MODELING THE ELECTROMAGNETIC POLLUTION OF THE ELECTRIC ARC FURNACES

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Key words: Power quality, Electromagnetic pollution, Harmonics, Electric arc furnace (EAF), Electric arc modeling.

The electric arc furnace is a three-phase load representing one of the most important generator of harmonic currents, reactive power and unbalanced conditions in electrical power systems. This paper aims to achieve a study concerning the power quality of the energy at 3-phase electric arc furnaces. There are analyzed the main qualitative indicators of the electric power: power factor, reactive factor, distorting factor and the total harmonic distortion for current and voltage to a 100 t EAF from an industrial platform. There are also study the modeling of a three phase electric arc furnace installation. Thus, for modeling his behavior, it was used a model which parameters like of a real electric arc. The simulations results are comparing with the measurements.

1. INTRODUCTION

Electric arc furnace is a massive generator of disturbing in electrical power system. The three types of disturbing the electrical power system are: generation of the three phased harmonic currents, of an important reactive power and unbalanced high power three-phase load. In order to improve the electric power's qualitative indicators, it is necessary to use some solutions or specialized equipment to filter the harmonic currents, to improve the power factor and to balance the 3-phase electric charge [1–4]. The effect of these installations was analyzed using simulation program PSCAD/EMTDC [13]. PSCAD (Power System Computer Aided Design) is a graphical user interface capable of supporting a variety of power system simulation programs. This release supports EMTDC (Electro-Magnetic Transients in DC Systems).

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Using LMS Algorithm for Controlling the Active Power of Nonlinear Loads

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Abstract-- **In this paper is proposed an adaptive control method of the active power of a nonlinear load. One of the most representative nonlinear loads is the Electric Arc Furnace (EAF). Based on the experimental results will be proposed an adaptive control system of the process. The algorithm used is known as the LMS algorithm (Least Mean Square) being, due to its simplicity, the most used algorithm implemented in controlling systems. It was used standard and variable step size LMS algorithm. The efficiency of the proposed algorithms is verified using simulations based on modeling the electric arc. For modeling the electric arc it was used a model having parameters like of a real electric arc. For simulation it was use the PSCAD-EMTDC program (Power Systems CAD - a program dedicated to power systems).**

***Index Terms*—LMS algorithm, Nonlinear systems, Power quality, Power control.**

I. Introduction

Nowadays the numbers of the industrial nonlinear distorting loads that pollute the electric power supply network from electromagnetic viewpoint has increased. Their connection to the electric network produces significant current distortions and also voltage distortions, which damage the electric power's quality. One of the most representative nonlinear loads is the Electric Arc Furnace (EAF) [1-4]. EAF – Electric Arc Furnace changes the electrical power into thermal energy by electric arc in melting materials. The installed power reaches up to 1 MW/t. The random property of arc melting process is the main reason of the power quality problems to the supply system [1-4]. Therefore it acts as a source of disturbance in the electric network. The EAF generates harmonics and interharmonics, voltage unbalance and voltage fluctuations. But the most significant disadvantage of the EAF is the reactive power which occurs because the nonlinearity of the electric arc [2].

It is proposed an adaptive control method of the active power of the EAF, based on the experimental results made in the electrical installation of an EAF.

The algorithm used is known as the LMS algorithm (Least Mean Square) being, due to its simplicity, the most used algorithm implemented in controlling systems. It was used standard and variable step size LMS algorithm.

The efficiency of the proposed algorithms is verified using simulations based on modeling the electric arc. For modeling the electric arc it was used a model having parameters like of a real electric arc. For simulation it was use the PSCAD-EMTDC program (Power Systems CAD - a program dedicated to power systems).

II. Experimental Measurements in the Electrical Installation of the EAF

It was performed some measurement in the primary and secondary furnace transformer of an EAF. The measurements were made at a 3-phase power supply installation for an EAF capacity of 100 t [5]. The measurements were performed using a numerical system, based on data acquisition board. The data aquisition board allows the simultaneous acquisition of 3 currents and 3 voltages, for the low or medium voltage lines of the transformer which supplies the furnace, the acquisition frequency being 5 KHz.

