Design and Application of Zig-Zag Transformer for Mitigation of Harmonics

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Abstract -Generally, in 3 phases, 4 wire distribution systems is produce harmonics due to non-linear load. Consequently, zig-zag transformer is used to reducing the harmonics in neutral current. The design of zig-zag transformer consist 50Hz, 1000VA, 415V Zig-zag transformer installed between the distribution panel and non-linear load. At last analysis of the harmonics in star winding and mitigate the harmonics using zig-zag transformer. So that zig-zag transformer is feeding the non-linear load like, medical, academic, communication equipment and where stable operation is necessary.

***Key Words*: Zig-Zag Transformer, triplen harmonics, THD

I. INTRODUCTION

Three-Phase four-wire distribution power system has been widely used for supplying computer related equipment, automatic office machines, adjustable speed drives, lighting ballasts and other power electronic related equipment. Most of these loads produce high current harmonics due to its nonlinear input characteristic. Various methods is used to mitigate the harmonics but most of these solution have its limitation. The harmonic current will affect the power system and result in the problems such as overheating, vibration in rotating machine, degrading voltage quality, fault in electric power components, malfunction in medical facilities, etc. The current harmonics on the utility site has been attenuated by using Zigzag transformer. So we were design the zig-zag transformer to mitigate harmonic in neutral current.

II. LITERATURE REVIEW

[1]Some year ago, 3 phase 3 wire system is converted in to 3 phase 4 wire system using zig zag transformer to obtained neutral in the system.

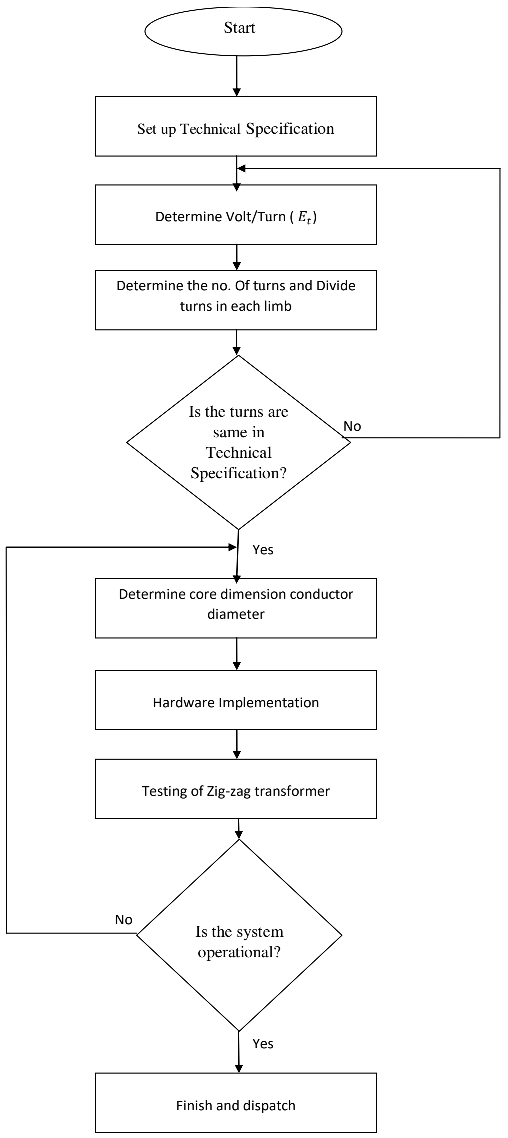
[2] Due to limitation of 3 phase single way rectifier, zig zag transformers used for avoiding DC magnetization and iron loss.

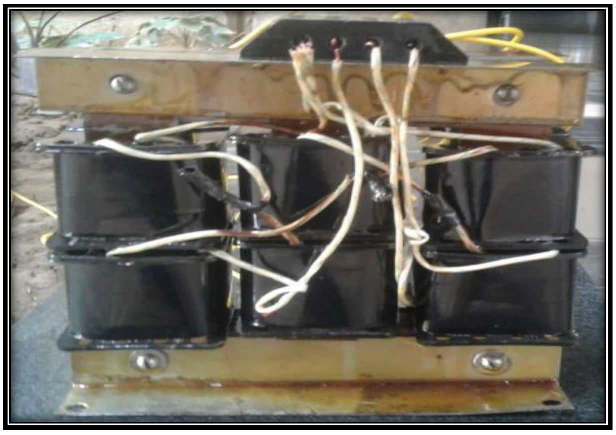
[3-4] The zero sequence harmonics current and neutral current has been generated by non -linear load like SMPS, UPS…. which is reduced by zig –zag transformer.

The contribution of this paper is used to understand design and performance of zig zag transformer and also study harmonics analysis are made practically without /with connecting Zig zag transformer and its application.

III. DESIGN

This flow chart represent, how we were design zig-zag Transformer.





