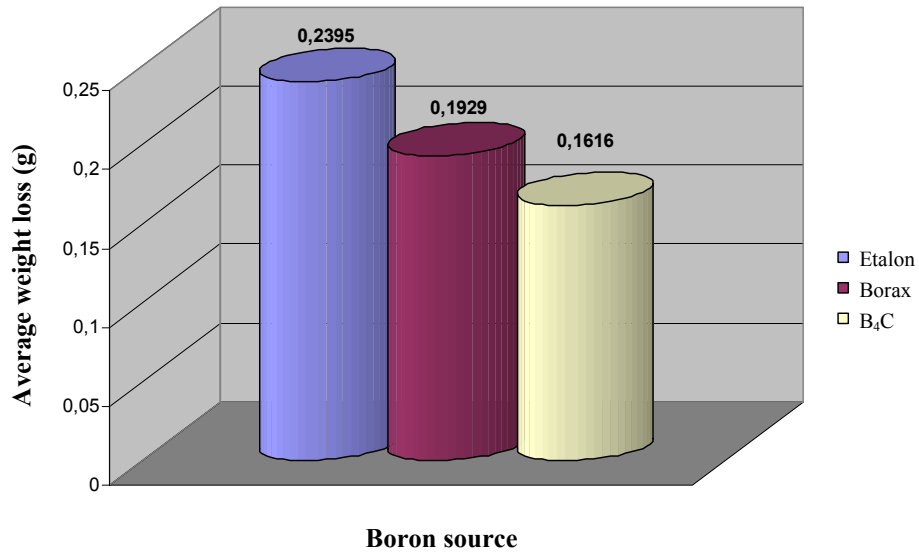


Fig. 2 Column diagram of average weight loss of steel 15 230 and etalon specimens

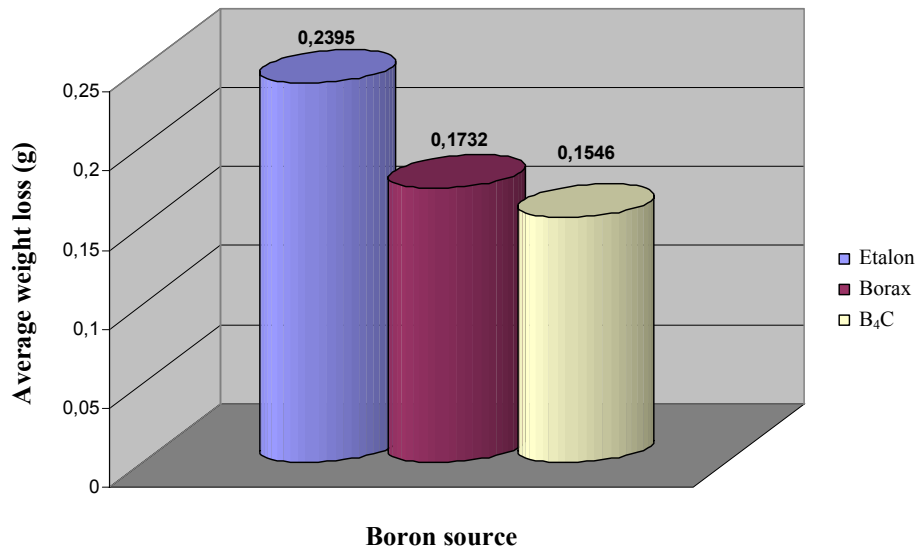


Fig. 3 Column diagram of average weight loss of steel 17 246 and etalon specimens

#### 4 DISCUSSION AND CONCLUSION

The process of remelting using electrical arc and dissociating sources of boron – borax and B<sub>4</sub>C generates conditions allowing to create steady structures of high mechanical properties and especially higher wear resistance. To verify these facts we used materials 15 230 and 17 246 compared to etalon 12 014.

Based on results, we can state, the abrasive wear resistance of selected steel depends on boron source significantly. While using borax, the total wear resistance of 15 230 specimens increased of 24%, using B<sub>4</sub>C as boron source it increased twice. This is even more significant in case of 17 246 steel. Using B<sub>4</sub>C, the total wear resistance of 15 230 specimens increased slightly over 38%, using B<sub>4</sub>C as boron source it was almost 55%.

Experiments results can in addition to other help in solving of operative problems of working tool wear of agricultural machines as well as in new machine components designing. Based on achieved data background material for machine maintenance and repair can be prepared.

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