Study on the effect of asymmetric load of MV/LV transformers on the voltage unbalance factor in low voltage network

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Abstract **The degree of voltage unbalance in electric power network is subject to limitation, and its value is defined by the regulations. Unbalance of output voltage of power transformers is caused mainly by asymmetric loads. The paper presents analysis of the effect of various types of load asymmetry on the value of the factor. The analysis was carried out with the help of the Mathcad software.**

Keywords **Transformers, voltage unbalance**

1. INTRODUCTION

The law "Power Industry Law" being in force requires, among others, that within a week 95 percent of the file of 10-minute average rms. values of symmetric negative sequence supply voltage must be contained in the interval from 0% to 2% of the positive sequence value. The standards related to synchronous machines require the ratio of negative to positive sequence voltage not to exceed 1 percent in case of the network with synchronous machines connected to.

2. CHARACTERISTICS OF THE PROBLEM

Voltage unbalance in a high voltage network is transferred to the low voltage network. High unbalance in a high voltage network arises when high power one- or two-phase receivers are connected to it. Such situations occur usually in case of feeding of induction furnaces, or less often the arc furnaces. Large asymmetric load occurs in AC current 25kV railway electric traction, where the three-phase electric power network feeds directly the traction network. In such cases even in the 110kV networks, supplying the traction networks, the degree of unbalance is relatively high. In case of the MV/LV transformers the asymmetric loads induce in secondary side the voltage unbalance, the unbalance factor of which usually exceeds the values admitted by the regulations, even if the primary voltage is symmetric. Three-phase motors are very sensitive to supply voltage unbalance, as in case of larger voltage unbalance they must not be charged with rated power, due to the risk of overheating. Rotational speed of these motors is below its rated value too. Therefore, efficiency of the devices driven by such a motor is reduced. The task was carried out with symmetric components method referred to electric machines. Among others, the k_1, k_2, k_3 factors were introduced, that characterize apparent changes in phase impedances of the transformer load. With such an assumption, the voltage unbalance factor of secondary side of the transformer is given by the relationship

$$K_u(k_1,k_2,k_3)=\frac{|U_2(k_1,k_2,k_3)|}{|U_1(k_1,k_2,k_3)|}$$

3. EXAMPLE CALCULATION

Taking into account low admissible volume of the paper, only small its parts are presented. Figure 1 shows example of the effect of the changes of k_1 and k_2 factors on the voltage unbalance factor K_u.

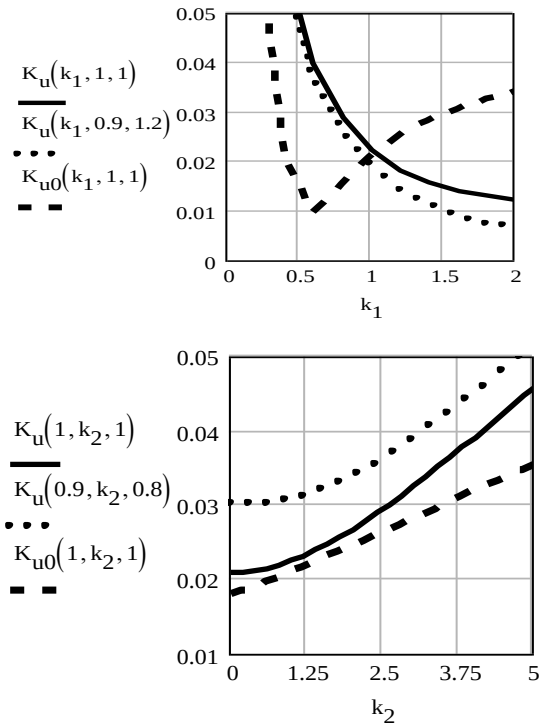

Fig. 1. The effect of k_1 and k_2 factors on the voltage unbalance factor

4. SUMMARY AND CONCLUSIONS

Voltage unbalance remarkably affects operation of the electric power network.

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