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Experimentally evaluated impact of nonlinear loads on the energy transmission losses and distortion of voltage waveforms

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The paper evaluates the impact of nonlinear loads on the losses related with the energy transmission and total harmonic distortion of voltages and currents. The analysis is based on currents and voltages measured during experiments performed under controlled conditions. A controlled voltage source of sinusoidal voltage is applied. It provides sinusoidal voltages with constant RMS values and THDs under 0.1 % in all operating conditions discussed in paper. Since the supply voltage is constant in all tests, the losses related with the energy transmission and the values of current THDs and load voltage THDs change exclusively due to the load properties.

In the cases of single-phase load, the losses related with the energy transmission are almost doubled when the linear load is replaced with the nonlinear load with the same active power. If the power of nonlinear load increases linearly, the losses related with the energy transmission increase faster than with the square. The value of the load voltage THD increases with the increasing power of nonlinear load, while the value of the current THD decreases with the increasing power of nonlinear load.

In the cases of wye connected balanced three-phase loads, the nonlinear load and the linear load with doubled power of nonlinear load cause similar losses related with the energy transmission. The neural conductor current contributes substantial share to the total losses related with the energy transmission in the case of nonlinear load. In the cases, when the load is composed of the linear and nonlinear load, the losses related with the energy transmission increase substantially. The impact of nonlinear load on the values of the load voltage and current THDs is dominant in the cases of combined loads.

The increasing share of nonlinear loads in electricity distribution networks could substantially increase losses related with the energy transmission and total harmonic distortion of currents and voltages. Thus, the appropriate measures, for minimizing the impact of nonlinear loads on distribution networks, are required.