# Operational Estimating of Arcs Voltage of Arc Steel Furnace

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**Abstract.** In this paper the possibility of improving accuracy of maintaining the regime of melting metal by appropriate control of the arc voltages in electric arc furnaces is presented. For this purpose the methodology of the determination of the own and mutual inductances of the three flexible cables, are proposed and analyzed. This methodology based on realization experiments of the three-phase short network, as well as three biphasic short network when in the third phase arc is absent. The proposed methodology was implemented to determine the parameters of current propulsion of electric arc furnace type DSP-100. The determined cabel parameters (resistances and inductances) are used to form the control effect of the automatic control system by moving the electrodes and hence the power of the arcs of each phase.

**Keywords:** Arc furnace · Determination · Inductances · Voltages Experiment · Control

## 1 Introduction

Almost all electric arc furnaces, in which the melting of the charge is carried out for the purpose of obtaining electro technical steels (Fig. 1), are functioning due to the automatic control system (ACS) which provide appropriate displacements of the electrodes.

These control systems provide an automatic ignition of the arc in each of the three phases of supply the arcs, as well as maintenance of arc capacities in accordance with the directive schedule of the melting process. This is realizing due to the using of the impedance principle of regulation [1–4], which consists in the fact that the control voltage of the electrodes drive is formed as the voltage of the discrepancy:

$$\Delta_j = a_j \cdot I_{dj} - b_j \cdot U_{dj} \tag{1}$$

where $I_{dj}$, $U_{dj}$ are current values of currents and voltages of arcs in the $j$ phase; $a_j$, $b_j$ are coefficients (set point) that define the condition $\Delta_j = 0$, when a certain arc length is set and the appropriate power in the furnace's space is entered.

The measuring of currents $I_{dj}$ is not problematic, but voltages $U_{dj}$ cannot be measured directly. This is due to the fact, that the arc is burning in a closed furnace

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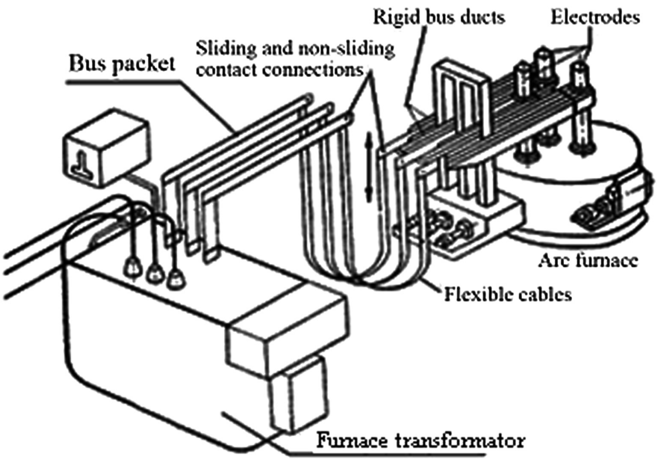


**Fig. 1.** Components of the arc steel furnace.

space and connecting the measuring apparatus to the end of the electrode with the arc is not possible. Therefore, the phase voltages are measured between the phase output of the furnace transformer and the zero point formed by the three arcs on the charge.

Voltage sequences are determined according to known parameters of flexible cables (short network) and electrodes of each phase, and then the $U_{dj}$ voltage is formed which ensures the functioning of the ACS by the displacement of the electrodes. Thus, the accuracy of determining the parameters of flexible cables with the electrodes of each phase influences on the power supply into the furnace space, and on the efficiency of an arc steel furnace (ASF) exploitation. Typically, the values of these parameters are given in the reference literature [5, 6] and they are reduced to the resistances and reactances of the short network $r_{kj}$, $x_{kj}$, and the electrode $r_e$. It is assumed that these parameters are the same in each phase.