Follow the measurements it was obtained a maximum value of the active power approximately 55-60 MW and 50 MVAR for reactive power. There were obtained values between 5 - 25% for total harmonic distortion voltage (THDU), respectively 5 - 35%, higher in the melting phase, for the total harmonic distortion current (THDI). Comparing these values with maximum permissible harmonic levels results that THDI and THDU exceeds these limits ([6] and [7]). It is found that the minimum value of the current's negative non-symmetry factor is of 5%, value which exceeds that maximum permitted limit of 2% ([6] and [7]). As regards the voltages negative non-symmetry factor, it is found that in the melting phase and at the beginning of the stable burning phase is over 2%, but towards the end of the melting process is situated around 2%, and rarely over this value.

A. The power quality improvement

Following the measurements, results that the power quality can be improve by using a complex system including:

- a reactive power compensation system
- harmonics filters
- a load balancing system

Such a complex system was designed in [8], [9] and [10]. The reactive power compensation system was design in [8]. The harmonics filters parameters was calculated in [9] for passive filters. The load balancing system was designed in [10]. These systems influence

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Artificial neural networks in predicting current in electric arc furnaces

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Abstract. The paper presents a study of the possibility of using artificial neural networks for the prediction of the current and the voltage of Electric Arc Furnaces. Multi-layer perceptron and radial based functions Artificial Neural Networks implemented in Matlab were used. The study is based on measured data items from an Electric Arc Furnace in an industrial plant in Romania.

1. Introduction
The Electric Arc Furnace (EAF) is used in the melting process of the scraps which are loaded in the furnace tank. The EAF is one of the modern ways of making steel, but having very large power input ratings. It also behaves like a nonlinear load and can cause large power quality problems, mainly harmonics, interharmonics, the flicker phenomenon and voltage unbalances. Because of these, solutions must be identified through which these disturbances should not be injected in the power supply network. So, the prediction of the future values of the current arc and voltage is need. Based on these values actions can be taken to mitigate (lessen) the disturbances.

2. The AC Electric Arc
The power supply equivalent diagram for a single phase is show in figure 1, where r and L being the resistance, respectively the equivalent inductance of the supplying circuit, and R_A and v_A the resistance of the electric arc, respectively the arc voltage [1]. The waveforms of the electrical issues (current arc, voltage arc and voltage supply) are also show in figure 1.

3. Modelling the AC Electric Arc
EAFs are used in the production of steel and other metals. EAFs are very large, dynamic and time varying loads due to the nonlinearity of the electric arc. Electric-arc steelmaking generally has two successive stages, a melting stage and a refining stage. For these reasons it is very difficult to find an accurate model for the electric arc. In the reference literature many modeling methods can be found: nonlinear resistive models [3], [4] voltage source models [5], [6] models based on V-I characteristics of the EAF [7], models based on relations between the length of the arc, the voltage and the current of the arc [2], model that used chaos theory [8] and advanced models that use neural networks and fuzzy logic [8-12]

Modeling of the Electric Arc Behavior of the Electric Arc Furnace

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Abstract. During the electric arc furnace operation appear disturbances, which can affect the other equipments that are connected to the same power network. So it is necessary to develop models for the electric arc which characterizes the electric arc behavior in order to identify methods and solutions through which the disturbances that appear in the power network can be reduced.

This paper presents two proposed models used to simulate the electric arc behavior of a 3-phase electric arc furnace which were implemented using the Simulink toolbox of Matlab. In order to facilitate the analysis of the influence of the model parameters, graphical user interfaces were implemented. Then, the simulation results were compared with known results.

Keywords: electric arc furnace, voltage-current characteristic, electric arc model.

1 Introduction

Because of the electric arc dynamic behavior during melting process, the electric arc furnaces are an important source of disturbances of which can be mentioned: harmonic currents, reactive power circulation, unbalanced load, voltage flicker. Regardless of the furnace type (DC or AC), disturbances are of random nature and generate high-order harmonics.

