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SIMULATION OF THREE PHASE TRANSFORMER WITH DIFFERENT SUPPLIES

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Abstract

Transformer is a static electrical device which consists of two or more stationary circuit interlinked by a common magnetic circuit for the purpose of transferring electrical energy between them. It can raise or lower the voltage with a corresponding decrease or increase in current. Continuous supply can be defined as the supply where the current and the inductive energy storage never reaches zero. The various types of continuous supply are like:-Saw tooth, square, sinusoidal, triangular wave etc. Discontinuous supply can be defined as the supply when the current and inductive energy storage may reach or cross zero. The various types of discontinuous supply are like: impulse, discrete etc. Here the three phase transformer with the different types of supplies was analyzed by which we will be able to use the same transformer for various purposes. By this, various parameters like Efficiency and Voltage Regulation with different inputs for the same transformer can be simulated. MATLAB/Simulink is used for simulation.

Index Terms: *Transformer, continuous supply, discontinuous Supply.*

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1. INTRODUCTION

The history of transformer goes back to the early 1880s. With the sharp increase in demand for electric power, power transformer in 400KV rating were produce d as early as 1950s. In the early 1970s unit ratings as large as 1100MVA were produced and 800KV and even higher KV class transformer were manufactured in the early 1980s.

The transformer is a electromagnetic energy conversion device that transfers energy from one electrical circuit to another electrical circuit through the medium of magnetic field and without a change in the frequency. The electric circuit which receives energy from the supply mains is called primary winding and the other circuit which delivers electric energy to the load is called the secondary winding. In a transformer, the electric energy transfer from one circuit to another circuit takes place without the use of moving parts- it has, therefore, the possible efficiency out of all the electrical machines and requires almost negligible amount of maintenance and supervision [1][2].

2. MODELING OF TRANSFORMER

2.1 IDEAL TRANSFORMER

The ideal transformer shows the transformation of voltage and current between primary and secondary winding. The transformer magnetization curve is assumed to be linear [3][4].

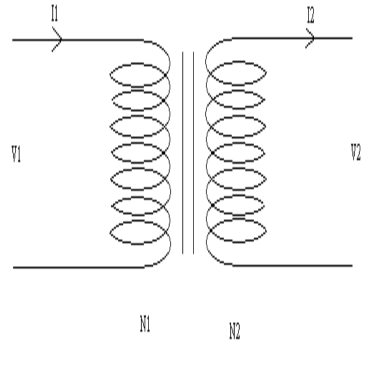

Fig-1: Ideal transformer circuit diagram

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2.2 EQUIVALENT CIRCUIT OF A TRANSFORMER

The equivalent circuit is simply a circuit representation of the equation describing the performance of the device. If any electrical device is to be analyzed and investigated further for suitable modification, its appropriate equivalent circuit is necessary[5].

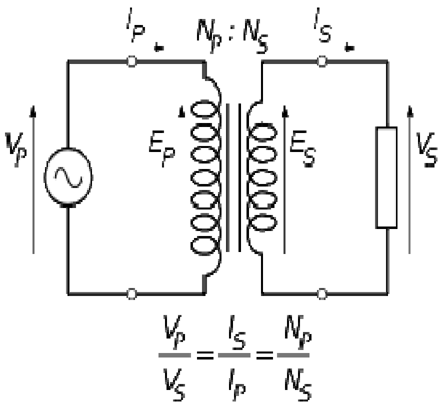

Fig 2 Equivalent circuit of a transformer

$R_c = V_1/I_c$………………………… (1)

X_m=magnetizing reactance

$X_m = V_1/I_m$…………..…...………. (2)

P_c=core loss

$P_c = (I_c)*2*R_c = [(V_1)*2]/R_c$ ….………………..(3)

3. PERFORMANCE OF TRANSFORMER

3.1 INTRODUCTION

The performance analysis of three phase transformer is the determination of voltage regulation and efficiency of transformer. To find this parameter we have to perform open circuit test and short circuit test. The performance of a transformer can be calculated on the basis of its equivalent circuit which contains four main parameters, the equivalent resistance, the equivalent leakage reactance, the core loss conductance and the magnetizing susceptance. These parameters can be determined by short-circuit test and open circuit test.

3.2 THREE PHASE TRANSFORMER:

Three-phase system is used to generate and transmit large amount of power. Three-phase transformers are required to step up or step down voltages in various stages of a power system network [6].

