

Kovalenko V. L., Mastenko R. V., Strelenko N. M.

National Technical University of Ukraine «Igor Sikorsky Kiev Polytechnic Institute». Ukraine, Kiev

### THE INFLUENCE OF THE TEMPERATURE OF THE PREHEATING OF THE BASE METAL ON THE STABILITY OF THE EXISTENCE OF AN ARC DISCHARGE

*In this paper, the problem of determining the stability of arc combustion with the use of direct current is considered. The difference between arc oscillograms using different types of fluxes and different preheating temperatures is shown. The coefficient of stability of the existence of a welding arc discharge is calculated.* [dx.doi.org/10.29010/083.7]

*Keywords:* welding; burning stability of the welding arc; welding arc discharge; criterion.

For the quality of welded joints made in hot-tempered steels, especially those that are welded at low temperatures, the importance of preliminary heating and subsequent slow cooling of the metal in the zone of thermal impact and welding seam is of great importance [1]. By reducing the speed of cooling the welding seam and the zone of thermal action, the probability of formation of hardening structures decreases, which increases the plastic properties of the welded joint and reduces the probability of the formation of cold cracks in the process of cooling and subsequent operation. In addition, residual stresses are partially reduced as a result of passing through a welded connection of temperature respiration [2]. However, there is an increased dissipation of thermal energy. The amount of heat used to heat the weld is several times greater than that required for welding the seam. This is especially relevant for submerged arc welding as products to be heated, usually have considerable weight and dimensions and therefore require significant energy costs for their heating. At this time it should be noted that the rollers that fill the welding seams with the use of the previous and accompanying heating of the base metal are better formed and have greater depth and width, with the same energy parameters of the welding mode.

To ensure the high quality of the formation of rollers, and therefore the most welded joints, it is necessary to ensure the burning stability of the arc and transfer of droplets of the liquid metal through the interelectrode gap, which is determined by the stability of the welding arc burning, and hence the stability of the existence of the welding arc discharge, which is directly dependent on the energy parameters, which include welding current and voltage at the arc and the level of the previous and the accompanying heating. In many works research data on the influence of the welding current and the voltage on the arc on the stability of the existence of an arc discharge in the interelec-

trode gap is given [3]. At the same time, the literature does not give data on the effect of preheating on the above characteristics.

In connection with the above-said in this paper are presented results of studies of the impact on the stability of preheating existence welding arc discharge and quality formation of welding beads. The study of the effect of preheating on the stability of the existence of the welding arc discharge and the quality of the formation of the welding rollers is based on computer oscillography of the digital oscillograms of the welding arc with the subsequent mathematical treatment of the results. [4]

For the computer oscillography energy parameters of the welding arc discharge scheme we used to connect a PC ADC voltage divider to the welding range (Figure 1). [5]

The proposed scheme allows to fix the change in the energy parameters of the welding arc discharge, namely current and voltage during its existence, and through an analog-digital converter (ADC) to transfer this data to a personal computer, where their further analysis and processing are carried out.

The experiment was carried out as follows. The rollers were deposited on a plate 10 mm thick one after another, which allowed each successive roller to be executed at different heating temperatures of the plate. Before the start of surfacing each roller, the temperature of the plate was measured using a thermocouple and the oscillograms were removed during the welding process. The surfacing was performed by a wire of 2 mm in diameter under the fluxes of grades AN-60, AN-348A, AN-348AP and OCP-45 [6]. The chemical composition of these brands of fluxes is given in Table 1. The surfacing was carried out in the modes shown in Table 2.

As a result, we received 4 groups of rollers, welded under various flux brands, shown in Figures 2, 3, 4, 5.