Generally, most AC electric arc furnaces are of high and very high power (UHP EAF), disturbances produced by them being larger. Considerable attention for power quality, asked for some actions by which these disturbances should be eliminated or reduced. In these conditions it is important to study the electric arc behavior, because, this being a nonlinear circuit element, it is the main cause of the produced disturbances by electric arc furnaces.

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Study About the Possibility of Electrodes Motion Control in the EAF Based on Adaptive Impedance Control

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***Abstract*—The paper presents a study about the possibility of adaptive process control in three phased electric arc furnace. The method is based on the electrodes motion control. The control principle is depending on impedance of the electric arc. The method proposed use a data acquisition board whose input signals are taken from electric arc. These signals allow the calculation of electric arc impedance. Using a numeric computer, it can be commands the control of electrodes position independently on each one of three phases. We propose to use a static frequency converter on each phase to control the electrodes motion**

***Keywords*— Adaptive control, motion control, power factor correction.**

I. Introduction

An electrical arc furnace (EAF) changes the electrical power into thermal energy by electric arc in melting the raw materials in the furnace. During the arc furnace operation, the random property of arc melting process and the control system are the main reasons of the electrical and thermal dynamics. That will cause serious power quality problems to the supply system [1], [2], [3], [4], [5], [6], [7].

Nowadays, AC-Electric Arc Furnaces (EAF) is typically designed to melt a batch of scrap into liquid metal within 1-3 hours [8]. Therefore the installed power reaches up to 1 MW/t. Melting down the scrap bunch and superheating it is a high dynamic process. The AC arc furnace has a non-linear current-voltage characteristic. Therefore it acts as a source of disturbance in the grid from which it is supplied. It emits both harmonics and interharmonics and generates voltage unbalances, voltage dips and voltage fluctuations. Another disadvantage in the EAF is caused by the variations in the line voltage leading to flicker, which can be observed due to the luminosity fluctuation of incandescent lamps.

However, one of the most substantial disadvantages of arc furnace is caused by the reactive power due to the non-linearity of the electric arc [9], [10]. The significant values of the reactive power cause important losses of active power, therefore the efficiency are affected [1], [2], [5], [6], and [11].

The closed-up loop control is not optimized at many furnaces; the run of voltage is very dynamic. With a more optimized control closed-loop it should be possible to enhance the energy input and consequently the productivity. For improving the functioning regime by power factor correction it is possible to make an adaptive impedance control.

The proposed solution is based on some measurements made on an industrial Plant in Romania, Hunedoara where a 100t, 100 MVA UHP EAF are in function.

II. The Electrical Parameters of the EAF

Figure 1 shows the physical model of the electric arc furnace [8]. In this particular EAF model, there are three electrodes that are moved vertically up and down with hydraulic actuators. Each of these electrodes has a diameter of roughly 1.5 m, weighs approximately 40 tons and is 1 to 2 stories tall. The ore is melted with a huge power surge from the electrodes. The actual product is denser than the scrap and thus falls to the bottom of the furnace creating the matte. Above the matte lies the slag where the electrode tips are dipped. The tremendous heat created by these electrodes causes the ore to liquefy and separate. Thereupon more raw materials are placed in the furnace and the process repeats itself.

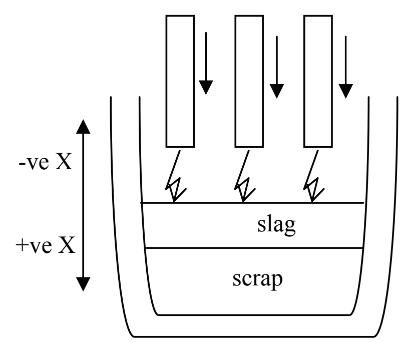

Fig. 1 The physical model of the Electric Arc Furnace

A. Arcing

Arcing is a phenomenon that occurs when the electrodes are moved above the slag. As the electrode approaches the slag, current begins to jump from the electrode to the slag, creating electric arcs. Depending on the magnitude of the input voltages of electrodes, the arcing distance can vary. Usually, arcing occurs in the region within centimeters of the slag (approximately 10 – 15 cm). Therefore, the EAF model must take into account the instances when x1, x2, x3 are negative (i.e. the electrodes are suspended above the slag), like in fig 1.

