Neural Network Based Steel Melting Furnace Short Circuit Parameters Identification

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Abstract **The method of continuous control of arc furnace short circuit elements parameters based on neural network is proposed. The block diagram has been developed and the synthesis of parameter identification neural network system has been developed. The mathematical and digital models have been developed and the accuracy of identification has been studied. The obtained results of model studies showed high accuracy of neural network identification of furnace short circuit parameters.**

Keywords **arc steel furnace, short circuit, neural network, identification, control.**

I. INTRODUCTION

Conditions and modes of arcs burning in three-phase electric arc furnaces (EAF) change continuously during melting. Loading modes have nonlinear asymmetric and random character. Parameters of the short circuit (resistance, own and mutual inductions) vary continuously in wide limits during the melting process. This causes a deviation of technical and economical indices of ESF from optimal values and negatively affects the dynamics of the electric mode coordinates control [1]. To adapt control to parameters changes operational information values are required.

II. PROPOSED SOLUTIONS

Direct measurement of the EAF short circuit elements parameters is technically impossible. A method for elements parameters identification, based on deterministic models, is proposed in [2]. But this method does not take into account the dependence of the parameters on the level of arcs currents non-harmonic distortions and therefore has a low accuracy. For continuous control of parameters with high precision we propose to use parameters identification based on neural network.

III. RESEARCH RESULTS

The developed diagram of continuous operational control of EAF short circuit element parameters is shown on fig 1.

Averaged on period values of arc currents I_{aA}, I_{aB}, I_{aC}, phase supply voltages of arcs U_{aA}, U_{aB}, U_{aC}, coefficients of currents non-harmonic distortions D_{cA}, D_{cB}, D_{cC} and signals of each phase electrode positions S_A, S_B, S_C form inputs of the neural network. These inputs of the neural network are formed on the outputs of averaged values sensors AVS of phase arc currents and voltages, non-harmonic distortions coefficients sensors of arcs currents DCS and electrodes position sensors EPS.

On the output of the neural network resistances R_A, R_B, R_C, own L_A, L_B, L_C and mutual L_{AB}, L_{BC}, L_{CA} inductances of EAF short circuit are continuously identified.

Three static neural networks with direct signal propagation and learning algorithm based on error "back propagation" are used for each group of parameters identification.

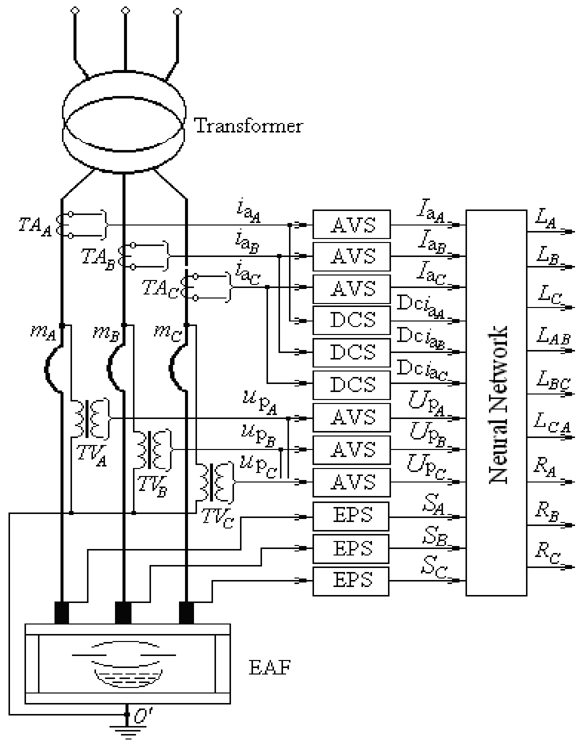

Fig.1. Block diagram of EAF short circuit parameters identification

Research of the neural network short circuit parameters identification accuracy has been performed on a digital model of three-phase power supply circuit of EAF arcs.

IV. CONCLUSIONS

Experiments shown the average relative identification error of mutual inductances $\delta = 1.5 \cdot 10^{-7} - 1.4 \cdot 10^{-6}$, maximum error on the interval of identification $t \approx 30s$ was $\delta = 0.6 \cdot 10^{-2}$ related to reference value. The average relative error of resistance $R_A(t_i), R_B(t_i), R_C(t_i)$ identification is $\delta = (1.0 - 1.4) \cdot 10^{-5}$.

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