Prediction of magnetizing current waveform in single phase power transformer under DC bias

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Abstract

Geomagnetically induced direct currents in the windings of power transformers result in the saturation of the core during the half cycle in which they have the same direction as the magnetizing current, triggering undesirable effects like additional eddy current losses due to the higher leakage flux.

These effects can be predicted numerically once the time function of the magnetizing current is known. The aim of this paper is to present a method based on the finite element analysis of the transformer capable of predicting the waveform of the magnetizing current if the voltage of the winding as well as the magnitude of the DC bias are given.

Using a finite element model of the transformer, the relationship between the flux linkage of the winding and the value of the magnetizing current is determined assuming static conditions. The voltage of the winding being sinusoidal, the time function of the flux is the sum of a given sinusoidal function and an unknown bias. With the aid of the flux-current curve, the dependence of the waveform and hence of the DC component of the magnetizing current upon the bias flux can be established. Using this relationship, the flux bias yielding the given DC component can be obtained by suitable iterative techniques, hence arriving at the waveform of the magnetizing current having the prescribed DC value.

Measurement of the current waveform at various voltages and DC bias has been carried out on a single phase transformer. The computed waveforms agree well with the measured ones.