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THE ANALYSIS OF THE RESULTS OF DEVELOPMENT AND PRODUCTION OF COATED ELECTRODES WITH A CORE OF FLUX-CORED WIRES

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Abstract: The process of alloying of the weld metal during welding with coated electrode may be from the core and the coating of the electrode. Replacing of solid metal core with flux-cored wire provides broader technological capabilities in terms of the flexibility of introducing alloying elements in the weld metal alloying, oxidation loss of alloying elements, increase in welding speed. Replacing flux cored wire instead of solid wire for making the core of coated electrodes provides real opportunities that with its chemical composition the cored wire combined with appropriate coating give the desired composition of the weld metal. Proper selection of adequate quality cored wires for core production and optimal composition of the coating of the new electrode can significantly improve the quality of welded joints and increase productivity. Production of the new electrode with a core made of flux-cored wire requires special technical solutions for individual technological operations. The objective of this paper is the analysis of the results of development and production of new coated electrodes with a core of flux-cored wires. The main objective of replacing the core of solid wire with flux cored wire is to improve the welding productivity and flexibility of changing the composition of the core, thereby obtaining a weld metal of designed chemical composition and mechanical properties. The technological process consists of the phase of production of cored wire designed for producing the core of the coated electrode and the second phase of applying coatings on the press for continuous coating.
Keywords: covered electrodes, cored wire, manual metal arc welding process

1. INTRODUCTION

This is explained by the simplicity of the welding process, the good and easy operation, streamlined composition of weld metal.

The process of alloying of the weld metal during welding with coated electrode may be from the core and the coating of the electrode. According to literature [1-3] the best way to alloy weld metal in terms of chemical composition uniformity is from the electrode core with alloying elements coming from solid metal core. Replacing of solid metal core with flux-cored wire provides broader technological capabilities in terms of the flexibility of introducing alloying elements in the weld metal alloying, oxidation loss of alloying elements, increase in welding speed. To create a cored wire core materials used are similar in composition to materials for coating the electrode.

Replacing flux cored wire instead of solid wire for making the core of coated electrodes provides real opportunities that with its chemical composition the cored wire combined with appropriate coating give the desired composition of the weld metal. Proper selection of adequate quality cored

wires for core production and optimal composition of the coating of the new electrode can significantly improve the quality of welded joints and increase productivity. Production of the new electrode with a core made of flux-cored wire requires special technical solutions for individual technological operations in particular in cutting ends and closing to prevent powder spilling [1-3].

2. EXPERIMENTAL

The experimental part includes the production of coated electrodes with a core of solid and flux-cored wires for the purpose of comparison of test results. To create a solid wire core wires of 2.0 and 3.25 mm in diameter is selected with a chemical composition: 0.10% C, 0.03% Si, 0.6% Mn. For making an electrode core of flux-cored wire, on the line for calibration and filling in IHIS RDC Belgrade, produced was a certain quality cored wire, from a steel strip 0.8 mm thick and 10 mm wide, chemical composition: 0.10% C, 0.03% Si, 0.45% Mn, from domestic production. Plastic processing of the flux-cored wire was continued on the wire drawing machine reducing the diameter of 4.0 mm to a final diameter of: 2.0 and 3.25 mm. Coils of solid and flux-cored wire with final diameters 2.0 and 3.25 mm were, using a straightening and cutting machine, cut into rods 350 mm in length intended for the production of the core of the coated electrodes.

Mastering and pilot production of coated electrodes was carried out on an experimental line for coating in the IHIS Research and Development Center in Belgrade.

Layout of longitudinal cross section of a new special coated electrode with a core of flux-cored wire is shown in the diagram, Figure 1. Before the coating process of flux-cored wire the ends need to be closed by a coating of graphite powder and binder.