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Study About the Possibility of Electrodes Motion Control in the EAF Based on Adaptive Impedance Control

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Keywords

Author Keywords: Adaptive control; motion control; power factor correction

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Study about the possibility of flicker effect simulation caused by nonlinear power loads

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Abstract: - The Electric Arc Furnace (EAF) is a very large power load, determining the negative effects on the power quality: flicker effect, harmonics currents, unbalanced load, and reactive power. These negative effects are due to the nonlinear characteristic of the electric arc. This paper present a study based on simulation about flicker effect caused by Ultra High Power Electric Arc Furnace (UHP-EAF). For simulation it was use an electric arc model, depending on the nonlinearity of the electric arc. The model was validating using measurements made in an industrial plant in Romania.

Key-Words: - simulation and modeling, power quality, flicker, harmonics, interharmonics

1 Introduction

The electric arc is a nonlinear element. For study the behavior of the systems based on electric arc it must use techniques to model the nonlinearity of the electric arc. Because the electric arc's nonlinearity, this is a massive generator of harmonic currents and reactive power in electrical power system. The EAF are also a reactive power source because the electric arc is also a reactive load. The electric arc furnace is also and unbalance load. However, one of the most substantial disadvantages of arc furnace is caused by the variations in the line voltage leading to flicker, which can be observed due to the luminosity fluctuation of incandescent lamps. Electric arc furnaces are a main cause of voltage flicker due to the interaction of the high demand currents of the loads with the supply system impedance.

Therefore the main point of analysis focuses on the characteristics of harmonics, and also on the flicker.

The effect of these installations was analyzed using simulation program PSCAD/EMTDC [14]. PSCAD (Power System Computer Aided Design) is a multi-purpose graphical user interface capable of supporting a variety of power system simulation programs. This release supports only EMTDC (Electro-Magnetic Transients in DC Systems).

For simulation it was use an electric arc model, depending on the nonlinearity of the electric arc. The modeling approach adopted in the paper is graphical, as opposed to mathematical models embedded in code using a high-level computer language. The well-developed graphic facilities available in an industry standard power system package, namely PSCAD-EMTDC, are used to conduct all aspects of model implementation and to carry out extensive simulation studies.

2. Light flicker due to voltage fluctuations

One definition of flicker is "Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time" [1]. This means the perception of light flicker is a physiological process. Over the past years numerous studies have been conducted in order to understand the mechanisms behind the flicker phenomenon. There are at least three different mechanisms influencing the light flicker perception by a human. These are:

- The characteristics of the light source.
- The frequency response of the eye-brain of a human
- The time constant of the eye-brain

Examples of flicker sources

The flicker is in reality a statistical calculation, defined by the EN IEC 61000-4-15 standard and obtained from measuring the rapid variations in voltage. These rapid variations in voltage (figure 1) are, generally speaking, caused by variable loads such as arc furnaces, laser printers, micro-wave ovens or air conditioning systems being started up.

As mentioned in the previous section the main source of severe voltage fluctuations are industrial loads with fluctuating power demands but also wind turbines and wave power etc. can generate flicker. Theoretically, flicker can also be caused by sub- and

About the Possibility of Power Controlling in the Three-Phase Electric Arc Furnaces Using PSCAD EMTDC Simulation Program

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***Abstract*—The electric arc is a nonlinear element. For this reason it must be used special techniques of modeling the electric arc that should reflect as closely as possible the behavior of the real electric arc. In this paper, the modeling of the functioning of the electrical installation of the electric arc furnace was done using the PSCAD-EMTDC simulation program. The electric arc furnaces do not absorb sinusoidal currents and generally consume reactive power. These two phenomena produce some disturbances like the dysfunction of the equipment in the worst cases. It is perform a study of the possibilities of controlling the electric arc power, in order to obtained maximum of the active power and reducing the reactive and distorted power.**

***Index Terms*— power control, reactive power, power system harmonics**

I. THE AC ELECTRIC ARC MODELING

The AC electric arc is a nonlinear element. The variation curves of the electrical issues from the equivalent scheme of the supplying circuit are presented in figure 1. If we analyze the variation curves, we obtained the following conclusions: after electric arc ignition, the arc voltage u_A is practically constant and because the current is variable, the electric arc can be considered as a nonlinear element; the arc voltage u_A and the current i_A from the circuit are in the same phase, which means that the electric arc has a resistive character; the AC electric arc has a rectifying character.