Zig –Zag Transformer

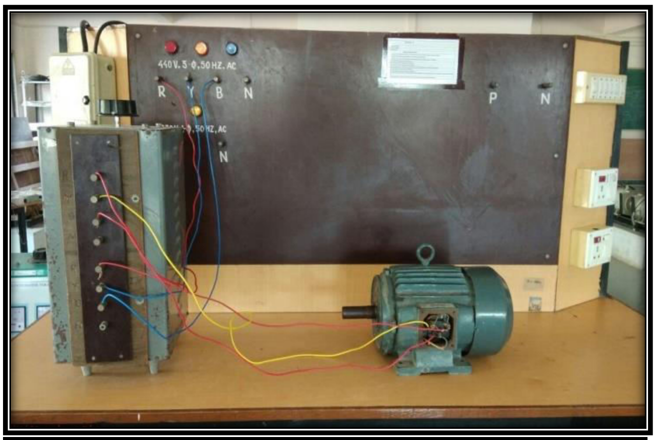
As per defined the parameter 1000VA, 415V, 50Hz. The calculation of core size, Copper conductor is used for winding, Dimension of the core, Winding current and Number of layer of winding. All parameters which are shown in table1.

Table 1
DESIGN PARAMETERS

Parameter	**Value**
Output	1000 VA
Voltage	230/440 V
Frequency	50 Hz
Efficiency	90%
Maximum flux	1.17 mwb
Ac	0.975 $*10^3$ mm^2
Agc	1.083$*10^3$ mm^2
N	889
SWG for winding	20

IV. RESULT AND DISCUSSION

Fig.1 represents the harmonics analysis with/without connecting zig-zag transformer in system. In which harmonics current are present in the system due to the nonlinear load then we installed zig zag transformer between distribution panel and nonlinear load. In which harmonics are reduce due to presence of zig-zag transformer in the system



Harmonic Analysis without connecting zig-zag transformer

Fig.1 Harmonic Analysis with connecting zig-zag transformer

Table -2: represent the each Phase current and THD% in the system with/without connecting zig-zag transformerAccording to the testing result we could analyze harmonic in the system without and with connecting zigzag transformer in system. In R, Y, B Phase harmonics THD were reduced from 8.3%to 4.3%, 7.5% to 5.1%, and 7.5% to 4.8% respectively.

Table 2
EXPERIMENTAL RESULTS

	WithoutZig-Zag Transformer		**WithZig-ZagTransformer**	
Phase	**Current (Amp)**	**THD (%)**	**Current (Amp)**	**THD (%)**
R	1.7 A	8.3%	1.6 A	4.3%
Y	1.3 A	7.5%	1.6 A	5.1%
B	1.5 A	7.5%	1.8 A	4.8%

Testing result without/with connecting zig-zag transformer

Phase	**Without Zig-Zag Transformer**	**With Zig-ZagTransformer**	**%Reduction**
R	8.3 %	4.3%	48%
Y	7.5%	5.1%	32%
B	7.5 %	4.8%	36%

Comparision of Total Harmonics Reduction

Table 3
PERFORMANCE ANALYSIS

Harmonic order	**% THD in Each Phase**		
	R	**Y**	**B**
1st	8.3	7.5	7.5
3rd	8.0	7.5	7.5
5th	7.8	7.3	7.5
7th	7.8	7.4	7.7
9th	8.0	7.4	7.6

Reading of Harmonics order without connecting zig-zag transformer

Harmonic order	% THD in Each phase		
	R	Y	B
1st	4.3	5.1	4.8
3rd	4.0	5.1	4.8
5th	3.8	4.9	4.8
7th	4.5	5.0	5.0
9th	4.4	5.0	5.1

Reading of Harmonics order with connecting zig-zag transformer

Table -3: represent the effect of with and without zig zag transformer had on the electrical system. The result obtained show thatzig zag transformer take triplen harmonics and supplied it to the line thereby decreasing the harmonics in each phase.

V. APPLICATION

It is special purpose transformer so that we use……..

As a grounding transformer.

As an earthing transformer

Convert 3 phase 3 wire system in to 3 phase 4 wire system

Harmonic voltage suppression.

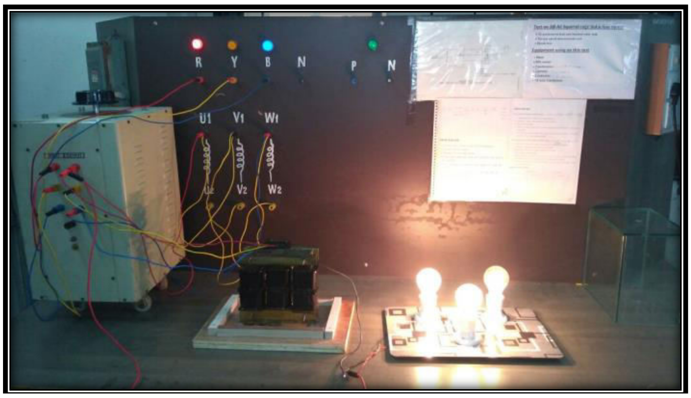


Fig -2: Application

VI. CONCLUSIONS

Mitigation of harmonic in distribution system using zig-zag transformers is more effective for reducing harmonics in the neutral conductors of a three phase Measurements of current draw before and after the installation of a zig-zag transformer is presented. Testing results show that THD (%) reduction in R,Y,B is 48%,32% and 36% respectively. So that zigzag transformer could be viable choice to mitigate harmonics in healthy electrical distribution system. Installing zigzag transformers at the Distribution Panel will improve overall system performance and reduce risk associated with harmonics.

The proposed approach is much simpler and reliable compared to approaches using other mitigation techniques like L.C tuned filter, K-rated transformer and Delta connected primary winding transformer.

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