Mitigation of inrush currents of electrolyzers via filter units

The present publication is dedicated to the exploration of a solution for the technical problem of increasing the green hydrogen production in electrolysis systems. The challenge lies in integrating these systems with existing renewable energy sources or connecting them to island grids, both characterized by a relatively low value of short-circuit power. This makes these systems sensitive to transient processes, such as the energization of the rectifier transformer, which results in high inrush currents that can lead to equipment failure and insulation aging.

Traditionally, electrolysis systems have not been equipped with devices to mitigate these high inrush currents during the energization of transformers. Proposed solutions have included controlled energization or the installation of special premagnetization transformers. However, these solutions require expensive additional equipment for every electrolyzer unit, which is economically unfeasible given the trend of increasing the number of electrolyzers in a plant.

The present invention disclosure aims to mitigate inrush current in island networks for groups of electrolyzers connected to the same busbar or switchgear. The novel approach involves filtering out harmonic currents that appear during energization. It's proposed to design a small filter tuned for harmonic orders that appear only during transformer energization. This filter would not need a high rating in MVar and, therefore, wouldn't be costly. As one busbar or switchgear can feed up to six electrolyzers connected in parallel, a single filter could solve the problem of high inrush currents for six electrolyzer units at the same time.

The figures below (Figure 1, 2 and 3) aim to figurate a full inrush current and the following results of their Fourier transformation (FFT) at two distinctive points: the peak (when the inrush current reaches its maximum value) and the lowest point (when the energization of the transformer is finished).

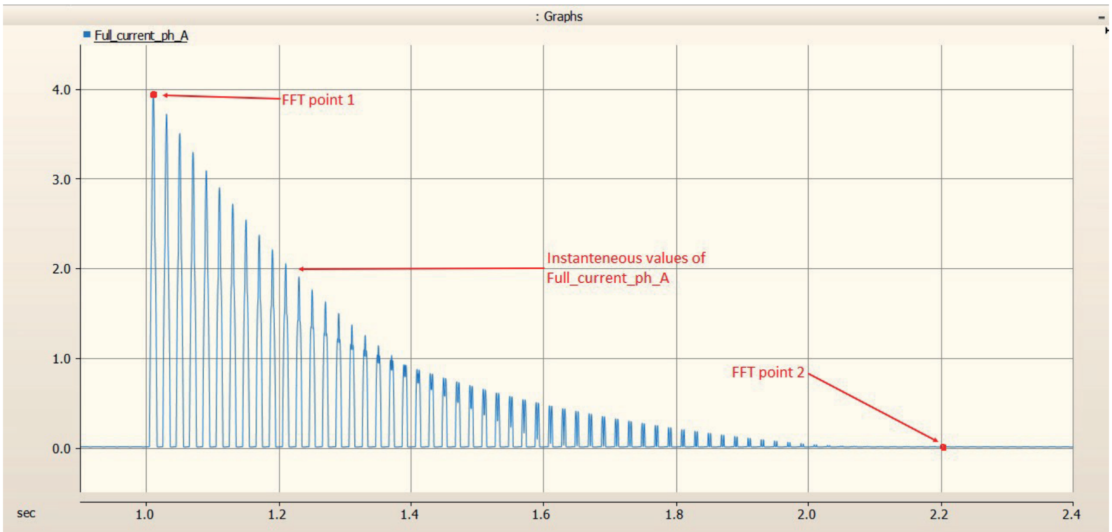

Figure 1. Inrush current during energization of transformer.

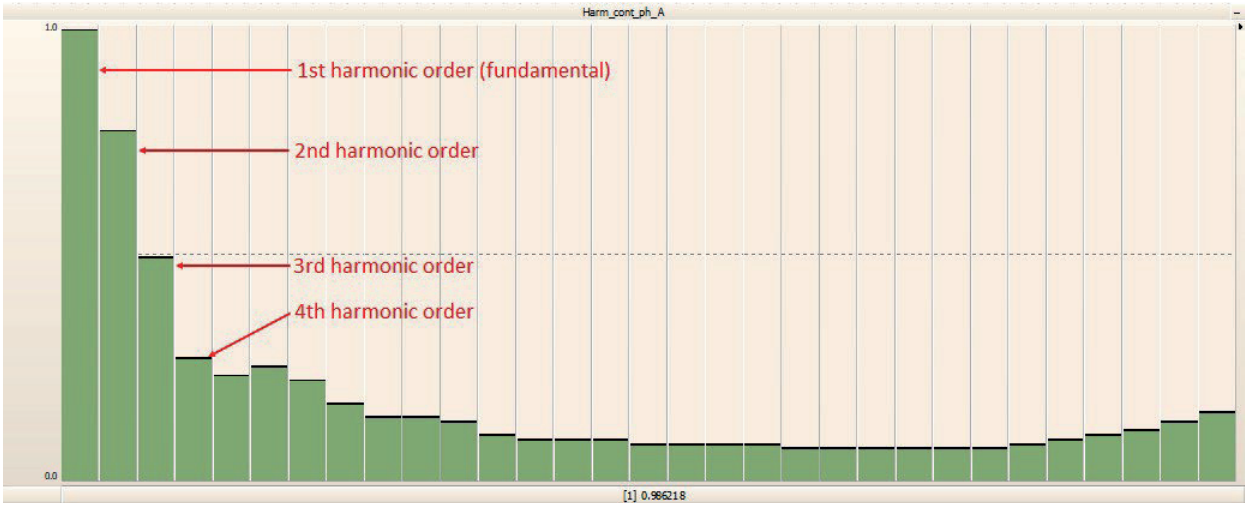

Figure 2. Harmonic content at FFT point 1.

Figure 3. Harmonic content at FFT point 2.

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The proposed solution does not intend to replace large harmonic filters installed on medium voltage or high voltage levels. These filters are designed to compensate for harmonics in the whole system during continuous operation. The proposed filter is intended to catch only specific harmonics that appear during the energization of transformers.

The invention provides several advantages over existing solutions. Firstly, it allows the mitigation of inrush currents without needing expensive controlled switching devices or solutions to increase grid strength. Secondly, it applies to all units connected to the same busbar, improving the power factor in the network, and reducing the size and cost of reactive power compensation units.

However, one limitation is that the filter design requires specific harmonic studies to ensure that the filters do not cause unexpected series or parallel resonances. But as the design and integration studies for island networks require harmonic studies, the proposed approach would only extend the scope of the study.

To conclude, the proposed solution presents a viable and cost-effective method to mitigate the high inrush currents that occur during the energization of transformers in electrolysis systems. This innovation will not only improve the efficiency and effectiveness of these systems but also contribute to the acceleration of green hydrogen production, a critical component for a sustainable future.