Wiesław BROCIEK[1], Robert WILANOWICZ[2]

Warsaw University of Technology (1) , Radom University of Technology (2)

Modeling of power system containing filtering-compensating device

Abstract. The paper presents the simulation results of the power system supplied by the middle voltage overhead line with the filtering-compensating device (FCD).The magnitude characteristics of the system impedance presented as the function of frequency will considered. The FCD device will be placed in two points of the system: at the beginning and at the end of the system. The parameters of FCD device will be adjusted to compensate the 5th harmonic. The supplying line was simulated by a two-port of the distributed parameters. The numerical data used in experiments have been acquired from the real (physical) power system. All experiments have been performed using Micro-Cap 8 program. In the paper we have included the exemplary results of the numerical calculations.

Introduction

Different compensating structures are used to reduce the effect of the nonlinear load [1,2]. One of such solution, leading to the reduction of the voltage distortion, is the application of the filters of higher harmonics. The branches of the filter are of capacitive characters for the frequencies below the resonance frequency, hence they may be used to compensate the reactive power for the fundamental harmonic. In practice such filters may be treated as the filtering-compensating devices. The main subject of this work is determination of the frequency characteristics of the absolute value of the impedance supplying system at different variants of installation of the filter of 5th harmonic. These characteristics are important in practice, since they inform us at what frequencies the reduction of the voltage is expected as a result of installation of such filter. High reduction of voltage may cause the increase of THD at the main supply point. This negative effect can be observed in the supply system, when the nonlinear load generating higher harmonics, is attached to the system. This situation is illustrated in Fig.1, when the nonlinear load will be attached at node 2.

System description

Figure 1 presents the general scheme of the power system. The model presented in Fig.1 composed of following elements: supplying point (PCC) of 15kV, 10 km overhead supply line of 15kV and filter of 5th harmonic. The influence of the passive filter on the voltage waveform is analyzed using the equivalent impedance of the terminals at node 2, investigated as a function of frequency. In such way we may investigate the changes of impedance in the whole frequency range. Remember, that connecting even single filter causes the change of the frequency characteristics of the whole circuit.

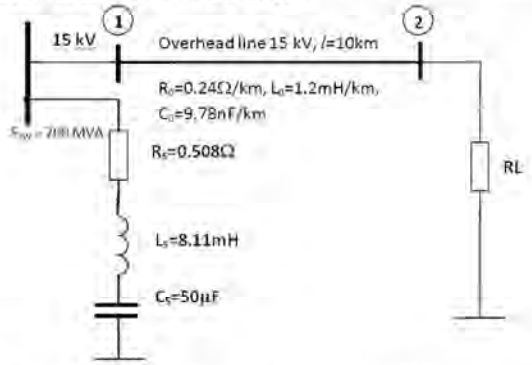

Fig.1. The general structure of the simulated system

Figures 2 – 3 present the change of the absolute value of the impedance $Z_{we} = f(\omega)$ of the power system seen from the node 2 for the following cases: power system without FCD (Fig.2), power system with FCD attached at the end of supply line (Fig.3).

Comparing the analyzed characteristics of the simulated system we may conclude, that the best variant is placement of the filter of k[th] harmonic at the end of supplying line (node 2 of Fig.1).

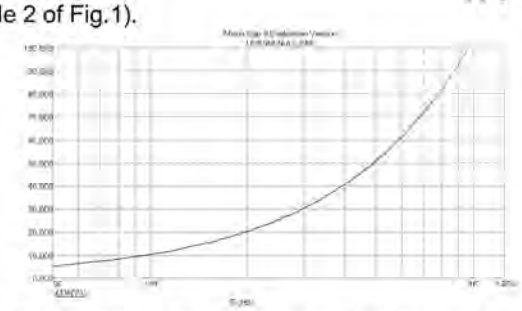

Fig.2. The change of the absolute value of the impedance $Z_{we} = f(\omega)$ of the supply system without FCD

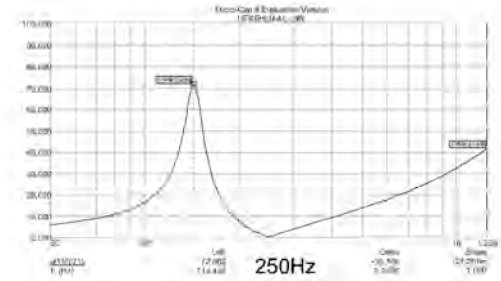

Fig.3. The change of the absolute value of the impedance $Z_{we} = f(\omega)$ of the supply system with FCD attached at end of supply line

Conclusions

The filtering-compensating devices are used to eliminate the appropriate harmonic components of the voltage. In practice we use either single or double filters. Their application improves the value of THD. At the same time it is advised to determine the change of the modules of impedance frequency characteristics before and after adding the FCD. The computer program, presented in the paper, implements this task.

This work was supported by National Science Center of Poland.

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***Authors**: dr inż. Wiesław Brociek, Warsaw University of Technology, IETiSIP, E-mail: brociek@iem.pw.edu.pl, dr inż. Robert Wilanowicz, Radom University of Technology*