The electrodes in different phases worn out in different ways during the technological process of melting steel in the ASF, and therefore the electrode holders occupy different levels. Consequently, the configuration of the flexible cables of each phase will be different. In addition, the effect of mutual induction and the phenomenon of the transfer of active power between the phases, that accompanying it, are strongly manifested between the phases of the short network. Thus, a short network should be taken into account by using of its inductances $L_{k11}$, $L_{k22}$, $L_{k33}$, mutual inductances $L_{k12}$ = $L_{k21}$, $L_{k23}$ = $L_{k32}$, $L_{k31}$ = $L_{k13}$ and the appropriate resistances $r_{k1}$, $r_{k2}$, $r_{k3}$. Then the inductance of each phase of the short network could be represented by an equivalent value:

$$\left.\begin{aligned} L_{eq1} &= L_{k11} - L_{k12} - L_{k13} + L_{k23} \\ L_{eq2} &= -L_{k12} + L_{k13} + L_{k22} - L_{k23} \\ L_{eq3} &= -L_{k23} - L_{k13} + L_{k12} + L_{k33} \end{aligned}\right\} \tag{2}$$

Equation (2) are obtained by solving magnetic connections between the three phases of the cables. Determination of the cable parameters is possible according to the results of measurements during a series of experimental researches, which should be performed after each electrode replacement at least in one phase, or more often. Own and mutual inductances are most easily determined through reactancesre. They make sense only with sinusoidal currents and voltages. Unfortunately, conducting of special experiments not always could be realized due to material losses caused by lowering the efficiency of the ASF. These losses are increasing with capacity of the furnace. Therefore, the problem of measuring the voltage of arcs by data of passive experiment without interference with the technological process is actual for heavy electric arc furnaces.

## 2 Proposed Methodology to Determination of Arc Voltages

### 2.1 Determining of Arc Voltages Using Measurement Results Obtained from Active Experiment

The condition of sinusoidal currents and voltages in a short network is not fulfilled during arcs burning. Realization of different combinations of short networks and idle stroke (absent arc) in phases leads to possibility of elimination the distortion of currents and voltages from the lower side of the furnace transformer. It is possible to realize the following experiments on the current three-phase arc furnace, in which the currents and voltages will be sinusoidal, in particular, the three-phase short network, as well as three biphasic short network when there is no arc in the third phase. Under these conditions, the voltage between the phase of the furnace transformer at the zero point accessed by the furnace design can be written in a complex form. So for a three-phase short network might be written:

$$\left.\begin{aligned} \dot{U}_1 &= \dot{I}_1 \cdot (r_{\mathrm{k}1} + j\omega L_{k11}) + \dot{I}_2 \cdot j\omega L_{k21} + \dot{I}_3 \cdot j\omega L_{k31} \ , \\ \dot{U}_2 &= \dot{I}_2 \cdot (r_{\mathrm{k}2} + j\omega L_{k22}) + \dot{I}_1 \cdot j\omega L_{k12} + \dot{I}_3 \cdot j\omega L_{k32} \ , \\ \dot{U}_3 &= \dot{I}_3 \cdot (r_{\mathrm{k}3} + j\omega L_{k33}) + \dot{I}_1 \cdot j\omega L_{k13} + \dot{I}_2 \cdot j\omega L_{k23} \ . \end{aligned}\right\} \quad (3)$$

For short network in phases 2 and 3 during the idle stroke in phase 1:

$$\left.\begin{aligned} \dot{U}'_2 &= \dot{I}'_2 \cdot (r_{\mathrm{k}2} + j\omega L_{k22} + j\omega L_{k23}) \ , \\ \dot{U}'_3 &= \dot{I}'_2 \cdot (r_{\mathrm{k}3} + j\omega L_{k33} + j\omega L_{k32}) \ . \end{aligned}\right\} \quad (4)$$

For short network in phases 3 and 1 during the idle stroke in phase 2:

$$\left.\begin{aligned} \dot{U}''_1 &= \dot{I}''_1 \cdot (r_{\mathrm{k}1} + j\omega L_{k11} + j\omega L_{k13}) \ , \\ \dot{U}''_3 &= \dot{I}''_3 \cdot (r_{\mathrm{k}3} + j\omega L_{k33} + j\omega L_{k31}) \ . \end{aligned}\right\} \quad (5)$$