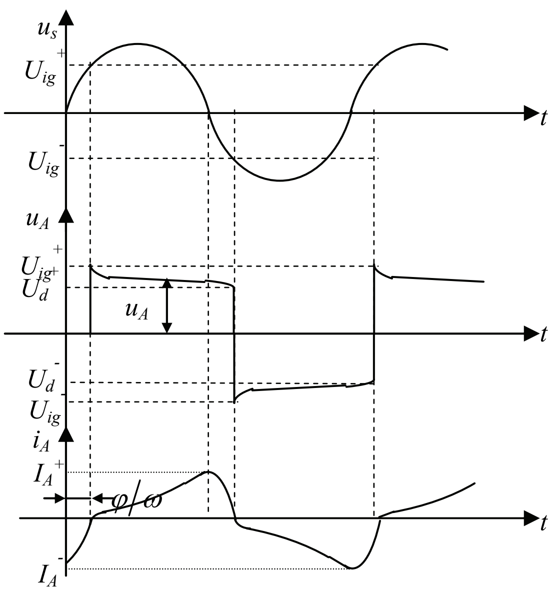

Figure 1. The variation curves of current and voltages

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The authors have analyzed the main models of electric arc from the reference literature [5] – [18] and have come to important conclusions related to the validity of each model, the way of implementing it and the results of computer simulation of the behavior of arc-furnaces. In order to be able to obtained comparative conclusions as to the performances of the models under consideration, all the models were implemented on the same electric installation, most often given in the reference literature [6], [9]. This installation under consideration is fed from the high voltage bars IT through a three-phase transformer 220/21 kV having the power of 95 MVA, and from the medium voltage bars MT through a three-phase transformer 21/0,4-0,9 kV having the power of 60 MVA. The electric resistance on each phase of the short network is 0,3 $m\Omega$, and the electric reactance on each phase of the short network is 3 $m\Omega$. In order to allow a comparison between the models under consideration, in all the simulations the *power of the electric arc* was chose 25,4 MW, been composed by *the power transferred to the metal bath* and *the power loss on the electric arc*, proportional to the surface of the hysteresis curve of the current-voltage characteristic. The usual mean value of the amplitude of the electric arc voltage is according to [6], [8] and [11] of 200 V. Considering that the electric arc voltage has a rectangular shape, the effective value will be equal to the amplitude, according to relation:

$$U_{Aef} = U_A = 200\ \text{V}\ . \tag{1}$$

For this value, from relation (3) results that the minimum value of the amplitude of the phase voltage for which we have an uninterrupted current is $U_s \geq 370{,}37\ \text{V}$, value which corresponds to a minimal line voltage in the secondary of the medium voltage transformer of

$$U_{\min} = 453{,}6\ \text{V}\ , \tag{2}$$

which is in the range of values given by the secondary of the MT transformer**.**

Under these conditions, the mean value of the electric arc resistance along one phase is

$$R_A = R_{med} = \frac{3U_A^2}{P} = 4{,}72\ \text{m}\Omega\ . \tag{3}$$

One important problem that has to be solved by a model is the possibility of controlling the power of the electric arc. A generally valid solution, irrespective of the model used for the electric arc, may be the modification of the effective value of the voltage supplied by the secondary of the medium voltage transformer. There are two possibilities of

Simulation Result about Harmonics Filtering for Improving the Functioning Regime of the UHP EAF

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Abstract: - This paper present the results obtained by simulation for the functioning regime improvement of an UHP Electric Arc Furnace. Because the nonlinearity of the electric arc the EAF functioning regime are perturbed from three causes: the current harmonics, the reactive power and the unbalanced load. In this paper there are study the possibilities of harmonics filtering and compensate the reactive power. The study was made using the results of some measurements made on an EAF and using an electric arc model for simulation. The simulations are performed in PSCAD EMTDC simulation program, a program dedicated to the power system.

