Harmonics and cable sizing with an energy efficiency approach

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Power quality disturbances, usually defined as "deviations of voltage or current from the ideal waveforms", have to be considered in the operation of electrical systems to provide an assessment of their severity. However, also at planning stage power quality disturbances have to be accounted for because of their effects on the electrical system and on the electrical equipment. Among the power quality disturbances, harmonic distortion is considered as one of the major issues and currently considered in the relevant literature [1]-[2].

Today, in residential buildings, in small, medium and large buildings, as well as in industry and infrastructure environment, power electronic devices are the main causes of harmonic distortion of current. Examples of non-linear loads are several; they range from bridge rectifiers, variable speed drives, uninterruptible power supplies, to information technology equipment and domestic equipment. Lately, battery chargers (including the ones used for the electric vehicles) have also entered this category of distorting equipment.

The presence of harmonic distortion of current leads to several problems, including the voltage distortion, the increase of the losses (both in terms of Joule losses and dielectric losses) and also the risk of dangerous resonances.

A standard recently issued [3] provides requirements and suggests recommendation for the design of electrical installations with an energy efficiency approach; the standard refers to low voltage electrical installations. For electrical installations, energy efficiency is defined as a system approach, which objective is to optimize the use of electricity. This includes the minimization of energy losses, as well as the usage of electricity according to the tariff rules; the maintenance of performance all along the installation life cycle is also emphasized.

In this context, the electrical conductor sizing has an important role at the design stage [4]. The sizing has to account for the additional heating of the conductors due to the circulation of current harmonics and to the skin effect and eddy current losses at frequency higher that the fundamental one.

In the contribution, the traditional criteria used for thermal and economic [5-7] sizing of medium and low voltage cables will be revisited to account for the presence of harmonic distortion of voltage and current and taking into account energy efficiency issues. The sizing of the neutral conductor will also be considered. The criteria will be applied to some case study to demonstrate the effectiveness of the approach, to assess the impact of harmonic distortion on the cable sizing and to evaluate the energy efficiency improvement.

References

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