For short network in phases 1 and 2 during the idle stroke in phase 3:

$$\left.\begin{aligned} \dot{U}_1''' &= \dot{I}_1''' \cdot (r_{k1} + j\omega L_{k11} + j\omega L_{k12}), \\ \dot{U}_2''' &= \dot{I}_2''' \cdot (r_{k2} + j\omega L_{k22} + j\omega L_{k21}). \end{aligned}\right\} \tag{6}$$

During such experiments, it is necessary to ensure the same position of the electrode holders of the corresponding phase, as in the case of a three-phase short network experiment, and of two-phase short network experiments. Under these conditions, the corresponding own and mutual inductances will have the same value for different experiments in Eqs. (3)–(6). Corresponding resistances will be the same. It should be noted that $r_{kj}$ also includes resistances of electrodes. Resistances are determined by the wattmeter and ammeter measurements in each phase.

The values of six unknown inductions $L_{k11}$, $L_{k22}$, $L_{k33}$, $L_{k12}$, $L_{k23}$, $L_{k13}$ could be calculated as the solutions of the Eqs. (3)–(5). We can write these equations in projections on the imaginary axis of the complex plane:

$$\left.\begin{aligned} U_1 \sin\alpha_1 &= I_1 r_{k1} \sin\beta_1 - I_1 \omega L_{k11} \cos\beta_1 - I_2 \omega L_{k12} \cos\beta_2 - I_3 \omega L_{k31} \cos\beta_3, \\ U_2 \sin\alpha_2 &= I_2 r_{k2} \sin\beta_2 - I_1 \omega L_{k12} \cos\beta_1 - I_2 \omega L_{k22} \cos\beta_2 - I_3 \omega L_{k23} \cos\beta_3, \\ U_3 \sin\alpha_3 &= I_3 r_{k3} \sin\beta_3 - I_1 \omega L_{k13} \cos\beta_1 - I_2 \omega L_{k2} \cos\beta_2 - I_3 \omega L_{k33} \cos\beta_3, \\ U_2' \sin\alpha_2' &= I_2'(\omega L_{k22} + \omega L_{k23}), \\ U_3' \sin\alpha_3' &= I_2'(\omega L_{k33} + \omega L_{k23}), \\ U_1'' \sin\alpha_1'' &= I_1''(\omega L_{k11} + \omega L_{k13}) . \end{aligned}\right\} \tag{7}$$

where $\alpha_1 \div \alpha_3$, $\alpha_2' \div \alpha_3'$; $\alpha_1''$ – arguments (angles) of voltage vectors $\dot{U}_1 \div \dot{U}_3$, $\dot{U}_2' \div \dot{U}_3'$, $\dot{U}_1''$ in accordance; $\beta_1 \div \beta_3$ – arguments (angles) of current vectors $\dot{I}_1 \div \dot{I}_3$.

Having solved the Eq. (7), we obtain:

$$\begin{aligned} L_{k13} = {} & \frac{I_2 \cos\alpha_2 (I_2 r_{k2} \sin\alpha_2 - U_2 \sin\beta_2 - U_2' I_2 \cos\alpha_2 \sin\beta_2 / I_2' +}{\omega I_1 \cos\alpha_1 (I_2 \cos\alpha_2 - I_3 \cos\alpha_3 + I_1 \cos\alpha_1)} \rightarrow \\ & \rightarrow \frac{+ I_3 r_{k3} \sin\alpha_3 - U_3 \sin\beta_3 - U_3' I_3 \cos\alpha_3 \sin\beta_3 / I_2' -}{} \rightarrow \\ & \rightarrow \frac{-I_1 \cos\alpha_1 \left(I_1 r_{k1} \sin\alpha_1 - U_1 \sin\beta_1 - U_1'' I_1 \cos\alpha_1 \sin\beta_3 / I_3\right)}{}, \end{aligned} \tag{8}$$

