Prediction of Transformer Core Noise

R. Haettel[1], A. Daneryd[1], M. Kavasoglu[1], C. Ploetner[2]

[1]ABB Corporate Research, Västerås, Sweden
[2]ABB Transformers, Varennes, QC, Canada

Abstract

Today, low noise is a mandatory feature for power transformers in order to comply with customer specifications and environmental regulations. Therefore, it is crucial to develop sound prediction tools with an accuracy sufficient to avoid overkill margins in design and costly modifications after transformer completion.

Three main sources of sound can be identified in transformers: no-load noise or core noise generated by magnetostriction in the core steel laminations, load noise produced by electromagnetic forces in the windings and noise due to auxiliary equipment such as fans and pumps used in the cooling system.

The paper will focus on core noise which is a typical multiphysics phenomenon involving electromagnetism, mechanics and acoustics. When applying an alternating voltage to the transformer winding, a magnetic flux is generated in the core laminations made of grain oriented electrical steel. This material has a non-linear anisotropic property called magnetostriction implying alternating changes of core dimensions due to the magnetic flux. Those magnetostrictive forces cause core vibrations which can be transmitted to the tank via the core clamping points and to the insulation oil. The acoustic energy is eventually radiated by the tank walls as noise.

The finite element model coupling the different physical fields has been developed by using COMSOL Multiphysics®. Some simplifications have been introduced to reduce problem size and computing time in order to perform parametric studies.