Comparative characteristics of standard welding electrodes and welding electrodes with the addition of nanopowders

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Abstract. This article presents the comparative performance of standard welding electrodes and electrodes of the same, but with the addition of nano-structured materials. The dependence between the amount of injected nanopowder and mechanical properties of the resulting weld is been described. There is shown the obtained mechanical properties and chemical composition of the weld metal formed by welding electrodes using nanosized materials.

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Keywords: liquid glass, nanopowder, welding electrodes, manual arc welding, cavitation, mathematical relationship

Introduction

Welding electrodes type MP3.

Coated welding electrodes are designed for manual arc welding of metal structures of different steels, metals and alloys, for surfacing layers with special properties on the surface of parts and assemblies, as well as arc cutting and gouging metal. [5]

Coated electrodes have a number of important functions:

- supply the electric current to the arc gap;
- ignite the arc and move it into the space;
- govern the current mode of the welding process;
- melted base and filler metals;
- form the weld pool;
- form a weld required geometry and quality [10].

As mentioned in [1,2,3,4,6], the essence of the experiment was as follows: in the water glass with a modulus of 3.13, a viscosity of 0.604 Pa s and a density of 1.433 g / cm ³ add nanopowder of complex composition (Al2O3, Si, Ni, Ti, W) with nanoparticles with a size of 25 nm and a purity of 99.91% in an amount of 1.0% by weight of liquid glass. Introduction of the nanopowder in the liquid glass is produced by mechanical-cavitation installation for 2 minutes at a temperature of 30-35 º C. Let's consider the change in the modulus, the viscosity and density based on the amount of insertion of the powder.

"When fluid under pressure is below the threshold (tensile stress), then the integrity of its flow broken and vaporous cavities appear. This phenomenon is called cavitation. When the local pressure of the liquid at a certain point falls below the value of corresponding to the saturation pressure at the given ambient temperature, then the liquid moves into another state and forms, void cavities, called cavitation bubbles "[7,8,9].

Data on changes in the module are shown in the graph (see Figure 1). Data on the change in viscosity are shown in the graph (see Figure 2). Data on changes in density are shown in the graph (see Figure 3).

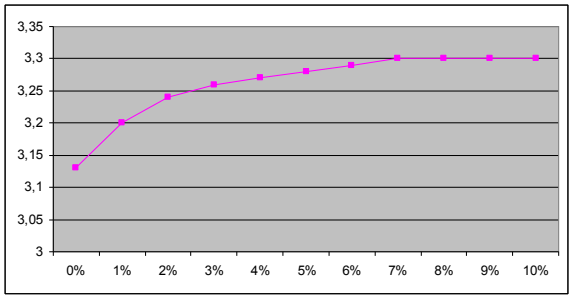

Figure 1. The dependence values of the modulus on the percentage of the nanopowder in the liquid glass

As it comes clear from this one and the following graphs, the effect of nanopowder on liquid glass in which it is attended is determined by the threshold of 7%. If you exceed this threshold of concentration nanopowder, all the studied characteristics of liquid glass stop changing and fixed at a certain level.

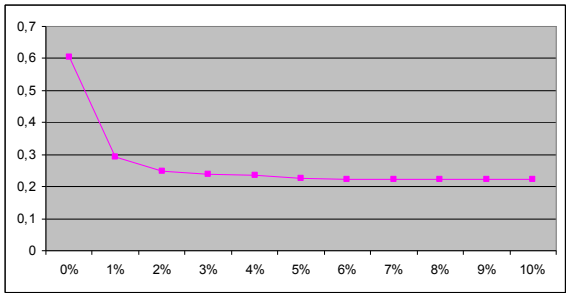

Figure 2. Dependence of viscosity values on the percentage of the nanopowder in the liquid glass

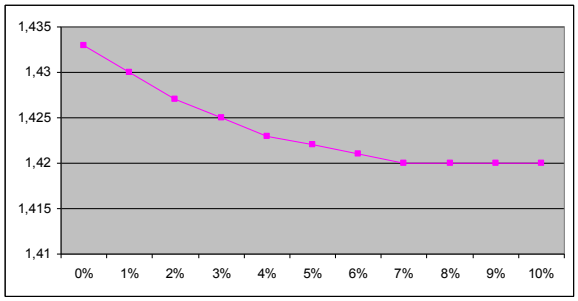

Figure 3. The dependence density values on the percentage of the nanopowder in the liquid glass

Next let's consider the effect of nanopowder attended in the liquid glass on the mechanical properties of the weld metal. Figure 4 shows the dependence of σ_v, N / mm ² on the concentration of the nanopowder in the liquid glass, in Figure 5 - the dependence of δ_5 % on the concentration of the nanopowder in the liquid glass, and finally, Figure 6 - the dependence KCU, J / cm ² on the concentration of the nanopowder in the liquid glass.