Key-Words: - PSCAD-EMTDC simulation program, electric arc modeling, harmonics mitigation, filtering, reactive power compensation

1 Introduction

The electric arc is a nonlinear element. For study the behavior of the systems containing an electric arc it must use techniques to model the nonlinearity of the electric arc. Because the electric arc's nonlinearity, this is a massive generator of harmonic currents and reactive power in electrical power system. The EAF are also a reactive power source because the electric arc is also a reactive load. The electric arc furnace is also and unbalance load. For improving the functioning regime of the electric arc furnace it can be used harmonic filters and a reactive power compensation installation. The effect of these installations was analyzed using simulation program PSCAD/EMTDC [15]. PSCAD (Power System Computer Aided Design) is a multi-purpose graphical user interface capable of supporting a variety of power system simulation programs. This release supports only EMTDC (Electro-Magnetic Transients in DC Systems).

For simulation it was use an electric arc model, depending on the nonlinearity of the electric arc. The modeling approach adopted in the paper is graphical, as opposed to mathematical models embedded in code using a high-level computer language. The well-developed graphic facilities available in an industry standard power system package, namely PSCAD-EMTDC, are used to conduct all aspects of model implementation and to carry out extensive simulation studies.

2 The Electric Arc Model

In [1], [3], [4], [11], [12], [13] and [14] was present some models for the electric arc. From these models in this paper was choose the model based on the empirical relation between the arc current, arc voltage and arc length. This model are considered by the authors the most appropriate model for describe the electric arc behavior. This model, given in [3], [4], [11] and in [12], considers the characteristic current-voltage described by relation

$$U_A = U_{th} + \frac{C}{D + I_A}. \quad (1)$$

In this relation U_A and I_A are the arc voltage and arc current, and U_d are the threshold voltage. The C and D constants determine the difference between the current increasing part and current decreasing part of the current–voltage characteristic (C_a, D_a irrespective C_b, D_b). The typical values ([3], [4], [11], [12]) are: U_d = *200 V*, C_a = *190000 W*, C_b = *39000 W*, $D_a = D_b$ = *5000 A*. Because the real values of the model parameters depend on the voltage arc variations, the dynamic arc voltage–current characteristic must be an arc length function, given by relation ([3], [4]):

$$U_A = k \cdot U_{A0}(I_A). \quad (2)$$

In (2) U_{A0} represent the value of the arc voltage for a reference arc length l_0 and k is the ratio between the threshold voltage value for arc length l, $U_{th}(l)$ and the threshold voltage value for arc length $l_0, U_{th}(l_0)$.

USING A MODEL BASED ON LINEARIZATION OF THE CURRENT – VOLTAGE CHARACTERISTIC FOR ELECTRIC ARC SIMULATION

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ABSTRACT
The simulation is very useful in analyzing the behavior of nonlinear loads such the electric arc furnaces. The electric arc is a nonlinear element and from this reason it give rise to negative effects on the electric power quality, especially in case of the UHP electric arc furnaces (harmonic currents, reactive power and unbalance three phase load). For this reason it must find a model which reflects the behavior of the electric arc. In this paper it was use a model based on the current – voltage characteristic of the electric arc. The simulation results was compared with the measurements made by the authors on an industrial plant, where a 100 t UHP electric arc furnace functioning. All the simulation was performed using the PSCAD EMTDC simulation program.

KEY WORDS
Electric arc modeling, PSCAD EMTDC simulation program

1. Introduction

The electric arc is a nonlinear element. Thus, the three phase electric arc furnace is a nonlinear load. This load are unbalance too because the different values of the arc's length on the three phases. For this reason, the electric are furnace give rise to negative effects on the electric power quality. For study these effects it is necessary to simulate the electric arc furnace installation. This can be done using a model for the electric arc. In the reference literature are used many models of the electric arc [1]-[20] These models can be grouped in several categories: models using non-linear and time – variable resistances, models using time – variable arc voltage, models using stochastic processes, model using empirical relation between arc length, arc voltage and arc currents. These models were study by the authors in several previous papers. This study is useful because it can be use for the improvement of the power quality on the supplying line of the electric arc furnaces. This paper present the model based on the linearization of the arc current – voltage characteristic.