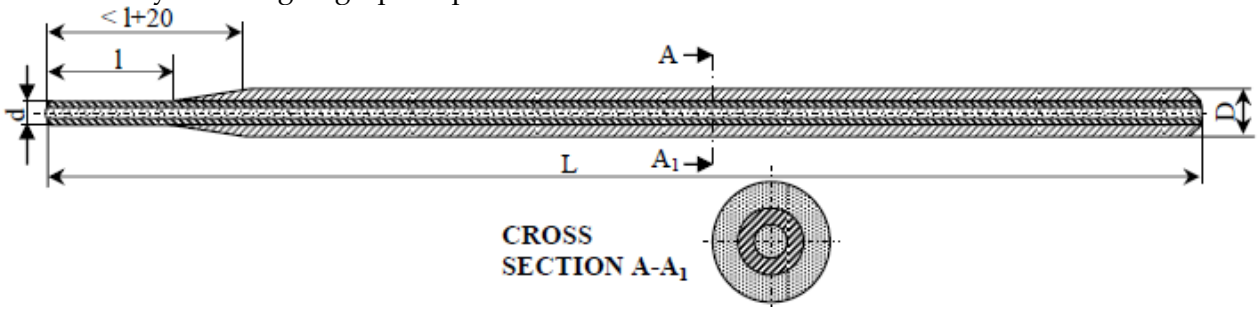


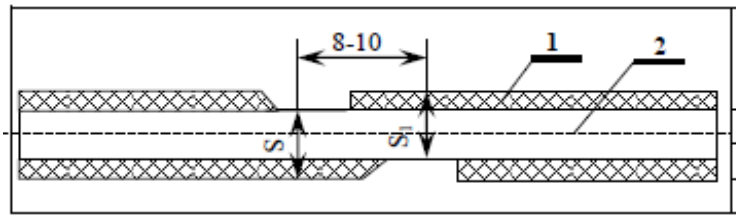
Figure 1. Sketch of the longitudinal cross section of the coated electrode with a core of flux-cored wire

3. RESULTS AND DISCUSSION

Tested was the compactness and eccentricity of the coating, then the metallographic and mechanical properties of welded joint as well as testing the welding-technological properties of coated electrodes with cores of solid and flux-cored wire.

Examination of compactness of coating is performed by dropping the electrode in free fall on a smooth steel plate from a height of 1 m. The results obtained by testing compactness using the selected method are very satisfactory since there was no crumbling or falling off of coating. A particular problem in the coating of flux-cored wire is the appearance of coating eccentricity which is necessary to be brought to the allowed level. Eccentricity of the coating (*e*) has been tested using a method based on measuring the thickness of electrode coating in three places lengthwise at a distance of 50-100 mm and the circumference of at an angle of 120º. Eccentricity values were calculated using the formula: $e = S\text{-}S_1$ and the measurement results are given in Table 1. According to literature allowed coating eccentricity is up to 1 mm.

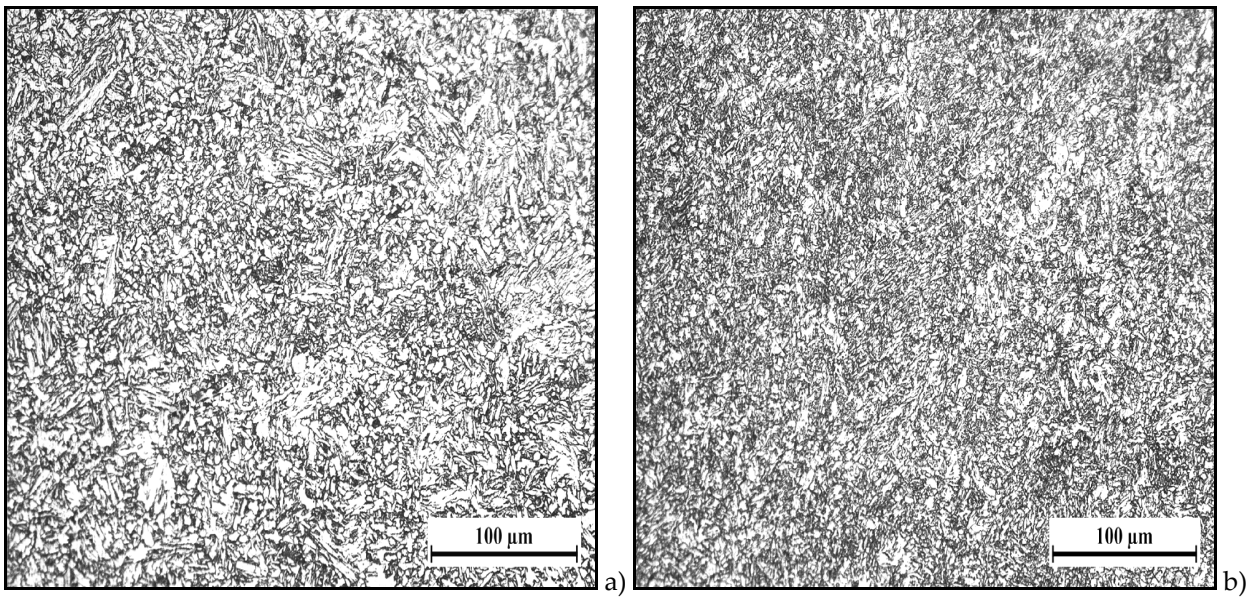
Table 1. The measured values of thickness of coating and the calculated eccentricity (*e*)



