Volodymyr O. Lebediev

OPTIMIZATION OF THE PROCESS OF ARC WELDING (SURFACING) BASED ON THE NEW DESIGNED MECHANISM OF PULSE WIRE FEEDING

DOI 10.15589/SMI20170217

Volodymyr O. Lebediev doctor of technical sciences
office@paton.kiev.ua
ORCID: 0000-0002-0006-3576

The E.O. Paton Welding Institute of the NAS of Ukraine, Kyiv

Abstract. The paper considers some features of the application of pulse feeding of the electrode wire with adjustable parameters. A new type of the electric drive for controlled pulse feeding is developed on the basis of a computerized valve electric drive. It is shown that equipment with pulse electrode feeding expands the possibilities of the arc welding process, reduces energy expenditure and allows saving material resources.

Keywords: arc welding; electrode wire; feed; pulse control algorithm; equipment; measurement of electricity consumption.

References

[1] Voropay N. M. *Parametry rezhimov i tekhnologicheskiye vozmozhnosti dugovoy svarki s impulsnoy podachey elektrodnoy i prisadochnoy provoloki* [Mode settings and technological capabilities of arc welding with pulse feeding of the electrode and filler wire]. *Avtomaticheskaya svarka — Automatic Welding*, 1996, no. 10, pp. 3–9.

[2] Paton B. Ye., Lebedev V. A., Pichak V. G., Poloskov S. I., Shchavelev L. N. *Analiz tekhnicheskikh i tekhnologicheskikh vozmozhnostey impulsnoy podachi elektrodnoy provoloki v protsesakh dugovoy svarki i naplavki* [Analysis of technical and technological capabilities of pulse feeding of the electrode wire in the processes of arc welding and surfacing]. *Svarochnoe proizvodstvo — Welding Production*, 2002, no. 2, pp. 24–31.

[3] Lendel I. V. *Dugovaya naplavka v uglekislom gaze s impulsnoy podachey elektrodnoy provoloki. Avtoreferat Diss.* [Arc welding in carbon dioxide with a pulse feeding of the electrode wire]. Kiev, 2015. 19 p.

[4] Lebedev V. A., Gulyy M. V., Plekhotko G.A. *Ustroystvo dlya otsenki energoeffektivnosti protsesov* [Device for evaluating the energy efficiency of processes]. *Svarka i Diagnostika — Welding and Diagnostics*, 2011, no. 3, pp. 50–53.

Problem statement. It is commonly known that one of the problems of welding (surfacing) in general and in carbon dioxide in particular is a loss of the electrode metal on spattering while maintaining satisfactory performance. An effective way to solve it is to use pulse process algorithms of the welding mode control provided by advanced power supplies. Currently, researchers have established and developed the general laws of the influence of individual parameters (such as frequency, step and shape of the current pulse and the electrode wire feeding) on the transfer and the amount of the electrode metal when it is being spattered and the formation of the weld bead.

There have been created mathematical models of the process of electrode wire feeding through a long flexible guide channel. General technical requirements to the systems providing a mechanized welding process with the pulse electrode wire feeding are formulated, as are the methods of constructive selection and calculation of the pulse feeding mechanisms and appropriate electrodes. Using advanced equipment (inverters) and the research results, it was possible to achieve a sharp reduction of spattering by eliminating large droplets by the lack of the arc wandering and decrease of fluctuations dropping the molten electrode wire [1, 2]. It was also established that the spattering level is practically independent of the arc voltage. Thus, the use of welding (surfacing) with a controlled short circuit has reduced the level of the metal loss on fumes and spattering by 3–4 times as compared to conventional welding technology (surfacing) in carbon dioxide with the use of traditional sources of current and the roller mechanisms of constant wire feeding.

However, the development of pulse arc welding (surfacing) technology is currently limited by certain design deficiencies of common pulse wire feeding mechanisms. For example, some structural schemes provide a narrow range of change of the feeding step (0.5 – 3.0 mm), which is not sufficient. The periodicity of the step of the set value is difficult to achieve during a working process due to a large number of friction surfaces and their increased wear. This parameter, known as the duty cycle, is not adjustable on the many mechanisms and has the value of 2 meander. Its regulation requires availability of costly components, such as cams, eccentrics, feed rollers, etc.

BASIC MATERIAL

Taking the above considerations as a basis for further improvement, the E. O. Paton Electric Welding Institute has developed a mechanism of pulse wire feeding (MPWF) that is devoid of most of the given shortcomings (Fig. 1) [3].