Transformers for 3-phase circuits can be constructed in one of the following ways:-

1. Three separate single- phase transformers are suitable connected for 3- phase operation. Such an arrangement is called a 3- phase bank of transformers.
2. A single 3- phase transformers in which the cores and windings for all the three phases are combined in a single structure.

3.3 THREE PHASE TRANSFORMER CONNECTIONS

A three- phase transformer consists of three transformers, either separate or combined on one core. The primaries and secondary's of any three- phase transformer can be independently connected in either a star (Y) or delta (), thus, there are four possible connections for a 3- phase transformer bank:

1. Delta primary- Delta secondary
2. Star primary- Star secondary
3. Delta primary- Star secondary
4. Star primary- delta secondary

3.4 TESTS ON A TRANSFORMER

The various parameters of a transformer can be easily determined by two tests

a) Open-circuit test
b) Short circuit test

These tests are very economical and convenient, because they finish the required information without actually loading the transformer.

The tests on a transformer help to determine

c) The parameters of the equivalent circuit
d) Voltage regulation
e) Efficiency

The equivalent circuit parameters can also be obtained from the physical dimensions of the transformer core and its equivalent winding details.

4. MODELING OF SOURCES

Continuous supply can be defined as the supply where the current and the inductive energy storage never reaches zero. The various types of continuous supply are like:-Saw tooth, square, sinusoidal, triangular wave etc. [7][8][9][10][11].

DIFFERENT SOURCES WITH MATHEMATICAL EQUATIONS

4.1.1 SAW TOOTH WAVEFORM

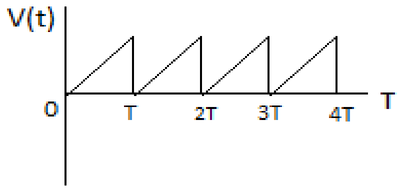

Fig-3: Saw tooth wav form

$$f(x) = \frac{K_1}{2} + \sum_{n=1}^{\infty} \left(-\frac{K_1}{n\pi} \sin \frac{n\pi x}{L}\right)$$

4.1.2 TRIANGULAR WAVEFORM

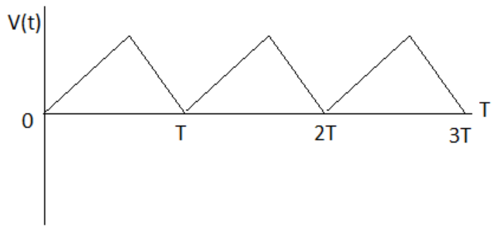

Fig-4: Triangular waveform

$$f(x) = \frac{V}{2} + \sum_{n=1}^{\infty} \left(\frac{4V}{\pi^2 n^2} \cos \frac{n\pi x}{L}\right)$$

The above equation is valid for only n=1, 3, 5, 7…….. And at n= 2, 4, 6, 8……..a_n=0.

4.1.3 SQUARE WAVEFORM

A square wave is a kind of non-sinusoidal waveform, most typically encountered in electronics and signal processing. An ideal square wave alternates regularly and instantaneously between two levels.

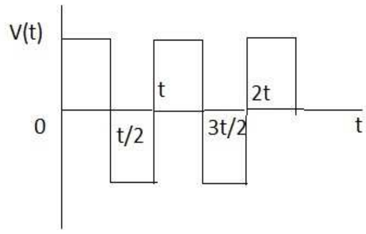

Fig-5: Square waveform

$$f(x) = \sum_{n=1}^{\infty} \left(\frac{4V}{\pi n} \sin \frac{n\pi x}{L}\right)$$

The above equation is valid for only n=1, 3, 5……. and at n=2, 4, 6…… an=0.

4.1.4 SINUSOIDAL WAVEFORM

The sine wave or sinusoid wave is a mathematical function that describes a smooth repetitive oscillation. It occurs often in pure mathematics, well as physics, signal processing, electrical engineering and many other fields.

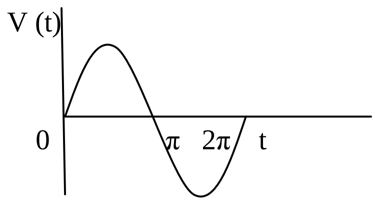

Fig-6: Sinusoidal waveform

$$f(x) = \frac{I_m}{\pi} + \sum_{n=1}^{\infty} \left(\frac{2I_m}{\pi(1 - n^2)} \cos \frac{n\pi x}{L}\right)$$

The above equation is valid for only n=2, 4, 6……and at n=1, 3, 5……. an=0.

