EXPERIMENTAL RESEARCHES REGARDING THE ELABORATION OF A STAINLESS MARTENSITE ELECTRODE DESIGNED FOR THE LOADING AND FOR THE RECONDITIONING THROUGH THE WELDING OF THE IMPELLERS FROM THE HYDRO-ENERGETIC COMPOSITION ASSEMBLY

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***Abstract:** In the paper, it is presented the fabrication technology of a stainless martensite electrode is presented designed for the hard facing and for the reconditioning through the welding of the impellers from the hydro energetic composition assembly. The clinkering system, the alignment and basicity system of the coating has been elaborated. The structural analysis of the deposited material as well as the determination of the mechanical characteristics has been effectuated. The obtained results allow the usage of this electrode, the welding and the reconditioning of the hydraulic impellers, being easily absorbed in the production.*

1. INTRODUCTION

When working out experimental electrodes on laboratory scale were taken into account the results of the research concerning the features of reference electrodes FOX CN 13/4. Research carried out on the reference electrode highlight the need for creating a basic character cover, being well known the fact that basic covers provide a good protection of the arc, as well as getting a metal deposited with increased purity and reduced tendency to cracks.

When working out laboratory experimental networks the purpose was to obtain covers able to provide a good behaviour on welding in the conditions of welding steels of T09CuMoMnNiCr185-Ti and T08CuMoMnNiCr165-Ni types. For such purpose, on the grounds of the expertise acquired so far, there were produced cover versions in the following slagging systems: CaO-$CaFe_2$-FeO; CaO-CaF_2-SiO_2; CaO-$CaFe_2$-TiO_2.

The determination of electrode welding features was done by testing in order to establish the welding behaviour, testing to determine the degree of penetration on welding and test to determine the electrodes deposit features.

The check up of the welding behaviour was performed according to STAS 112/1-91 following the arc stability, electrode fuse, spraying, slag removal and aspect of the deposit on welding for E410 electrodes.

The test performed in such purpose highlighted the following:

- the arc ignition is easily performed
- burning is stable in case of short art welding, otherwise the stability gets worse
- the electrode fuse is uniform, the cave depth is 1,5 mm
- the electrodes have the tendency to spray
- the slag is easily removed, with tendency of micro adherence
- the slag has an average thickness and uniformly covers the seam
- uniform deposit, with fine scales and slight tendency of superelevation

2. DRAWING UP THE SLAGGING SYSTEM

Out of the tested slagging systems, the best results were obtained with nets drawn up in system CaO-CaF2-TiO2. This slagging system was studied on the ternary diagram displayed in image 1,

The ternary diagram reveals that the researched versions are grouped into 4 ranges:

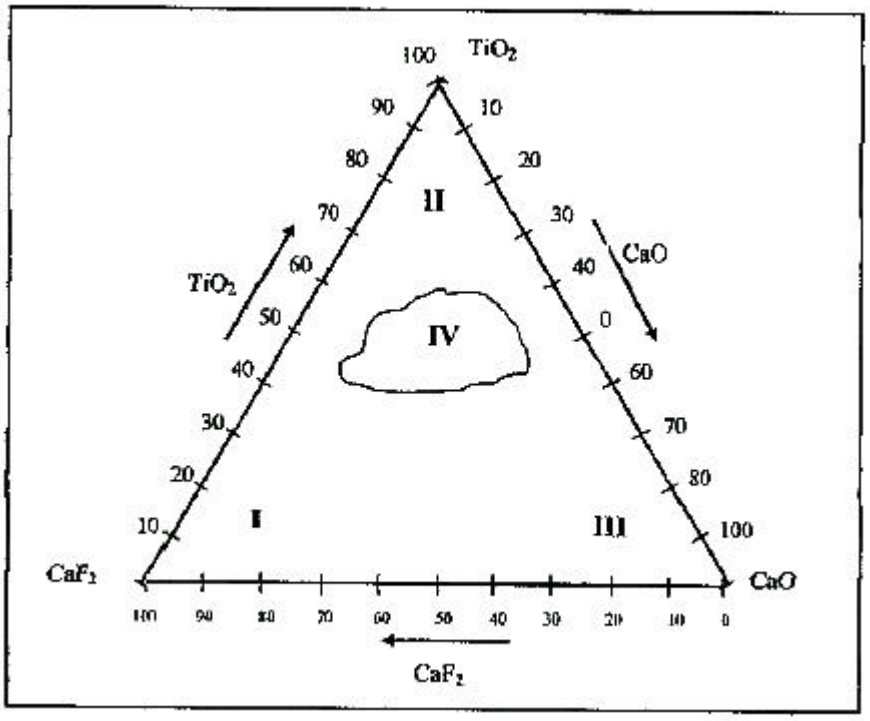

Figure 1 Ternary diagram CaO-CaF2-TiO2

- range I CaO = 0 – 30% CaF_2 = 60 – 100% TiO_2 = 0 – 40%	- range II CaO = 0 – 30% CaF_2 = 0 – 40% TiO_2 = 50 – 100%
- range III CaO = 50 – 100% CaF_2 = 0 – 30% TiO_2 = 0 – 40%	- rangeIV CaO = 15 – 35% CaF_2 = 20 – 40% TiO_2 = 30 – 50%

The research of slag in the 4 ranges highlights the following:

- in range I the slag is abundant and gathers at the edge of the welding seam
- in range II the slag is viscous and the arc stability is small
- in range III the slag is difficultly removed and shows adherences on the edge of the welding seam
- in range IV the experimental electrodes during welding have a good behaviour, the arc ignition is easily performed, the arc burning is stable, the cover fuse is uniform, reduced fusion, the slag is easily removed and the welding seam is uniform (6).