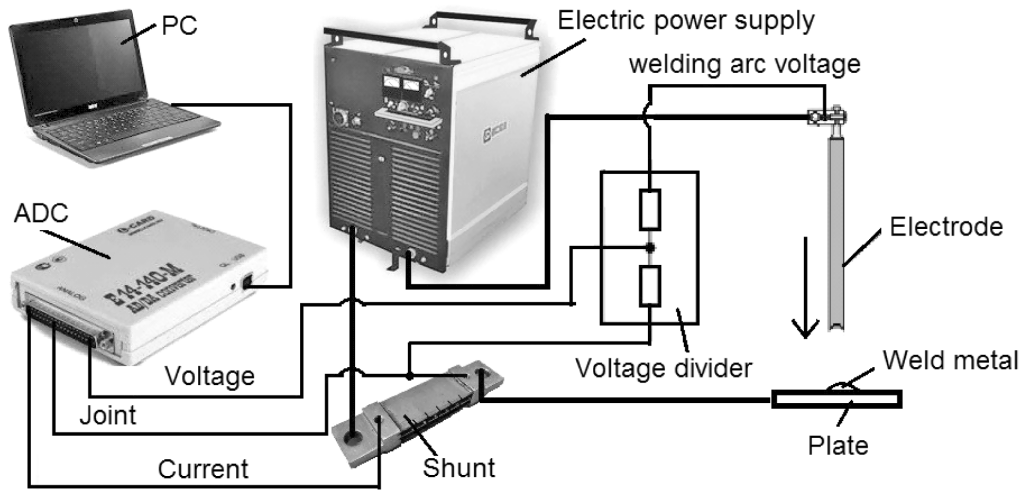


Fig. 1. Scheme of computer oscillography

After surfacing rollers, oscillograms were obtained at each of them, as well as the temperature of the base metal before the roller was executed. The oscillograms of the energy parameters of the existence of a welding arc discharge, namely current and voltage, are shown in Figure 6.

Ideally, the temperature of the base metal before the execution of each roller should have increased due to

more and more heat from the arc, but in real conditions of the experiment, this could not be achieved, since between the surfacing of each roller the human factor was included, and different time spent on the preparation of flux, the beginning of the welding and flux removal process. Considering this, it was decided to divide all experimental data into three groups at a temperature of 0–14°C, 150–199°C, and 200–300°C.

Table 1

**Chemical composition of fluxes of grades AN-60, AN-348A, AN-348AP and OSC-45**

Brand flux	Mass fraction of elements, %								
	SiO <sub>2</sub>	Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	MgO	MnO	CaF <sub>2</sub>	S	P
AN-60	42.12	0.55	4.1	6.61	2.55	37.83	6.08	0.014	0.016
AN-348A	40.2	1.6	4.95	9.89	2.23	31.25	4.13	0.016	0.067
AN-348AP	40–44	0,5–2,2	<13	<12	<7	31–38	3–6	<0.11	<0.12
OSC-45	41.85	0.99	2.26	7.89	1.27	38.26	6.79	0.007	0.042

Table 2

**Modes of surfacing**

Brand flux	Coating thickness, mm			
	I <sub>w</sub> , A	U <sub>w</sub> , B	V <sub>w</sub> , m/h	V <sub>p.l.</sub> , m/h
AN-60	220	32	31	198
AN-348A	220	32	31	198
AN-348AP	220	32	31	198
OSC-45	220	30	31	198