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5. CASE STUDY AND RESULTS

5.1 OPEN CIRCUIT TEST

Open circuit test was performed with different continuous supply given at the input. One winding of the transformer whichever is convenient but usually high voltage winding is left open and the other is connected to its supply of normal voltage and frequency. A wattmeter W, voltmeter V and an ammeter A are connected in the low voltage winding i.e. primary winding in this case.

At the input we give sinusoidal voltage waveform, square voltage waveform and saw tooth voltage waveform and analysis the output voltage waveform and current waveform.

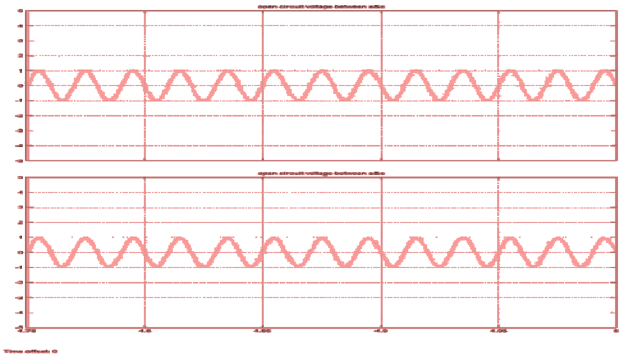

Fig-7: Graph for input, output voltage of sinusoidal supply for open circuit test

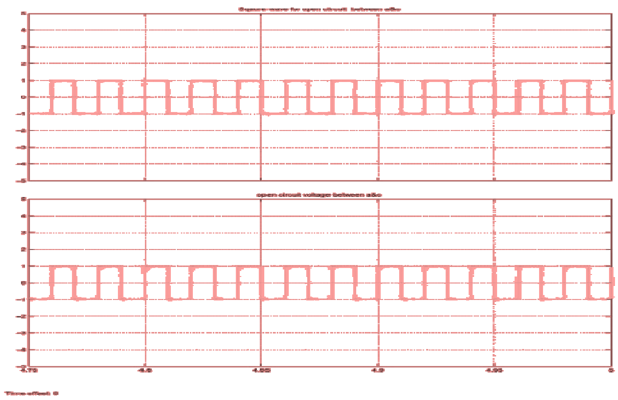

Fig-8: Graph for input, output voltage of square wave supply

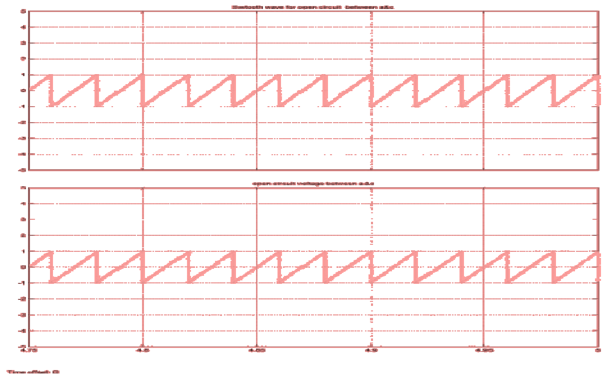

Fig-9: Graph for input, output voltage of saw tooth wave supply

5.2 SHORT CIRCUIT TEST

Short circuit test was performed with different continuous supply is given at the input. One winding of the transformer whichever is convenient but usually low voltage winding is shorted and the other is connected to its supply of normal voltage and frequency. A wattmeter W, voltmeter V and an ammeter A are connected in the high voltage winding i.e. secondary winding in this case.

A primary voltage of 2 to 12% of its rated value is sufficient to circulate rated current in both primary and secondary winding. When source taken is a sinusoidal waveform at the input then on the output we will get a same sinusoidal voltage waveform. But the output voltage waveform and output current waveform are not in the same phase.

Similarly when source taken is a square and saw tooth voltage waveform at the input then on the output we will get a same square and saw tooth voltage waveform. But the output voltage waveform and output current waveform are not in the same phase.

