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RESEARCH ON THE IMPACT OF AMPLITUDE OF VIBRATIONS ON ELECTRICAL PARAMETERS OF VIBROARC WELD OVERLAY IN ARGON

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The research is taken on the vibroarc welding apparatus ENTON-60 equipped with an axial non-inertial vibrator in argon shield. The criteria used for assessing the flow of the electric arc process and the formation of weld overlay clad surfaces are: short circuit voltage, voltage at the start of arc combustion, short circuit amperage, and amperage at the end of arc combustion. Wire electrode's vibrating frequency is considered as an input variable of the cybernetic model. It has been found that amplitude of vibrations has a significant impact on the vibroarc process – voltage parameters and welding current ratio, as the minimum amperage of short circuit and the lowest voltage at the start of arc combustion is realized at 2 mm amplitude of vibrations.

Keywords: argon welding, cycles, vibration magnitude, voltage, amperage

Vibroarc weld overlay is used to restore various components of small or large sizes, of simple or complex shape, with inner or outer surfaces of different metals and alloys. Argon reliably shields the arc and the weld overlay clad metal from the impact of oxygen and nitrogen in the air and at the same time prevents from the formation of pores, oxides and nitrides which increase the fragility of the weld overlay clad layer (Russo, 1984; Tonchev, 1989).

The electrical parameters (voltage and amperage) of the process of vibroarc weld overlay bear a significant impact on the transportation of molten metal and the formation of restorative coverage.

The increase in voltage leads to an increase in the arc interval, the time for the electric arc cycle, the combustion of alloying elements and defects in the weld overlay clad metal. The increase in short circuit amperage and especially the speed of increase of this amperage results in an increment in the area of thermal impact and dispersion of electrode metal. The change in these parameters in relation to amplitude of vibrations during vibroarc weld overlay in argon has not been a subject of many researches (Asnie, 1982; Lenivkin, 1989; Russo, 1984).

The aim of the research is to determine the impact of amplitude of vibrations on the electrical parameters during vibroarc weld overlay in argon.

The object of the study is restored components from tractors and farm machinery, whereas the subject of the study is the process of formation of vibroarc weld overlay clad surfaces in argon.

Material and methods

The criteria taken for assessing the flow of processes for vibroarc weld overlay in argon and the starting parameters of the model for studying are:

- the vector of voltage parameters (short circuit voltage, voltage at the start of arc combustion),
- the vector of amperage parameters (amperage of short circuit and amperage at the end of arc combustion).

Amplitude of vibrations has been chosen as an input factor of the model for studying.

The study has been carried out on the vibroarc system for weld overlay in shielding gases ENTON-60 with an axial non-inertial vibrator. Argon is fed into the nozzle of the vibroarc apparatus under pressure from a bottle via standard gas equipment.

Experimental models made of steel 45, 50 mm in diameter and 250 mm length have been used for weld overlay, corresponding to modal values from the statistical research of the construction and technological characteristics of components from the tractor and farm machinery (Tonchev and Stanev, 1979; Tonchev and Marinov, 1977).

Weld overlay has been carried out using low, medium and high carbon wires (Sv 08G2S, Np 30HGSA and DUR 500) 1.6 mm in diameter in the following mode: operating voltage 20 V, amperage 195 A, speed of weld overlay 0.9 m min^{-1}, wire feed speed 2.3 m min^{-1}, pace of weld overlay 3 mm, outlet of wire electrode 15 mm, shielding gas consumption 15 l min^{-1}, frequency of vibrations 46.7 Hz, angle of the point of arc combustion 45°, angle of directing the wire electrode in the vertical plane 30° and in the horizontal plane 15°.

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Amplitude of vibrations changed within the range from 0 mm to 2.5 mm.

The oscillogrammes of voltage and amperage have been obtained with the help of an oscillograph 12S-1. The data obtained from the oscillographic recording of the electric arc process were processed using statistical methods.

Results and discussion

The graphical dependencies for the impact of amplitude of vibrations on the electrical parameters of the vibroarc process and the weld overlay clad layer have been deduced based on the processed data (Figures 1–4).

The increase in amplitude of vibrations to 1 mm leads to an increase in short circuit voltage (Figure 1), whereas with the further increase in amplitude of vibrations, short circuit voltage keeps the values almost constant, at 3–3.4 V. When weld overlaying with the high carbon wire DUR 500, we get the highest short circuit voltage and an increased burning of alloying elements in comparison with other wire electrodes.

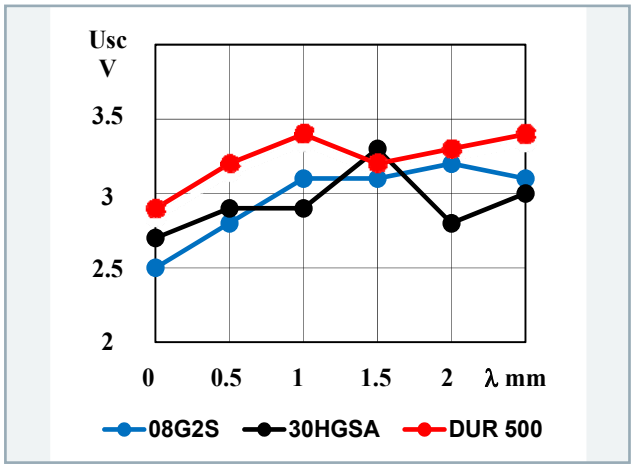

Figure 1 Impact of amplitude of vibrations (λ) on short circuit voltage (Usc short circuit) during vibroarc weld overlay in Ar with different electrode wiress