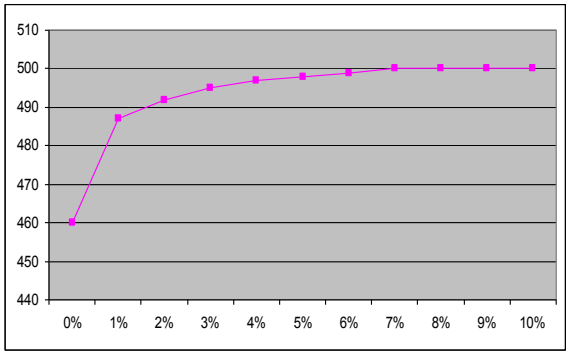

Figure 4. Dependence of σ_v, N / mm ² on % of the nanopowder in the liquid glass

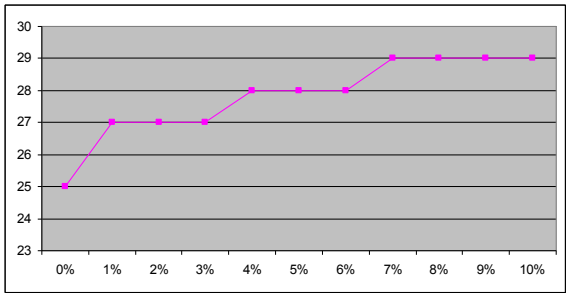

Figure 5: Dependence of δ_5,% on % of the nanopowder in the liquid glass

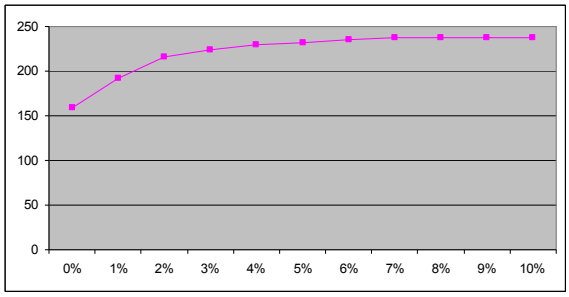

Figure 6. Dependence of KSU, J / cm ² on % of the nanopowder in the liquid glass

Welding electrodes UONY 13/45.

Let's carry out a similar experiment with the other electrodes. Let's take welding electrodes UONY 13/45 and consider the effect of nanopowder attended to the liquid glass on the mechanical properties of the weld metal when using these electrodes. Figure 7 shows the dependence of σ_v, N / mm ² on the concentration of the nanopowder in the liquid glass, Figure 8 - the dependence of δ_5,% on the concentration of the nanopowder in the liquid glass and, finally, Figure 9 - dependency of KCU, J / cm ² on the concentration of the nanopowder in the liquid glass.