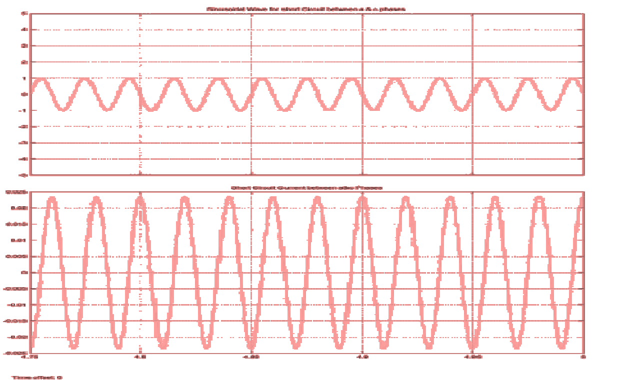

Fig-10: Graph for input, output current of sinusoidal supply

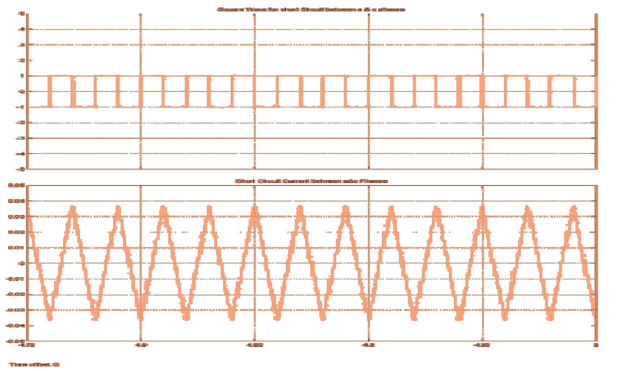

Fig-11: Graph for input, output current of square wave supply

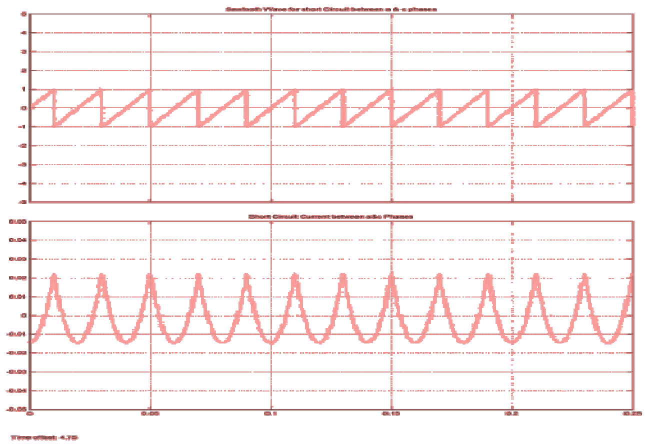

Fig-12: Graph for input, current of saw tooth wave supply

6. CONCLUSION

When a transformer is operated with different types of supply then the output and input waveform are not same. It was also observed that the output voltage and current waveform is not in the same phase. Test was performed by using continuous supplies as well as discontinuous supplies and graphs were plotted for the same. It was also observed that voltage leads the current not exactly at 90 degree but at some angle less than 90 degree. This particular approach can also be applied for finding various parameters of transformer like: Efficiency, voltage regulation and losses so that we can determine that by which type of supply a transformer give better efficiency with less amount of losses.

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REFERENCES

[1]. Dr. P. S. Bimbra, "Generalized Theory of Electrical Machines" Khanna publishers, Fifth Edition.
[2]. D.P. Kothari & I.J. Nagrath, "Basic Electrical Engineering", Tata McGraw hills publishers, Second Edition.
[3]. J B Gupta, "Theory and performance of Electrical Machines", S.K. Kataria and Sons publishers, Fourteen Edition.
[4]. B.L. Theraja and A.K. Theraja, "A Textbook of Electrical Technology Vol II", S. Chand publishers, Eighth Edition 2005.
[5]. Ronalad N. Bracewell, "The Fourier Transform And its Application", Tata McGraw hills publishers, Third Edition.
[6]. Ashfaq Hussain, "Electrical Machines", CBS publishers, Fifth Edition.
[7]. V. K. Mehta and Rohit Mehta, "Basic Electrical Engineering", S .Chand publisher, Sixth Edition.
[8]. A. E. Fitzegerald Charles Kingsley, Jr. Stephen D. Umans "Electrical Machinery", Tata McGraw hills publishers, Sixth Edition.
[9]. William H. Bartley P. E, "Analysis of Transformer Failures" IEEE-The Hartford Steam Boiler Inspection & Insurance Co Hartford, CT USA.
[10]. M. Sedighizadeh and M. Khatibi, "An Approach for Accurate Designing of Transformers Supplying DC Load Currents" IEEE -International Journal of Computer and Electrical Engineering, Vol.2, No.6, December, 2010, 1793-8163.

[11]. Ruchi Singour, Priyanka Solanki, Neeti Pathak, D.Suresh Babu, "Simulation of Single Phase Transformer with Different Supplies", in International Journal of Scientific and Research Publication Volume 2, Issue 4, April 2012, ISSN 2250-3153.

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