

Efficiency determination of non-linear loads

Master thesis project

Summary:

This thesis project aims to improve our understanding of non-linear grid loads and how to determine their efficiency. Non-linear loads in the electricity grid can be modern power electronics such as laptops or EV chargers. Power transformers can also become a non-linear grid load when the voltage increases above the nominal grid voltage.

Problem definition:

Efficiency determination of non-linear loads is not trivial, since these loads generate a wide spectrum of harmonic currents. As an example, present testing of the core losses of power transformers (see picture) gives different answers for the efficiency when only the 50 Hz losses are measured or when wider frequencies are taken into account. A particular effect seen in first experiments is the *generation* of harmonic power by the passive power transformer when the core is becoming non-linear. This thesis will further experimentally study this phenomenon, and will develop equivalent circuit models to explain the findings.



Testing of a transformer at Royal Smit Transformers

Method:

After a literature study to understand the present state of the art, to plan is to

- Perform laboratory tests of the core losses of a small lab transformer for different input voltage levels
- Evaluate the test results in terms of fundamental and harmonic losses
- Develop an equivalent circuit model that explains the experimental findings, in particular the possible generation of harmonic power of non-linear loads.

If the lab results are good, tests can also be performed at Royal Smit Transformers on an actual 100+ MW power transformer to confirm and extend the laboratory findings.



Research objectives:

Perform experiments and modelling that result in improved understanding of non-linear loads and the determination of their efficiency.

If good results are obtained, this work should lead to a peer-reviewed journal paper in IEEE

Courses and supervision:

No specific courses are needed as a background. Affinity with and interest in practical laboratory experiments is very beneficial for doing this assignment.

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