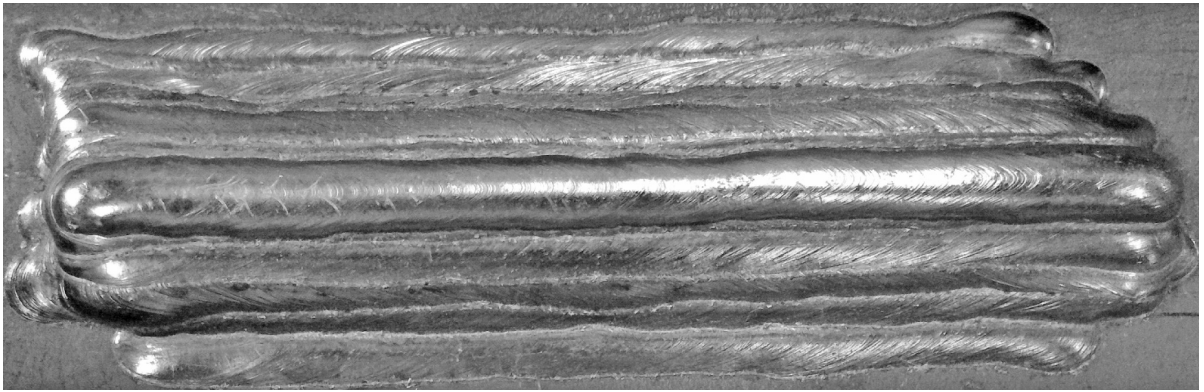


Fig. 2. External image of rollers made under the flux AN-60

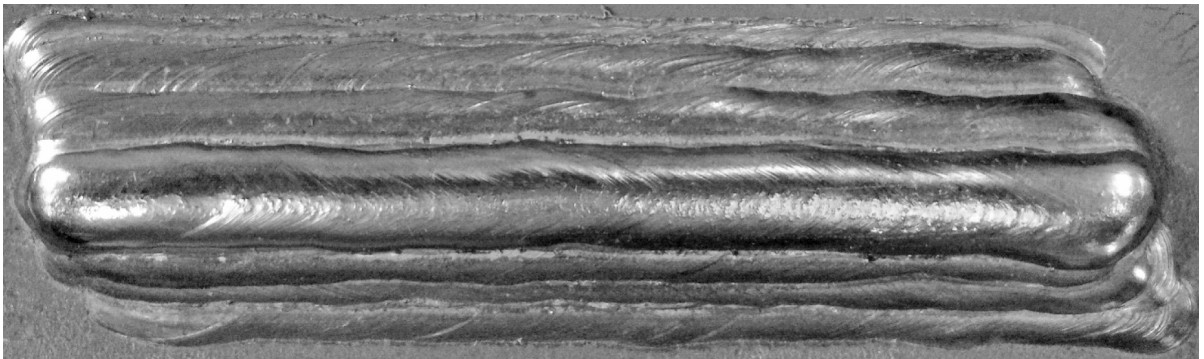


Fig. 3. External image of rollers made under the flux AN-348A

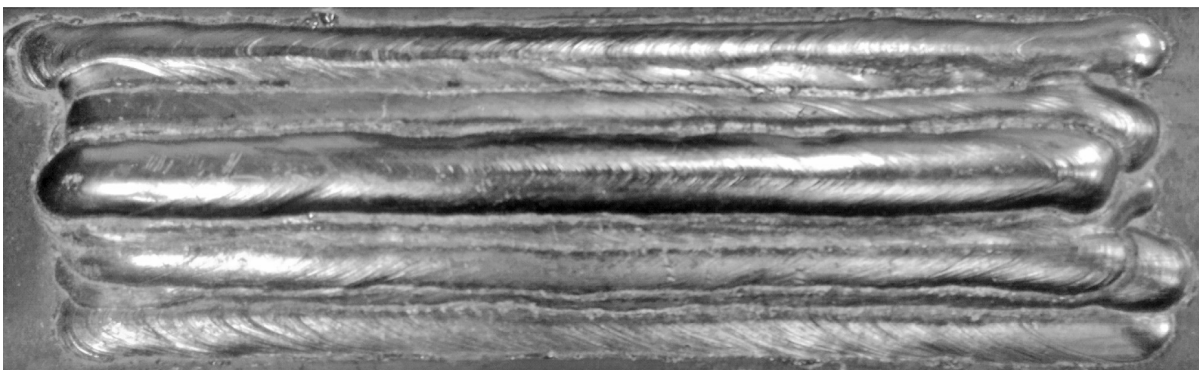


Fig. 4. External image of rollers made under the flux AN-348AP

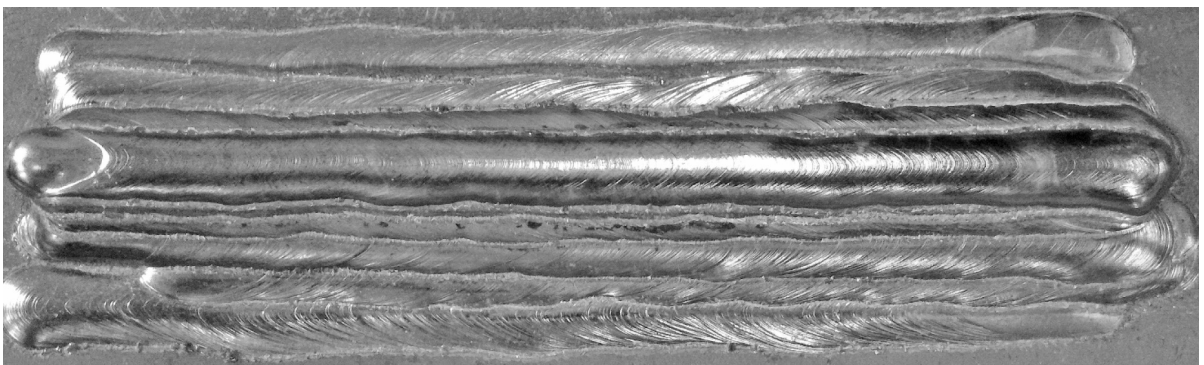


Fig. 5. External image of rollers made under the flux OCZ-45



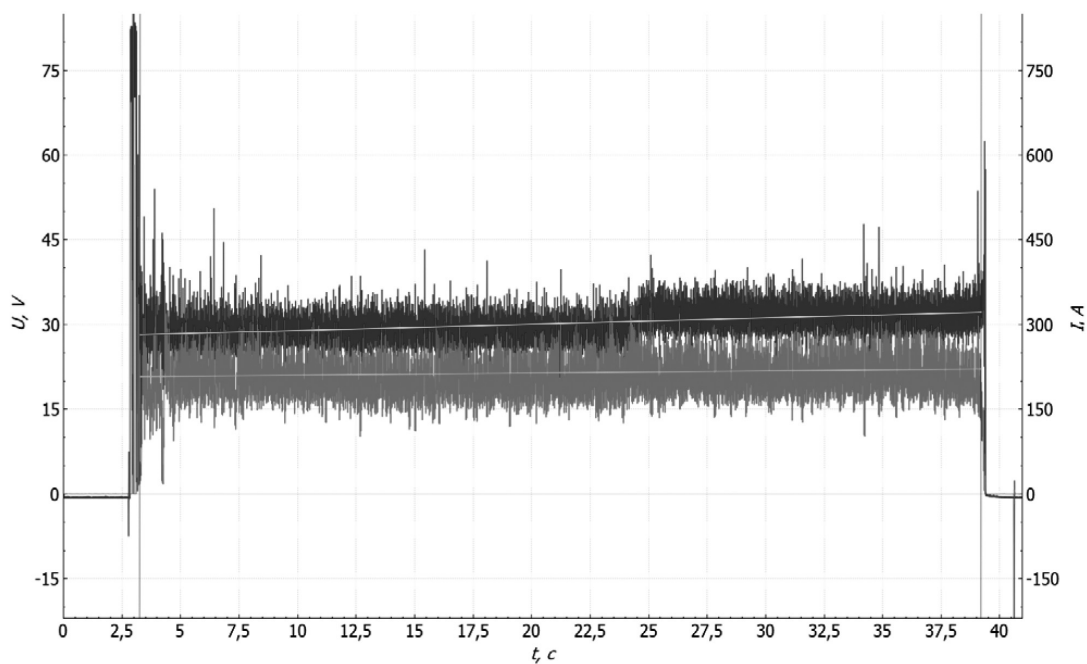


Fig. 6. Oscillogram of the existence of a welding arc discharge when welding under a layer of flux of mark AN-60 on a constant current of inverse polarity

After grouping these experiments, calculations were performed using a stability factor that takes into account the energy parameters of the welding process. The obtained stability coefficients for each temperature group for different grades of flux are shown in Table 1.