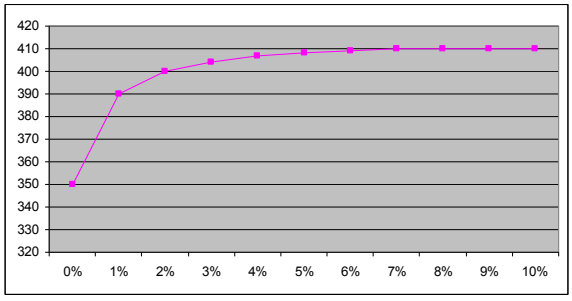

Figure 7. Dependence of σ_v, N / mm ² on % of the nanopowder in the liquid glass

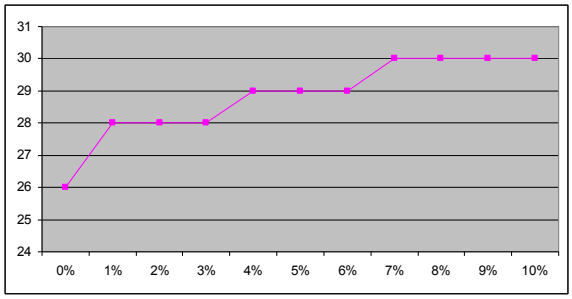

Figure 8. Dependence of δ_5,% on % of the nanopowder in the liquid glass

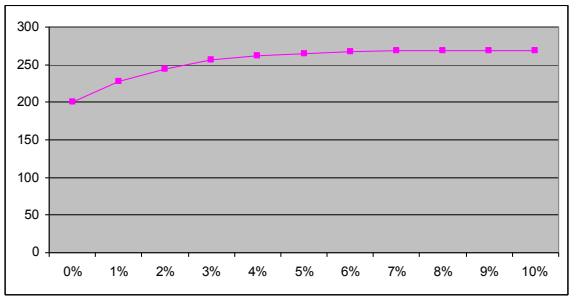

Figure 9. Dependence of KCU, J / cm ² on % of the nanopowder in the liquid glass

As it seen from the graphs, they also fully confirm the presence of a threshold concentration of seven percent when attending nanopowder to the liquid glass.

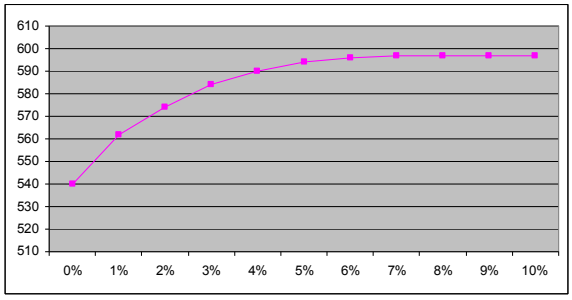

Figure 10. Dependence of σ_v, N / mm ² on % of the nanopowder in the liquid glass

Welding electrodes Lincoln

Let's repeat the same experience with welding electrodes brand of Lincoln. Let's consider the effect of nanopowder attendeded to the liquid glass on the mechanical properties of the weld metal when using these electrodes. Figure 10 shows the dependence of σ_v, N / mm ² on the concentration of the nanopowder in the liquid glass, Figure 11 - the dependence of δ_5,% on the concentration of the nanopowder in the liquid glass, and finally Figure 12 - the dependence of KCU, J / cm ² on the concentration of the nanopowder in the liquid glass.

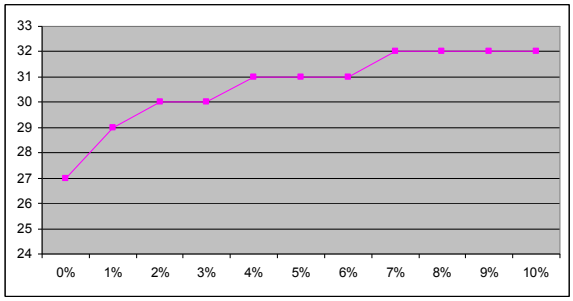

Figure 11. Dependence of δ_5,% on % of the nanopowder in the liquid glass

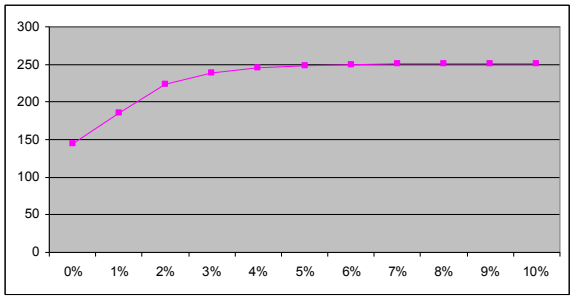

Figure 12. Dependence of KCU, J / cm ² on % of the nanopowder in the liquid glass

As it seen from the graphs, they also fully confirm the presence of a threshold concentration of seven percent when attending nanopowder to the liquid glass.

Conclusion

It has been found that the mechanical properties of the weld metal made by the welding electrodes, with the addition of nanostructured materials is higher than for standard electrodes without the addition of a nanopowder .

It was also found that the properties of the weld metal stop growing when added more than 7 % of nanopowder . From that it was concluded that the amount of 7% is the threshold , i.e. it is no need to attend more of the nanopowder in the welding electrode, because it will not increase the weld quality indicators , and will only increase the cost of manufacturing of the electrode.

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