$$L_{k12} = \frac{I_1 r_{k1} \sin\alpha_1 - U_1 \sin\beta_1 - U_1'' I_1 \cos\alpha_1 \sin\beta_1 / I_1'' - (I_3 \cos\alpha_3 - I_1 \cos\alpha_1) \omega L_{k13}}{\omega I_2 \cos\alpha_2} \tag{9}$$

$$L_{k23} = \frac{I_3 r_{k3} \sin\alpha_3 - U_3 \sin\beta_3 - U_3' I_3 \cos\alpha_3 \sin\beta_3' / I_2' - I_1 \cos\alpha_1 \omega L_{k13}}{\omega (I_2 \cos\alpha_2 - I_3 \cos\alpha_3)} \tag{10}$$

$$L_{k11} = U_1'' \sin\alpha_1'' / \left(\omega I_1''\right) - L_{k13}, \tag{11}$$

$$L_{k22} = U_2' \sin\alpha_2' / \left(\omega I_2'\right) - L_{k23} \tag{12}$$

$$L_{k33} = U_3' \sin\alpha_3' / \left(\omega I_2'\right) - L_{k23} \tag{13}$$

Using condition $\beta_1 = 0$ (vector of current $\dot{I}_1$ is placed on the axis of real numbers) form a triangle of currents, which are flowing at a three-phase short network (Fig. 2), the values of angles $\beta_2$ and $\beta_3$ are equal:

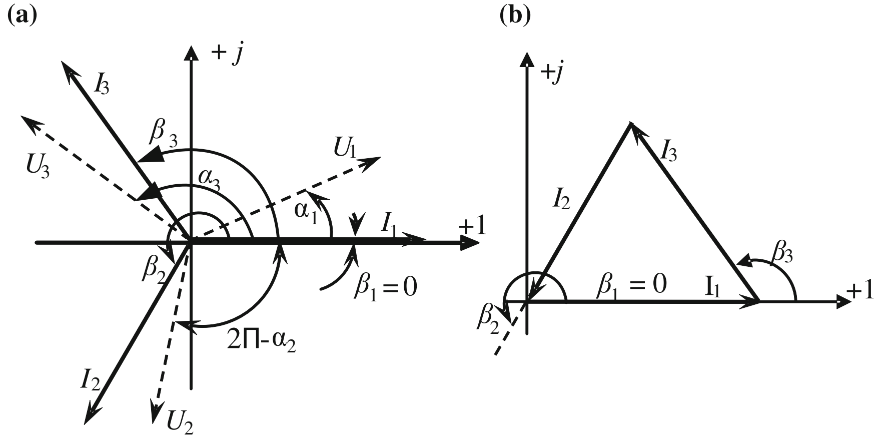


**Fig. 2.** Vector diagram of the currents of three-phase short network.

$$\beta_2 = \pi + arccos\left[\left(I_1^2 + I_2^2 - I_3^2\right)/(2I_1I_2)\right], \beta_3 = \pi - arccos\left[\left(I_1^2 + I_3^2 - I_2^2\right)/(2I_1I_3)\right] \tag{14}$$

The values of angles $\alpha_i$ for vector diagram presented on Fig. 2 could be defined as:

$$\left.\begin{array}{r} \alpha_1 = arccos[P_1/(U_1I_1)] + \beta_1, \\ \alpha_2 = arccos[P_2/(U_2I_2)] + \beta_2, \\ \alpha_3 = arccos[P_3/(U_3I_3)] + \beta_3\ , \end{array}\right\} \tag{15}$$

$$\left.\begin{array}{r} \alpha_2' = arccos\left[P_2'/\left(U_2'I_2'\right)\right], \\ \alpha_3' = arccos\left[P_3'/\left(U_3'I_3'\right)\right], \\ \alpha_1'' = arccos\left[P_1''/\left(U_1''I_1''\right)\right]. \end{array}\right\} \tag{16}$$

where $P_j$ are measurements of the wattmeter in phases during corresponding experiments, $U_j$, $I_j$ are measurements of corresponding voltmeters and ammeters.

