Load Noise Calculation of a Three-Phase Power Transformer

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INTRODUCTION: Vibrations and noise of high power transformers have attracted considerable experimental and theoretical interests over last few years [1, 2]. For such transformers operating under high voltage (~ 100 kV) and power (~ 100 MVA), noise generated is significantly attributed to load noise caused by winding vibrations [1]. In this study, we present a two-step finite element calculation which enables direct comparison with measurements from full-load tests.

COMPUTATIONAL METHODS: **(Step 1)** A 2D axis-symmetric electro-mechanical study is first carried out to calculate vibrational displacements in winding due to Lorentz forces in a single pair of primary and secondary windings (Figures 1 and 2). Calculation also considers back emf induced in the windings due to their vibrations.

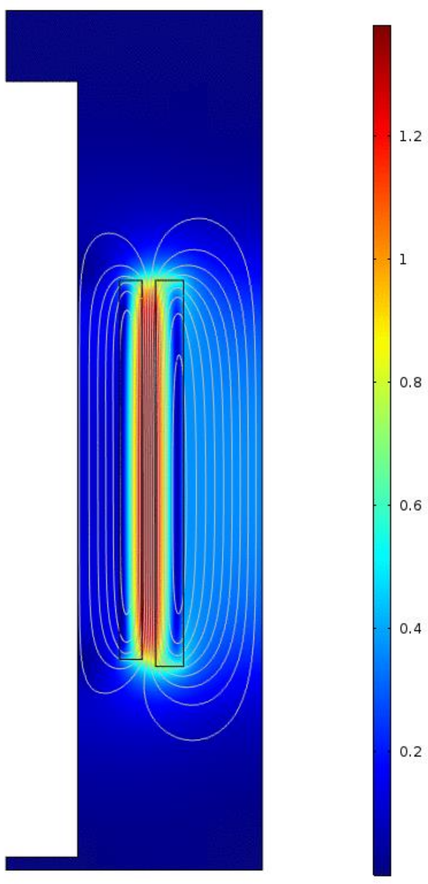

Figure 1. Calculated Magnetic flux density (in Tesla) distribution around a single winding pair

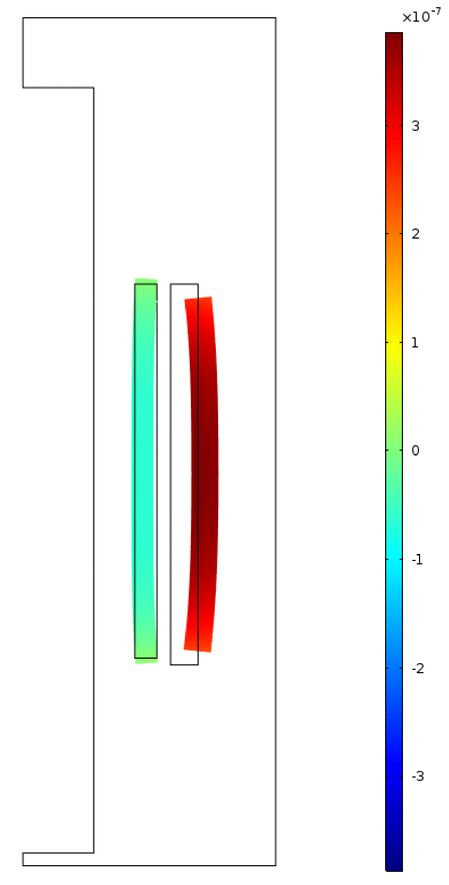

Figure 2. Calculated vibrational displacements (in meters) in a single winding pair

(Step 2) A 3D acoustic-structure simulation involving full geometry of the transformer and its surrounding then follows. Calculated displacements from the 2D simulation are mapped onto the three pairs of windings of the transformers as phase-added sound sources.