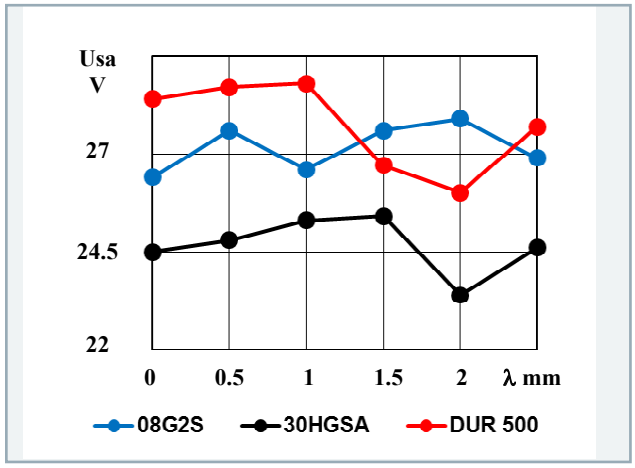

Figure 2 Impact of amplitude of vibrations (λ) on voltage at the start of arc combustion (Usa start of arc combustion) during vibroarc weld overlay in Ar with different wire electrodes

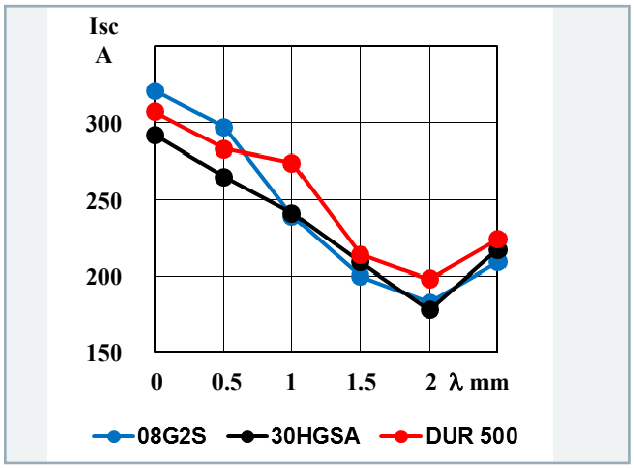

Figure 3 Impact of amplitude of vibrations (λ) on short circuit amperage (Isc short circuit) during vibroarc weld overlay in Ar with different wire electrodes

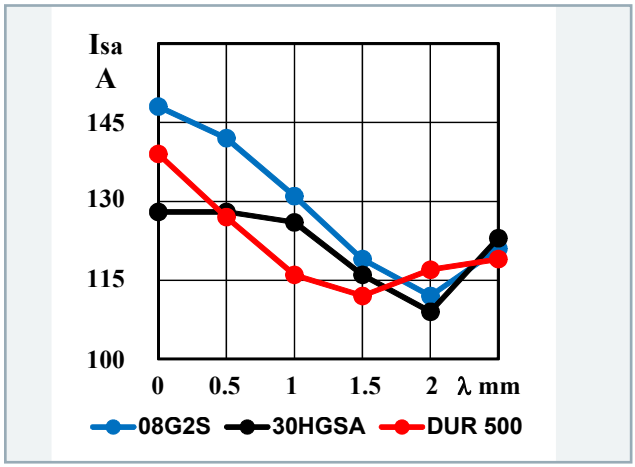

Figure 4 Impact of amplitude of vibrations (λ) on amperage at the end of arc combustion (Isa end of arc combustion) during vibroarc weld overlay in Ar with different wire electrodes

Amplitude of vibrations has a considerable impact on voltage at the start of arc combustion (Figure 2). The change in that voltage for low and medium carbon wires is of extreme nature, and the minimum values are obtained at the amplitude of vibrations of 2 mm. This is more characteristic for the electrode wires 30 HGSA and DUR 500.

Weld overlaying with the low (Sv 08G2S) and medium (Np 30HGSA) carbon wires is done at lower voltage at the start of arc combustion in comparison with the high carbon wire DUR 500. The change in voltage at the start of arc combustion bears a significant impact on the roughness of the weld overlay clad layer. There is a correlation between the change in voltage at the start of arc combustion and the roughness of the layer (Nikolov et al., 2002; Álló et al., 2014).

One of the main parameters of the electric arc process is short circuit amperage and amperage at the end of arc combustion.

Short circuit amperage and amperage at the end of arc combustion depend primarily on amplitude of vibrations. The change in short circuit amperage is of extreme nature

(Figure 3), with the minimum values obtained at the amplitude of 2 mm. This results in lower dispersion of the electrode metal at drop detachment. When weld overlaying with the medium wire electrode (Np 30HGSA), short circuit amperage is lower during the whole range of change in amplitude of vibrations than when weld overlaying with the low and high carbon wires.

When increasing the amplitude of vibrations, amperage at the end of arc combustion is of extreme nature, and the minimum values are obtained again at the amplitude of 2 mm (Figure 4). Short circuit amperage has a greater speed of change as opposed to amperage at the end of arc combustion. The medium and high alloyed wires Np 30HGSA and DUR 500 have lower values of amperage at the end of arc combustion in comparison to the low carbon wire Sv 08G2S.

Conclusion

Amplitude of vibrations has a significant impact on the parameters of voltage and amperage (short circuit voltage, voltage at the start of arc combustion, short circuit amperage and amperage at the end of arc combustion).

The increase in amplitude of vibrations leads to an extreme change in short circuit amperage and amperage at the end of arc combustion, voltage at the start of arc combustion and the minimum values are obtained at the amplitude of vibrations of 2 mm.

For the amplitude of 2 mm, the values of short circuit amperage and amperage at the end of arc combustion when weld overlaying with the medium carbon wire (Np 30HGSA) are the lowest.

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