Nonlinear and Unbalanced Load as a Basic Factor of a Neutral Conductor Current

Anton A. Belitskiy [1], Irina I. Rastvorova [2], Olga.V. Denisova[3]
Electromechanical faculty; Department of Electronic Systems
Saint-Petersburg Mining University
St. Petersburg, Russia
[1]belitckiy.anton@gmail.com, [2]rastvorova@mail.ru, [3]denisovaov@list.ru

***Abstract*—Neutral conductor current may exceed accepted value by several times in the modernized low voltage three-phase four-wire electrical network. In the article the nonlinear and unbalanced load in the low voltage three-phase four-wire electrical network was carried out.**

Firstly, value of total harmonic distortion for current and voltage, harmonic spectrum, unbalance factor for phase currents were found. It was revealed that nonlinear and unbalanced load is a basic factor of neutral conductor current.

Secondly, dependency graphs of neutral conductor current in terms of THDi and in terms of unbalance factor were received. The low voltage three-phase four-wire electrical network with nonlinear and unbalanced load was modeled in Matlab/Simulink.

Finally, we got the dependency graph unbalance factor in terms of harmonic distortion.

Keywords—harmonics; phase unbalance; the neutral wire; overload; current unbalance factor; total harmonic distortion

I. INTRODUCTION

Currently there are a huge number of electric consumers with different types of load and wide power range like PC, medical equipment, variable speed drive system, etc. Functioning of these devices is directly related to the appearance of such distortions as high harmonics of voltage and current and phase unbalance. High harmonics and phase unbalance can influence on the correct functioning of other electrical equipment [1].

Neutral current is one of the consequences of harmonic and unbalance phase current. A prolonged exceeding of the permissible neutral current can lead to the firing of the zero conductor and ignition in existing power supply system [2-3].

The aim of the work is study how phase harmonic and unbalanced current influence on the value of neutral current.

II. MATH MODEL OF 3-PHASE 4-WIRE POWER SUPPLY SYSTEM

Firstly mathematical model was created for research of phase harmonic current influence on the neutral current. Neutral current was determined by changing the current unbalance factor and total harmonic distortion of neutral current. Range of change: $K_{0I} = 0..1, K_n = 0..5$.

As a result value of neutral current depends on K_n nonlinearly (fig.1). The graph is formed in relative values – basis value of neutral current – neutral current contains only fundamental harmonic.

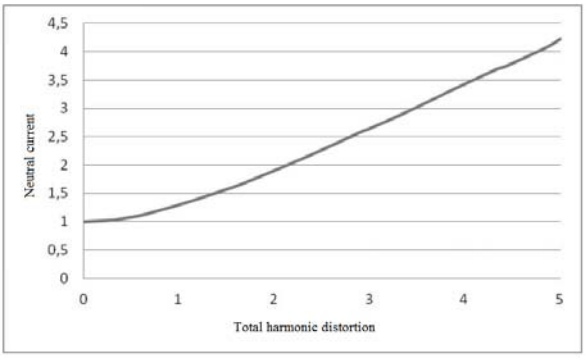

Fig.1 Dependency graph of neutral current from total harmonic distortion of neutral current

However total harmonic distortion of neutral current does not exist in the absence of phase unbalance current. Fig.1 is formed when value of phase unbalance current is changing from 0,077 to 1.

The fig.1 shows that function of relative value of neutral current from total harmonic distortion of neutral current does not exist from value of phase unbalance current.

Besides relative value of neutral current is higher, the higher is total harmonic distortion of neutral current.

Fig.1 can be approximated by power function (1).

$$I_0 = 0{,}0514 \cdot K_n{}^2 + 0{,}5802 \cdot K_n + 0{,}8553 \quad (1)$$

III. SIMULINK MODEL OF 3-PHASE 4-WIRE POWER SUPPLY SYSTEM

Next step of research is determination of the joint effect of current unbalance factor and total harmonic distortion of current on value of neutral current.

Model of 3-phase 4-wire power supply system was created in the MATLAB\SIMULINK for this research (fig.2).

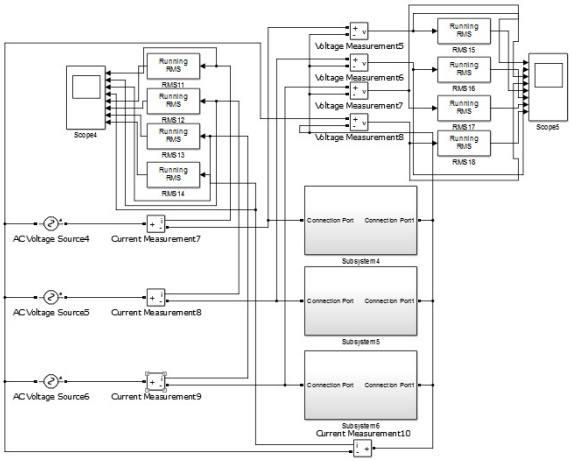

Fig. 2 The diagram of the model for 3-phase 4-wire power supply system

In this model electrical load is unbalance and non-linear load with variable current unbalance factor and total harmonic distortion of phase current. The results of modeling can be generalized on the any load connected to 3-phase 4-wire power supply system.

Function graph of total harmonic distortion of neutral current from phase current unbalance factor is shown on the fig.3.

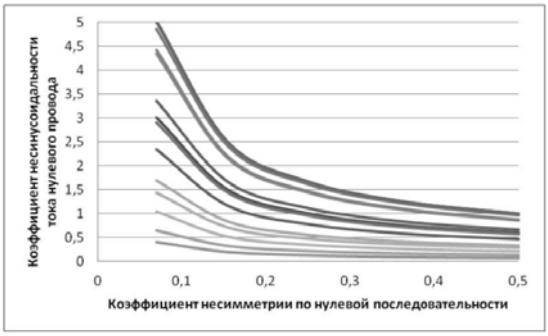

Fig.3 Dependency graph of total harmonic distortion of neutral current from phase current unbalance factor

Fig.3 can be approximated by function (2).

$$K_n = A \cdot \left(K_{0I}\right)^{-0,823} \qquad (2)$$

A – total harmonic distortion of phase current-dependent coefficient.

Revealed that the higher phase current unbalance factor, the lower total harmonic distortion of neutral current.

In this way it is possible to determine the joint influence of phase current unbalance factor and total harmonic distortion of current on value of neutral current for any electrical load.

IV. Conclusions

Using the math model of 3-phase 4-wire power supply system allows to determine the influence of phase current unbalance factor and total harmonic distortion of current on a value of neutral current.

Model of 3-phase 4-wire power supply system in the MATLAB\SIMULINK allows to determine the influence of phase current unbalance factor on total harmonic distortion of neutral current. This makes it possible to determine neutral current in power supply system with load of any power and configuration.

References

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