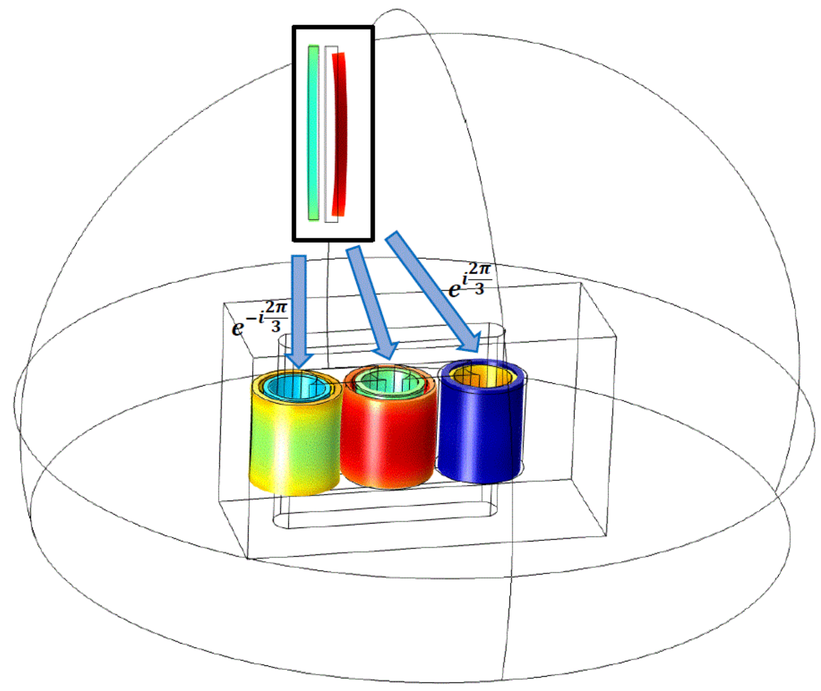

Figure 3. Mapping of phase-added displacements onto three pairs of windings as sound sources

RESULTS: The pressure and sound pressure level distributions in and around the transformer are calculated.

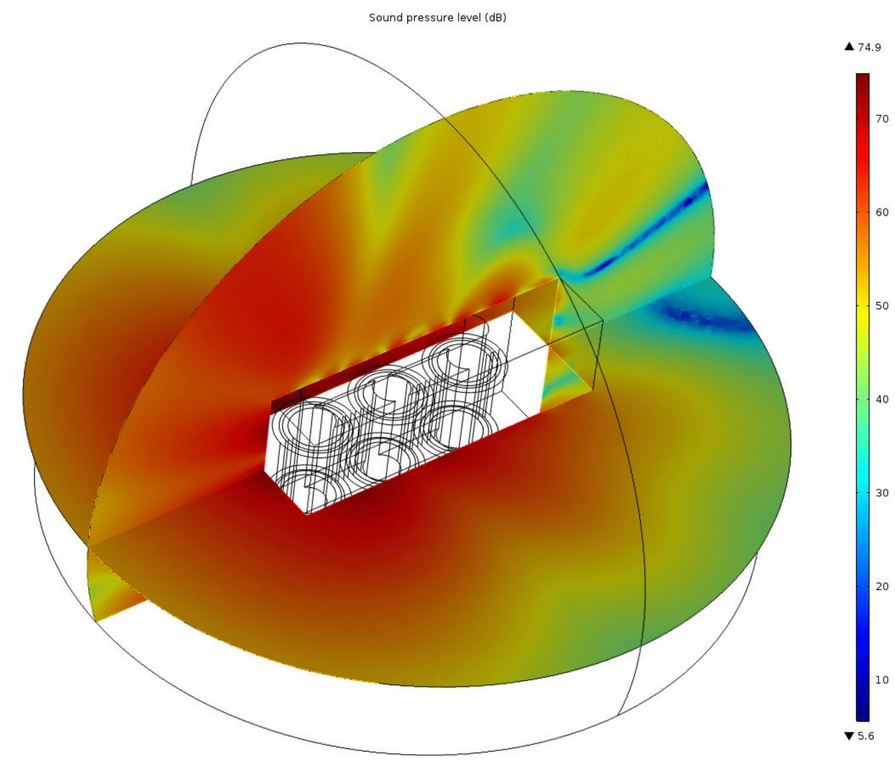

Figure 4. Sound pressure level distributions outside the transformer enclosure

Extracted sound pressure level values at different points around transformer enclosure accord reasonably well with full-load test measurements, with an error of around 4%.

CONCLUSION: A two-step Multiphysics simulation is carried out to estimate load noise of a power transformer. Results agree well with full-load test measurements.

REFERENCES:

1. E. Dogan, and B. Kekezoglu, International Journal of Energy and Power Engineering, Vol 10, No:1, (2016)
2. C. H. Hsu,Y. M. Huang, M. F. Hsieh, C. M. Fu, S. Adireddy, and D. Chrisey, AIP Advances 7, 056681, (2017)