This device consists of the valve electric drive “Impuls-2 PM-80” and the electrode wire clamp mechanism “MP-3”. The mechanical part with the wire feeding motor can be installed on welding machines, robots, or semi-automatic welding machines (Fig. 2).

All the operations at a particular mode of welding (surfacing) are programmed using the menu on the display of the electric drive. This drive provides a maximum number of available ways of controlling the supply of welding wire. The operation can be both autonomous and driven. The autonomous mode allows for technical operations involving the advance set program (cyclogram) and is characterized with a maximum noise immunity, performance and accuracy of implementation. The driven mode involves minimal presence of the operator, or complete absence, so that its control is fully transferred to some external master device. This mode allows for adjustment of the parameters of this mechanism to changing conditions.

Fig. 1. Layout of the MPWF based on of the valve electric drive “Impuls-2 PM-80”

The experimental-industrial test carried out with the use of this mechanism has revealed that the automatic arc welding with pulse wire feeding under certain conditions reduces spattering by 2.0 – 2.5 times in comparison to constant wire feeding. Moreover, the virtual absence of molten metal droplets on the working surface let thus avoid the repeated mechanical treatment of finished parts. In addition, the use of pulse wire feeding allows reducing the 2.0 mm allowance for mechanical treatment of the surface and increases the performance of the surfacing process to 15 – 20 %. According to the data provided by the Ilnitsky plant MSO, the economic effect from the introduction of automatic arc welding technology with pulse wire feeding through using the MPWF was 20000 hryvnias per year on one post.

The cost of electricity was determined with the help of the method described in [4]. The device developed in the E. O. Paton Electric Welding Institute was used for measurement (Fig. 3). This unit consists of power switch *1*, power connector *2* (220 V, 50 Hz), measuring

a) *b)* *c)*

Fig. 2. MPWF based on the valve electric drive and its possible uses:
a — as part of the welding machine; *b* — as part of the welding robot; *c* — as part of the semi-automatic welding machine

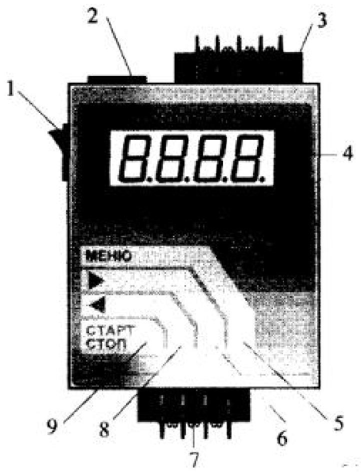

Fig. 3. Appearance of the electricity consumption meter with indication of controls and terminals

terminal to connect voltage sources and current-measuring shunt *3*, analog signal output terminal *7*, indicator *4*, buttons Menu, Next/Run, Previous/Select and Start/Stop labeled as *5*, *6*, *8*, *9*, correspondingly. The device was employed for the measurement of the process energy consumption at a constant and pulse wire feeding speed.

The measurement was followed by mathematical processing of the results with the use of the regression method via the technique described in [3]. As a result, the mathematical models were built on the basis of the graphs showing the electricity consumption according to the frequency and the pulse duty ratio of the electrode wire feeding. The analysis of these graphs indicated that electricity consumption is minimal in the low frequency range of 10.0–30.0 Hz and at the high index of the duty cycle (3.0–5.0 units). On average, the ratio of frequency to duty cycle in pulse wire feeding can reduce energy consumption up to 20%.

CONCLUSIONS

1. There has been designed a mechanism of pulse wire feeding (MPWF) mostly devoid of many design flaws of similar modern devices. The MPWF allows realizing the welding process, both with the participation of the operator and without it. It may be controlled from any other control device. Versatility of the MPWF allows for its use on welding machines, robots or semi-automatic welding machines.

2. The electricity consumption and the metal loss to spattering have been studied at the use of the MPWF. The waste of metal reduces by 2.0–2.5 times, and the electricity consumption reduces by 20%, which saves up to 20000 hryvnias per year on one post at an industrial enterprise. The experiment has proved that minimal electricity consumption is achieved for the technological modes where the frequency is in the range of 10.0–30.0 Hz and duty cycle of pulses is 3.0–5.0 units.

Статью рекомендует в печать
д-р техн. наук, проф. *А. Н. Дубовой*