Measuring point	S (mm)	S_1 (mm)	Eccentricity $e = S - S_1$ (mm)
1	4,00	3,8	0,20
2	4,05	3,8	0,25
3	3,90	3,9	0,00

Experimental welding was done by manual electric arc process using a coated electrode with a core of solid and flux-cored wire, and then testing of the characteristics of welded joints was performed. Visual inspection showed that: the electric arc is easily established and burns steadily; coating melts evenly; there was not much splatter, observed was uniform spreading of electrode material in all welding positions; notes even spreading of slag and only separation after cooling especially in surfacing in the horizontal position.

The structure of the weld metal is fine-grain pearlite-ferrite, Figure 2.a. In the surface passing to the face of the weld metal the structure is extremely coarse dendritic ferrite-pearlite with a share of bainite. HAZ structure is uniform ferrite-pearlite, Figure 2b.



a) b)

Figure 2. Microstructure of the weld metal (a) and HAZ of the welded joint (b) made with a coated electrode with a flux-cored wire core

4. CONCLUSIONS

Production of cored wire designed for welding the MIG / MAG process, submerged arc process in several metallurgical qualities is a basis for further upgrades to a new product in the form of a coated electrode with a core of flux-cored wire designed for welding and surfacing low-carbon, alloyed and high alloyed steels.

Based on the results of comparative analysis of welding properties of coated electrodes with a core of flux-cored wire with respect to electrodes with a classic solid wire core certain advantages were observed in terms of:

- ✓ easier management of the welding process;
- ✓ quality formation and separation of slag from the weld metal;
- ✓ stable arc management.

Moreover, it is expected that with the alloyed electrodes with a flux-cored wire to achieve uniform chemical composition along the length of the weld metal and lower oxidation loss of alloying elements compared to the classic coated electrode where the alloying elements are within the coating.

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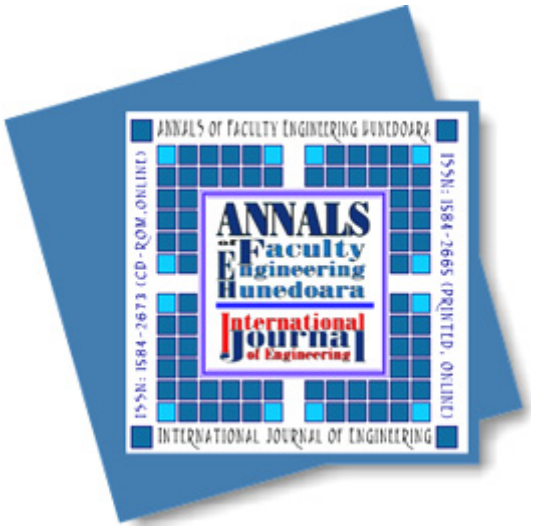

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