### 2.2 Implementation of Proposed Method Obtained from Active Experiment

The proposed methodology was implemented to determine the parameters of short network ASF –1.5. According to the reference data [6] for this furnace:

$$r_k^d = 1.12 \cdot 10^{-3}\ \text{Ohm},\ x_k^d = 4.15 \cdot 10^{-3}\ \text{Ohm}.$$

The values of the parameters were averaged (the average arithmetic value for the three phases) for a comparative analysis of these data with the results obtained on the basis of experimental researches.

The value of $r_k^e = 1.08 \cdot 10^{-3}$ Ohm for resistance to the results of experimental research. In this case, the relative deviation from the reference data is small and equals <4%.

The following values for the inductances of the cables ASF –1.5 are obtained:

$$L_{\text{k}11} = 14.2 \cdot 10^{-6}\ \text{H},\ L_{\text{k}22} = 15.2 \cdot 10^{-6}\ \text{H},\ L_{\text{k}33} = 11.92 \cdot 10^{-6}\ \text{H},$$
$$L_{\text{k}12} = 4.90 \cdot 10^{-6}\ \text{H},\ L_{\text{k}23} = 4.80 \cdot 10^{6}\ \text{H},\ L_{\text{k}13} = 3.45 \cdot 10^{-6}\ \text{H}.$$

According to these values the equivalent inductances (2) are:

$$L_{\text{eq}1} = 10.65 \cdot 10^{-6}\ \text{H},\ L_{\text{eq}2} = 8.95 \cdot 10^{-6}\ \text{H},\ L_{\text{eq}3} = 8.57 \cdot 10^{-6}\ \text{H}.$$

Then average arithmetic value is $L_{av}^e = 9.39 \cdot 10^{-6}$ H, that corresponds to reactance $x_{av}^e = 2.95 \cdot 10^{-3}$ Ohm. In this case, the deviation is almost 30%.

If not take into account mutual inductances, then

$$L_{av}^e = (L_{k11} + L_{k22} + L_{k33})/3 = 13.77 \cdot 10^{-6}\ \text{H}.$$

In this case, the deviation is almost 4%. The references give the values of their own inductances of the cables, which entails an increasing of the error in determination of the arc voltage.

### 2.3 Determining of Arc Voltages Using Measurement Results Obtained from Passive Experiment

Measurement of the cable parameters according to the considered algorithm requires specially planned experimental research (active experiment). Due to the peculiarities of the technological process of steel smelting in the ASF, it always has breaks due to the loading of the furnace, the introduction of special components for obtaining a certain mark of steel, removal of slag from the surface of the molten charge, etc. During such breaks it is possible to organize a series of experiments to clarify the parameters of the cable. It's clear that an active experiment takes some time, and therefore it can affect the performance of the ASF. If the measure of operation efficiency of an electric arc furnace has a higher priority, it is proposed to determine the parameters of the current transmission to be carried out according to the measurement during a passive experiment without interference in the technological process.

During the passive experiment there is a continuous control of the instantaneous value of the phase voltage from the low side of the furnace transformer ($u_1$, $u_2$, $u_3$) and the derivatives of the instantaneous values of arc current ($di_{1\partial}/dt$, $di_{2\partial}/dt$, $di_{3\partial}/dt$) [7] (Fig. 3).

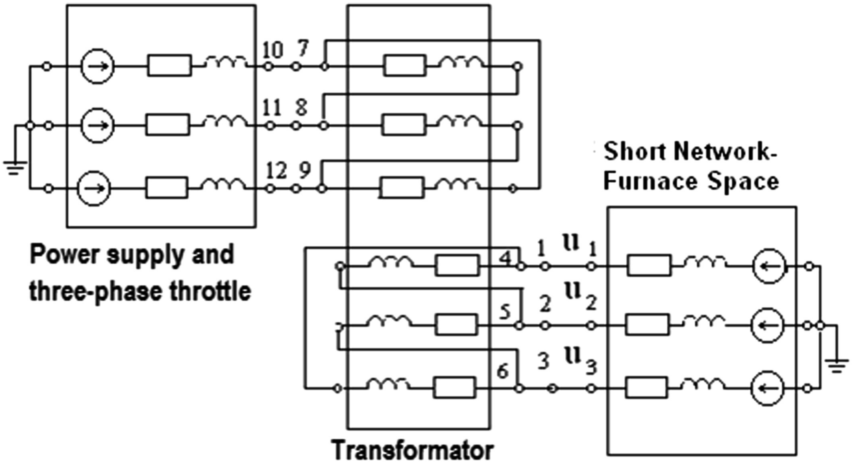


**Fig. 3.** The scheme of passive experiment in arc furnace.

The instantaneous values of these voltages can be written in the form:

$$\left.\begin{aligned} u_1 &= i_{1\partial}\cdot r_1 + L_{k11}\cdot\frac{di_{1\partial}}{dt} + L_{k21}\cdot\frac{di_{2\partial}}{dt} + L_{k31}\cdot\frac{di_{3\partial}}{dt} + u_{\partial 1},\\ u_2 &= i_{2\partial}\cdot r_2 + L_{k22}\cdot\frac{di_{2\partial}}{dt} + L_{k32}\cdot\frac{di_{3\partial}}{dt} + L_{k12}\cdot\frac{di_{1\partial}}{dt} + u_{\partial 2},\\ u_3 &= i_{3\partial}\cdot r_3 + L_{k33}\cdot\frac{di_{3\partial}}{dt} + L_{k23}\cdot\frac{di_{2\partial}}{dt} + L_{k13}\cdot\frac{di_{1\partial}}{dt} + u_{\partial 3},\end{aligned}\right\}\tag{17}$$

where $u_{\partial i}$ are the instantaneous arc voltages in appropriate phases.

It should be noted that the electric arc of the alternating current has an resistance character, as indicated by its dynamic volt-ampere characteristics [4, 8, 9] for different lengths in relation to the electric arc furnace type DSP-100 (see Fig. 4).

At time $t_j^{(1)}$ and $t_j^{(2)}$, when the current of $j$ - th phase passes through zero for a positive (at $t_j^{(2)}$) and negative (at $t_j^{(1)}$) the values of its derivative, on the basis of (17) taking into account that the voltage drops on the resistances and the voltage of the arcs in this case are equal to zero, the equations for instantaneous arc voltages in appropriate phases at these times have the following form

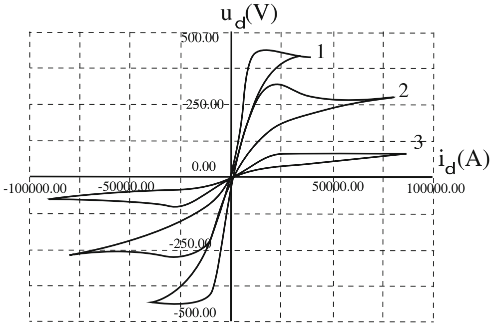


**Fig. 4.** Dynamic volt-ampere characteristics for different lengths in relation to the electric arc furnace type DSP-100.

