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Determination losses and estimate life of distribution transformers with three computational, measurement and simulation methods, despite harmonic loads

M.H. Amrollahi [1], S. Hassani[2]

[1] Electrical Engineering Department
Urmia University of Technology ,Urmia, Iran, Amrollahi_mh @yahoo.com

[2] West Azerbayjan Power Distribution Company, Urmia, Iran, sh592b@yahoo.com

Abstract. Transformers are the basic and valuable equipment of electricity network. Transformers correct function has important role in reliability of network .distribution transformers are designed for work at nominal frequency and full sinus current. Application of nonlinear loads in recent decades, such as power electronic loads, caused higher levels of harmonic. This kind of load can lead to creating heat, losses and therefore cause wear of insulation and aging of transformers. To prevent these problems, nominal capacity of transformers that will feed the nonlinear load, should be reduced.
In this paper the parameters affecting the loss of a single phase 15 KVA transformers with harmonic loading measurement and will be calculated with standards then The transformers with harmonic loads are simulated in MATLAB software for calculating losses Finally, the obtained results are compared. The reduction of nominal power (Derating) and transformer life and flow rate limits and losses are calculated.

Key words
losses, harmonic loads, measuring transformer losses, transformer harmonic model

Introduction

Increasing nonlinear loads, harmonic distortion, and the issue of power quality problems in recent years has been an important debate. Nonlinear loads and equipment in the network that having nonlinear characteristic is the main cause of distortion in sinusoidal voltage and current waveform and changing of waveform can cause harmonic. With increasing nonlinear loads measurement, exact analysis of harmonics seems essential to prevent energy losses, injuries, and its destructive effects on the network equipment. In recent decades by increasing nonlinear loads, harmonic levels in distribution networks has greatly increased, and increases in harmonic load current cause additional losses and increases in winding hot spot temperature and stress on insulation , and finally reducing the useful life of insulation and transformer capacity .The aim of this paper to determine losses and estimate life of distribution transformers under harmonic loads with three computational, simulation and measuring methods . First loss and capacity useful life of transformer under harmonic loads are determined and then the distribution transformers losses have been compared with three, Computational, measurement and simulation methods in software environments

1. Transformer losses in harmonic loads

Transformer losses under linear and harmonic loads are divided two categories no load and loading loss.

$$P_T = P_{NL} + P_{LL}$$

Where P_{LL} loading losses that is divided ohmic losses and eddy loss, P_{NL} no load is due to voltage induced in the core and P_T is total loss of the transformer.

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Loading losses: loading loss can be stated as follows:

$$P_{LL} = P_{dc} + P_{EC} + P_{OSL}$$

P_{dc} Is an ohmic loss due to coil resistance and P_{EC} eddy current losses and P_{OSL} is other eddy loss. The total losses P_{OSL} and P_{EC} refers to the total dispersion, it is calculated from ohmic losses minus of loading loss that obtained from short circuit test.ohmic losses, wending eddy loss and other losses is proportional to the current therefore in this paper effect of harmonic current is calculated.ohmic loss is proportional to square of the current therefore if the effective current increase because of harmonics the ohmic losses are increased.

$$P_{\Omega} = R_{dc} \times I_L^2 = R_{dc} \times \left(\sum_{h=1}^{h_{max}} I_{h,rms}^2 \right)$$

Eddy losses of coil with nonlinear load is changed with square of current and frequency

$$P_{ec} = P_{ec-R} \sum_{h=1}^{h=max} h^2 \left(\frac{I_h}{I_R}\right)^2$$

Considering the above equation loss factor can be based on effective value of current