Measurement based inductor modeling for the purpose of ferroresonance analyses

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Abstract **The paper presents the results of modeling and measuring verification of the nonlinear inductor model. A nonlinear inductor physical model based on a simplified theory was proposed and used in the computations. In the assumption it has to be easy to adapt in a far more complex static and dynamic circuit simulations and suitable for further development. A ferroresonance circuit was chosen as the exemplary measuring base. The waveforms obtained from measurements were used to calculate the parameters of the proposed model. The corresponding circuit has been developed in Matlab environment. Time functions resulting from the simulation have been verified with those obtained experimentally in the laboratory.**

Keywords **ferroresonance, inductor modeling, measurements, Matlab.**

I. Introduction

A resonance involving a capacitance in series with a saturable coil remains an interest to scientists due to the generation of higher time harmonics and unpredictable phenomena such as ferroresonance [1].

Due to the ferroresonance phenomena occuring in power system circuits, it is necessary to perform reliable computations and analyses to predict and avoid undesired and dangerous effects of the mentioned threats [2].

The proposed approach for the nonlinear coil modeling is focused on gaining the simplest and fastest way of mapping the real object for further and far more complex adaptation. It is important that the developed model was universal and provides access to all features and characteristics describing a nonlinear coil for any available measurement data.

II. Exemplary calculations

A ferroresonance circuit was chosen as the exemplary measuring base. The assumed and considered circuit model containing models of the linear resistance, linear capacitance and nonlinear inductor is shown in Fig. 1.

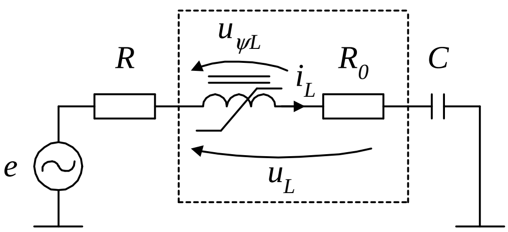

Fig. 1. Considered circuit model

The proposed nonlinear inductor model is described by the equations (1).

$$\frac{\mathrm{d}\Psi_L(i_L)}{\mathrm{d}t} + R_0 i_L = u_L,\ \Psi_L(i_L) = \Psi_0 \cdot \mathrm{atan}(\frac{1}{i_0} i_L) \quad (1)$$

The parameters of the model were chosen experimentally and have been confirmed and verified by measurements. Exemplary waveforms of the inductor voltage and current, both from simulations and measurements, are shown in Fig. 2 and 3.

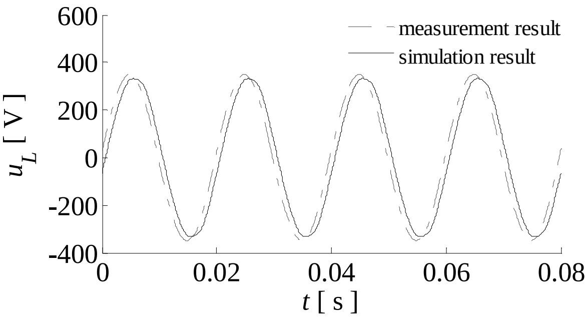

Fig. 2. Comparison of measured and simulated waveforms of the coil voltage

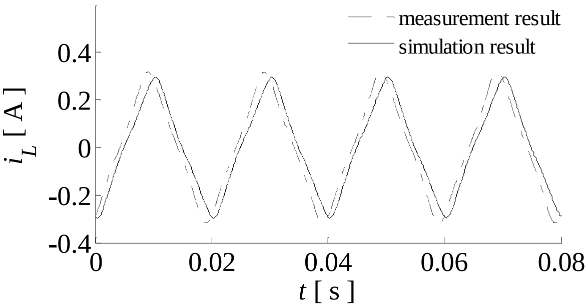

Fig. 3. Comparison of the measured and simulated waveforms of the circuit current

III. Conclusion

A satisfactory agreement between the measurements and simulations of the analyzed circuit has been achieved in the presented initial studies. The assumed model on nonlinear inductor and chosen methodology opens the opportunities for further development.

IV. References

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