3. ALLIGATION SYSTEM DRAFTING

For drafting the allegation system was taken into consideration the chemical composition of the wire S08Cr170 and the chemical composition of the metal deposited with electrodes E410.

The chemical composition for wire S08Cr170 is displayed in table 1.

Table 1

Marking	Chemical composition %							
	C	Mn	Si	Cr	Ni	Mo	P	S
S08Cr170	max. 0,08	max. 0,90	max. 0,08	15,0-18,0	max. 0,60	max. 0,30	max. 0,030	Max 0,020

The analysis of the metal chemical composition deposited with laboratory experimental electrodes, raster made in slagging system CaO-CaF2-TiO2, range IV, highlight the excess of the limits provided for Mn, Cr, Si, Mo, thus the content of Cr, Si, Mo is smaller and the Mn one is bigger.

The adjustment if Cr, Mn, Si, Mo was done by introducing into the basic recipe iron powder, chromium powder and ferromolybdenum.

The end of the research of making the allegation system was performed by establishing the recipe of experimental electrodes.

4. COVER BASICITY

The cover basicity was calculated with Boniszevski formula:

$$B_B = \frac{CaO + MgO + BaO + Na_2O + K_2O + 1/2(MnO + FeO)}{SiO_2 + 1/2(Al_2 + TiO_2 + ZrO_2)} \quad (1)$$

On the grounds of this expression, the character of the cover is divided into:

- cover with acid character, $B_B<1$
- cover with neutral character, $1<B_B<1,5$
- cover with semi-basic character, $1,5<B_B<2,5$
- cover with strongly basic character, $B_B>2,5$

The calculation of the basicity of the laboratory experimental electrode cover highlighted that it has a semi-basic character, the value of basicity index B_B is 2,32 (5)

5. STRUCTURAL ANALYSIS OF THE METAL DEPOSITED

The structural analysis aimed at determining the structure of the metal deposited and establishing the influence of the pre-heating temperature on it.

The determinations were made on samples, marked E 410.

Micro structural examinations were accompanied by sclerometer determinations, and the determination of hardness confirmed the conclusions of structural examinations.

The results of analysis and hardness measurements are displayed in table 2.

Table 2

Ord. no.	Sample mark	Brinell hardness HRC	Found structure STAS 10952/1-87	Image no.
1	E410	45, 46, 45, 48, 45	The cast structure consisting in martensite, phase σ isolated distributed and precipitations of variable size uniformly dispersed	2 3

Figure 2 (x 125)

Figure 3 (x250)

6. DETERMINATION OF MECHANIC FEATURES

Taking into account the conditions for exploitation of hydraulic turbine impellers blades, there were performed traction mechanical testing, shock bending testing, fatigue tests by rotating bending and wear tests on swinging disk.

All tests were performed on 4 samples marked A1.1, A1.2 without heat treatment and A2.1, A2.2 heat treated test specimens for tempering. The outcome of the traction tests are displayed in table 3.

Table 3

Traction test specimen	Usual mechanical features			
	Rp_{02} $(N/mm)^2$	Rm $(N/mm)^2$	A5 (%)	Z (%)
A1.1	583	938	4	8
A1.2	592	1030	5	8
A2.1	701	230	19	42
A2.2	683	933	18	55

The analysis of the outcome displayed in the table reveals:

- usual mechanical features of the tempered deposited material are different from the mechanical features of the not tempered material deposited by welding,
- the usual mechanical features of the deposited material are obviously influenced by the heat treatment

- usual mechanical features determined on the tempered metal deposited by welding are close to the ones mentioned by the manufacturer, displayed in table x

7. CONCLUSIONS

- Electrodes E 410 belong to the category of highly alloyed electrodes with low carbon content. The upper limit of the determined carbon is 0,07%
- After the tempering heat treatment, there are structural modifications
- The tempering heat treatment modifies the values of the martensitic Ms and Mf points
- The usual mechanical features are influenced by the tempering heat treatment and they are improved
- Pre-heating at temperatures under 100°C does not influence the metallographic structure and the mechanical features
- The slag shows tendency of micro adherences

Electrodes made on wires of general use S08Cr170 have been checked according to quality technical prescriptions and there was performed a batch of 5 kg for each type

The outcome got when making the electrode can be used in industry.

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