Design of Delta Primary - Transposed zigzag Secondary (DTz) Transformer to Minimize Harmonic Currents on the Three-phase Electric Power Distribution System

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Abstract: The delta primary - transposed zigzag secondary (DTz) transformer has been designed and used to reduce the bad impacts of the harmonic in the distribution power system. The DTz transformer is constructed with delta connection in primary winding and the three transposed windings at the different core legs of secondary winding. The harmonic reduction method of the DTz transformer applies two basic principles. The first principle is to inhibit electromagnetic energy of the harmonic currents by cancelling the phase polarity on the secondary winding. The second is to insulate the remaining of the mmf induction from harmonic current loads and minimize to circulate in the delta windings on the primary side.

The triplen harmonics currents generated on the primary and secondary winding of DTz transformer are simulated in this paper. Both balanced and unbalanced loads of the three-phase distribution system are examined. The experiment shows that the total THD current in the secondary winding when balanced loads are applied is about 70.8 %, and in the primary side is 24.3 %. While for unbalanced loads, the average THD in secondary winding is 68.44 % and in delta winding is 26.4 %. It means the DTz transformer has a filter-ability to reduce about 42 - 46 % THD for both balanced and unbalanced loads.

By comparing the computer simulation results and data measurements through experiment in the laboratory, it is proved that the use of the proposed DTz transformer is one of the methods to reduce harmonic currents and inhibit them to enter to the supply system.

Keywords: triplen harmonic currents, balanced and unbalanced loads, delta primary - transposed zigzag secondary winding (DTz) transformer, non-linear loads

1. Introduction

As a consequence of the increasingly widespread use of electronic devices and equipments or other nonlinear loads that are generating harmonics, current waveform and source voltage becomes a non-sinusoidal waveform due to the distortion. Harmonic problems on the power distribution system are getting worst now since more than 50% of the generated power capacity mostly serves the single-phase nonlinear loads [1]. Harmonic is a common phenomenon on the distribution system. An excessive harmonic distortion causes to the electric quality problem. One of them is that the power transformer has no longer effective and efficient anymore to prevent the flow of zero sequence currents into the supply side. As the result, the triplen harmonic currents from the consumer side freely enter to supply side without any reduction by transformer [2].

Transformer is a main tool in electric power systems [3]. The recent transformer has now being developed and expected to be able to resolve the harmonic problem of the electric quality at the electric power supply. Steinmetz (1916) was the first researcher who proposed the transformer with a delta winding configuration in order to block the third harmonic currents due to saturation of transformers iron core and electric machineries [4]. Furthermore, it's known that the primary delta winding is able to force the triplen harmonic currents from non-

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