As a result of experiments in surfacing rollers with different brands of fluxes, it was found when using preheating for welding under a flux layer, the value of the stability coefficient of the existence of the welding arc discharge increases, and, accordingly, the stability of the arc worsens. It should be noted that the fluxes for the stability of the existence of an arc discharge with the use of a DC reverse polarity are in the following

sequence: AN-60, AN-348 AP, AN-348 A, OCS-45, and this does not depend on the temperature of the preheating.

Thus, it is shown that the value of the coefficient of stability of the existence of a welding arc discharge depends on the mark used for surfacing the rollers of the flux of the temperature of the preheating. With what the higher the temperature of the heating, the higher the coefficient of stability of the existence of the welding arc discharge and the better formation of rollers.

References

- [1] Malyshev B. D. "Welding in construction", 1966.
- [2] Titov O. I. "Handwriter welder manual", 1989.
- [3] I. Y. Letyagin "Estimation of the stability of combustion of a welding arc when welding with coated electrodes".
- [4] Zhdanov L. A., Ph.D., Mastenko R. V., Student. (NTUU "KPI") The influence of polarity on processes in the reaction zone under flux welding. Materials of the eighth all-Ukrainian inter-branch scientific and technical conference of students, postgraduates and research staff "Welding and Related Technologies and Processes." / Kyiv: 10–12 June 2015.
- [5] Zhdanov L. A., Kovalenko V. L. A new criterion for assessing the stability of the arc discharge in the test of welding materials. Equipment and tools, 2011.
- [6] Zhdanov, L., Kovalenko, V., Strelenko, N., & Chvertko, Y. (2013). Peculiarities of thermal dissociation of oxides during submerged arc welding. Soldagem & Inspeção, 18(4), 314–321.

Table 1

Values of stability coefficients for different grades of flux depending on the temperature of the preheating

Flux brand	The value of the coefficient of stability at the temperature of the preheating		
	0–149°C	150–199°C	200–300°C
AN-60	5,4	5,925	6,7
AN-348A	6,97	7,208	7,26
AN-348AP	6,59	6,6	6,686
OSC-45	7,1	7,122	7,415

УДК 621.791.75.01

*Коваленко В. Л., Масненко Р. В., Стреленко Н. М.*

Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського». Україна, м. Київ

## ВПЛИВ ТЕМПЕРАТУРИ ПОПЕРЕДНЬОГО ПІДГРІВУ ОСНОВНОГО МЕТАЛУ НА СТАБІЛЬНІСТЬ ІСНУВАННЯ ДУГОВОГО РОЗРЯДУ

*В цій статті розглядається проблема визначення стабільності горіння дуги при використанні постійного струму. Показано різницю між осцилограмами горіння дуги з використанням різних марок флюсів та різною температурою попереднього підігріву. Обчислено коефіцієнт стабільності існування зварювального дугового розряду. [dx.doi.org/10.29010/083.7]*

*Ключові слова:* зварювання; стабільність горіння зварювальної дуги; зварювальний дуговий розряд; критерій.

### Література

- [1] Малышев Б. Д. «Сварка в строительстве» 1966 р.
- [2] Титов О. И. «Справочник электросварщика ручной сварки» 1989 р.
- [3] И. Ю. Летагин «Оценка стабильности горения сварочной дуги при сварке покрытыми электродами».
- [4] Жданов Л. А., к.т.н, Масненко Р. В., студ., (НТУУ «КПІ») Вплив полярності на процеси у реакційній зоні при зварюванні під флюсом Матеріали восьмої всеукраїнської міжгалузевої науково-технічної конференції студентів, аспірантів та наукових співробітників «Зварювання та споріднені технології і процеси»./ Київ: 10–12 червня 2015 р.
- [5] Жданов Л. А., Коваленко В. Л. Новый критерий оценки стабильности существования дугового разряда при испытании сварочных материалов. Оборудование и инструмент, 2011 р.
- [6] Zhdanov, L., Kovalenko, V., Strelenko, N., & Chvertko, Y. (2013). Peculiarities of thermal dissociation of oxides during submerged arc welding. Soldagem & Inspeção, 18(4), 314–321.