2. The model based on the linearization of the electric arc current – voltage characteristic

This model of the AC electric arc used in [1], [2], [3] is based on linearization of the current-voltage characteristic, typical for the electric arc. Also, this simulation technique is based on the fact that the parameters of the model depend on the power of the charge and therefore the model parameters depend on the work conditions. As the model uses the power absorbed by the electric arc furnace as an input, it results that the model allows the modification of the characteristic current-voltage, so that the power absorbed can be the prescribe power to be used by the charge circuit. The principle according to which the model under consideration takes into account the active power absorbed by the circuit is based on the fact that the area of the current-voltage characteristic represents the active power absorbed. The fig. 1 presented the typical dynamic characteristic and the linear approximation of the current-voltage characteristic of the AC electric arc and the real dynamic characteristic too.

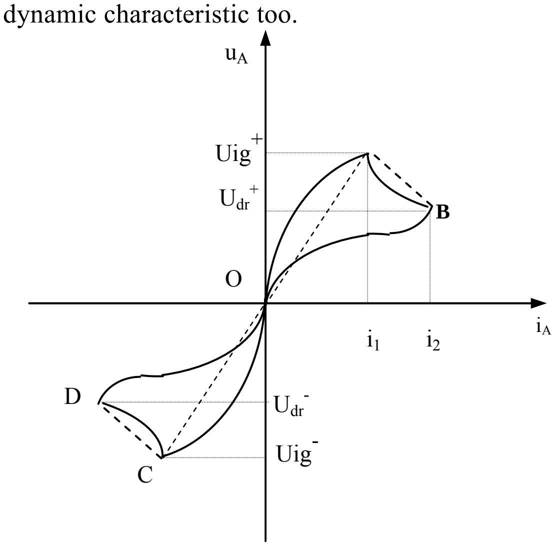

Fig. 1. The linearized and the real dynamic current-voltage characteristic.

Using a model based on linearization of the current-voltage characteristic for electric arc simulation

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Abstract

The simulation is very useful in analyzing the behavior of nonlinear loads such the electric arc furnaces. The electric arc is a nonlinear element and from this reason it give rise to negative effects on the electric power quality, especially in case of the UHP electric arc furnaces (harmonic currents, reactive power and unbalance three phase load). For this reason it must find a model which reflects the behavior of the electric arc. In this paper it was use a model based on the current - voltage characteristic of the electric are. The simulation results was compared with the measurements made by the authors on an industrial plant, where a 100 the UHP electric arc furnace functioning. All the simulation was performed using the PSCAD EMTDC simulation program.

Keywords

Author Keywords: electric arc modeling; PSCAD EMTDC simulation program

KeyWords Plus: FURNACE; COMPENSATION; FLICKER

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Adaptive Neuro-Fuzzy System for Current Prediction in Electric Arc Furnaces

Manuela Panoiu[1], Loredana Ghiormez[2], Caius Panoiu[3]

Abstract This research presents an adaptive neuro-fuzzy system which is used in the current prediction through the electric arc from an electric arc furnace. Electric arc furnaces are complex systems that are producing many problems, mainly harmonic currents, reactive energy, flicker effect, etc. Therefore, a prediction as good as possible is useful for the current of the electric arc. In order to do this, an ANFIS system was used which was trained using measured data from an electric arc furnace installation. ANFIS system performances are presented in this paper based on its architecture and training parameters.

Keywords: Anfis, current prediction, Electric Arc Furnace

1 Introduction

In order to produce steel, electric arc furnaces are widely used because these have a high productivity. However, these furnaces have also some disadvantages mainly given by the nonlinearity of the electric arc: reactive power, harmonic currents, unbalanced load, flicker effect, etc. [1], [2], [3], [4], [5], [13], [10], [15], [16], [20]. A prediction of the electric arc behavior is useful in order to prevent these negative effects and also to minimize their impact on the electric power quality.

Using ANFIS a method for the current and voltage prediction of the electric arc is proposed in this research. In order to obtain the predictive currents values, analyzed system uses measured data from an electrical installation of an electric arc

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