$$\left.\begin{aligned}
u_1\left(t_1^{(1)}\right) &= L_{k11}\cdot\left.\frac{di_{1\partial}}{dt}\right|_{t=t_1^{(1)}} + L_{k21}\cdot\left.\frac{di_{2\partial}}{dt}\right|_{t=t_1^{(1)}} + L_{k31}\cdot\left.\frac{di_{3\partial}}{dt}\right|_{t=t_1^{(1)}},\\
u_1\left(t_1^{(2)}\right) &= L_{k11}\cdot\left.\frac{di_{1\partial}}{dt}\right|_{t=t_1^{(2)}} + L_{k21}\cdot\left.\frac{di_{2\partial}}{dt}\right|_{t=t_1^{(2)}} + L_{k31}\cdot\left.\frac{di_{3\partial}}{dt}\right|_{t=t_1^{(2)}},\\
u_2\left(t_2^{(1)}\right) &= L_{k22}\cdot\left.\frac{di_{2\partial}}{dt}\right|_{t=t_2^{(1)}} + L_{k12}\cdot\left.\frac{di_{1\partial}}{dt}\right|_{t=t_2^{(1)}} + L_{k32}\cdot\left.\frac{di_{3\partial}}{dt}\right|_{t=t_2^{(1)}},\\
u_2\left(t_2^{(2)}\right) &= L_{k22}\cdot\left.\frac{di_{2\partial}}{dt}\right|_{t=t_2^{(2)}} + L_{k12}\cdot\left.\frac{di_{1\partial}}{dt}\right|_{t=t_2^{(2)}} + L_{k32}\cdot\left.\frac{di_{3\partial}}{dt}\right|_{t=t_2^{(2)}},\\
u_3\left(t_3^{(1)}\right) &= L_{k33}\cdot\left.\frac{di_{3\partial}}{dt}\right|_{t=t_3^{(1)}} + L_{k23}\cdot\left.\frac{di_{2\partial}}{dt}\right|_{t=t_3^{(1)}} + L_{k13}\cdot\left.\frac{di_{1\partial}}{dt}\right|_{t=t_3^{(1)}},\\
u_3\left(t_3^{(2)}\right) &= L_{k33}\cdot\left.\frac{di_{3\partial}}{dt}\right|_{t=t_3^{(2)}} + L_{k23}\cdot\left.\frac{di_{2\partial}}{dt}\right|_{t=t_3^{(2)}} + L_{k13}\cdot\left.\frac{di_{1\partial}}{dt}\right|_{t=t_3^{(2)}}.
\end{aligned}\right\} \tag{18}$$

It is well known [10–12] that the duration of displacement of the elements of the short network due to the functioning of the system of automatic control of the motion of the electrodes, which causes changes in the values of inductances, is much greater than the period of the supply voltage. This allows for several voltage periods to assume parameters as constant. Having solved the system of Eq. (18), we obtain the values of own and mutual inductances for the cables, which are used to determine the voltages of the arcs $u_d$ of the Eq. (18). Parameters $r_1$, $r_2$, $r_3$ are practically constant, given in the passport of the cables, or can easily be determined experimentally by the data of the wattmeter and the corresponding ammeters during the technological short networks required to ignite the arcs at the beginning of the technological process.

Thus, the time required to obtain the information necessary for correction of the values of inductances is commensurate with the period of instantaneous supply voltages, and therefore, until the specified parameters of the cables have not changed, the instantaneous values of the voltage of the arcs of the three phases of the $u_{\partial i}$ are calculated using these parameters on the basis of the Eq. (18). The instantaneous values of the $u_{\partial i}$ over one or several periods make it possible to determine their effective values, which are used by the ACS to move the electrodes to realize more accurate maintenance of a given length, and hence the power, arcs of each phase.

## 3 Results

For the electric arc furnace type DSP 100 N3A the values of their own and mutual inductances of the short network were calculated using the proposed methodology. Numerical values of phase voltages and derivative currents were determined as a result of processing of oscillograms, which were obtained experimentally on an existing ASF

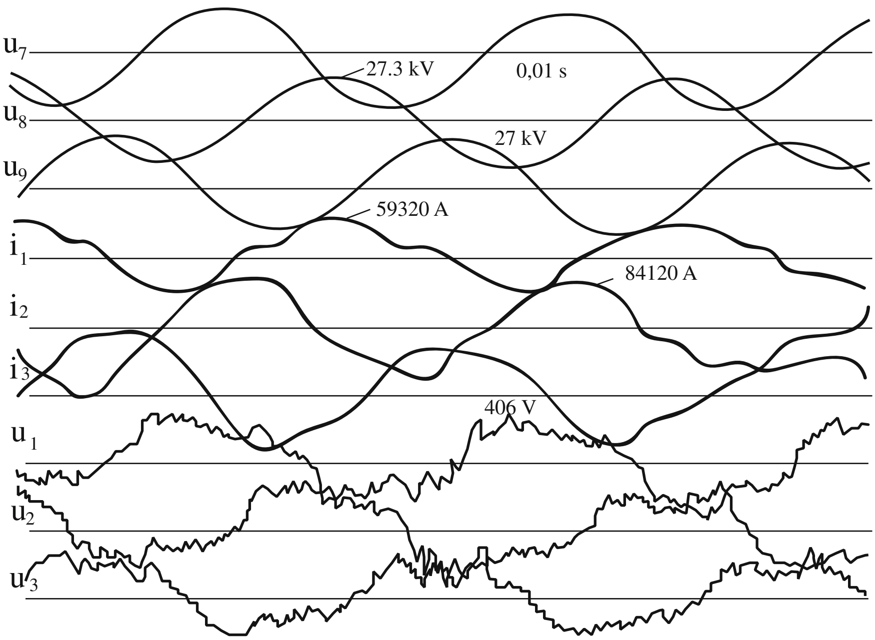


**Fig. 5.** Experimental oscilloscope diagrams for ASF.

(see Fig. 5).

As a result, the following values of the inductances were obtained for the position of the electrodes, in which the oscillogram was recorded:

$$L_{k11} = 19.6 \cdot 10^{-6}\text{ H}, L_{k22} = 2.6 \cdot 10^{-6}\text{ H}, L_{k33} = 21.5 \cdot 10^{-6}\text{ H},$$

$$L_{k12} = L_{k21} = -1.5 \cdot 10^{-6}\text{ H}, L_{k23} = L_{k32} = -3.5 \cdot 10^{6}\text{ H}, L_{k13} = L_{k31} = 6.7 \cdot 10^{-6}\text{ H}.$$

These values correspond to the following values of equivalent inductances calculated according to the formulas (2):

$$L_{\text{eq1}} = 10.9 \cdot 10^{-6}\ \text{H},\ L_{\text{eq2}} = 7.3 \cdot 10^{-6}\ \text{H},\ L_{\text{eq3}} = 16.8 \cdot 10^{-6}\ \text{H},$$

They have such reactances for sinusoidal current:

$$x_{\text{eq1}} = 3.42 \cdot 10^{-3}\ \text{Ohm},\ x_{\text{eq2}} = 2.29 \cdot 10^{-3}\ \text{Ohm},\ x_{\text{eq3}} = 5.28 \cdot 10^{-3}\ \text{Ohm}.$$

Then the arithmetic mean is $x_{av} = 3.66 \cdot 10^{-3}$ Ohm. If you calculate $\text{x}^*_{\text{aver}}$ without taking into account the mutual inductances then $x^*_{av} = 4.58 \cdot 10^{-3}$ Ohm.

Compare the results with passport values ($x = 3.66 \cdot 10^{-3}$ Ohm) it makes no sense because, as a rule, these values are calculated from data from experimental studies for short-circuit experiments when introduced ASF into operation. Obviously, this corresponds to some initial position of a short network and does not take into account the change in the configuration of the ASF coupling phase.

Regarding the current values of arc currents, which are also used by such ACSs it should be noted that for chipboard capacity up to 100 t the currents of arcs are measured from the low side using current transformers, and for furnaces with a capacity of more than 100 t the current measurement is carried out, or from the high side of the furnace transformer for using a current transformer with further recalculation of the measurement results, or from the low side using the Rogovsky belt with filters.

## 4 Conclusion

Taking into account the parameters of cables in full volume obtained on the basis of a series of active research experiments for ASF small capacity allows you to get complete information about the value of the parameters of a short network. Due to this, the determination of the voltage of the arc, which takes part in the formation of control influence ACS the displacement of electrodes is carried out more precisely than on the basis of the passport data of the parameters of the short network of the electric arc furnace. This increases the accuracy of maintaining the arc length and provides more effective introduction of melting.

For ASF of large capacity it is expedient to use the data of the passive experiment, as a result, the parameters of the phase of the current drive are determined operatively, taking into account both their own and the mutual inductances. Due to this, it is possible to more accurately measure the instantaneous arc voltage, which calculates their updated values. These operating values serve to form the control effect of the ACS by moving the electrodes, and hence the power of the arcs of each phase.

Thus, control is adequate to the real state of arcs in the furnace space and the implementation of the technological process of melting steel in accordance with the policy values of the procedure for the melting of this steel grade is provided.

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