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Electrical Transmission & Distribution Systems: A Review

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Abstract:- Transformers are heart of electrical transmission & distribution systems. Aim of transformer design is to obtain dimensions of all parts of transformer in order to supply these data to manufacturer. Transformer should be designed in a manner such that it is economically viable, has low weight, small size, good performance & at same time it should satisfy all constraints imposed by international standards. Several researchers are going to employ Artificial Intelligence techniques in order to performance analysis & transformer design optimization. However, true potential of AI techniques is yet to be fully explored for TDO problems. This paper is going to conducts a brief research review & development in case of transformers. It has been done using conventional optimization methods such as optimization techniques that are based on artificial intelligence. It is suggesting some of recent bio-inspired AI techniques which are going to be employed in case of TDO problems.

Keyword:-Transformers, *E*lectrical transmission, Artificial Intelligence, Leakage flux

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[1] INTRODUCTION

A **transformer** is a static electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Current that is varying in one coil of transformer is going to produce a varying magnetic field, that is going to induce a varying electromotive force in turn or voltage in a second coil. power might be transferred among two coils that are using magnetic field which is excluding a metallic connection among two circuits. Faraday's law of induction discovered in 1831 described this effect. In electric power applications Transformers have been utilized to raise or minimize alternating voltages.

As invention of first transformer in 1885, transformers had become significant in case of transmission distribution. It has been also utilized in case of alternating electrical energy. The Wide range of transformer designs has been encountered in case of electronic & electric power applications. The transformers

range in size from RF transformers that is less than a cubic centimetre in volume to units that has been interconnected to power grid which is weighing lot of quintals.

Distribution of Pole mounted transformer with center tapped secondary winding required to give split phase power in case of residential & light commercial service.

It has been considered two schematic models. It is considered that Ideal transformer is a linear transformer that is lossless as well as that has been coupled perfectly. Perfect coupling means that infinitely high core magnetic permeability has been provided. This is known as process of winding inductances as well as zero net magneto motive force. Current

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that is varying in transformer's primary winding. It is going to develop a varying magnetic flux in core of transformer. Varying magnetic field is impinging on secondary winding. Primary as well as secondary windings have been wrapped all over the core of infinitely magnetic permeability so that all of magnetic flux passes through both primary & secondary windings.

[2] LITERATURE REVIEW

S.Sendilkumar (2010) "Differential protection of power transformer based on HS-transform & support vector machine

Researchers are presenting a recent approach in case of power transformer differential protection that is dependent on HS-transform. It is supporting vector machine. Subsequently such features have been used as inputs to SVM in case of fault classification in order to check inrush current & fault current. It has been tested and trained with features extracted from frequency contours in case of various fault circumstances. Simulation of fault was done using MATLAB & SIMULINK software taken 2 cycles of data each 400 samples. Advantage of proposed algorithm provides more accurate results even with presence of noisy inputs & accurate in identifying inrush & fault currents. Overall accuracy of proposed method is found to be 92.85%.

H. D. Mehta1, Rajesh M. Patel (2012) "A Review on Transformer Design Optimization & Performance Analysis Using Artificial Intelligence Techniques"

They give an overview of literature regarding transformer design optimization using artificial intelligence techniques. Publications from various international journals & conference proceedings have been included to cover wide range of engineering methods & design considerations. This survey provides significant information about future trends in field of transformer design optimization.

Satya Kumar Behera(2014) " A Review of Transformer Protection by Using PLC System"

Distribution transformers of substation are one of most important equipment in power system network. Condition monitoring, data acquisition, automatic controlling has been considered as important issues. This is Due to huge count of transformers as well as several components over a wide area in power systems. This paper is presenting design & implementation of automatic control circuits that has been used in programmable logic controller's automation. It is to monitor as well as diagnose condition of transformer such as transformer temperatures, load currents & voltages. This paper has proposed system that is on-line monitoring and integrates a solid state device which is known as programmable logic controllers & sensor packages.

Akash Pathak, Vikas Sahu (2015) "Review & Study of Bidirectional of DC-DC Converter Topologies for Electric Vehicle Application"

Inclusion of bidirectional DC-DC converter among electric source as well as traction motor in case of Electric Vehicles facilitates. It is energy regeneration during braking at the time of motion along downhill slope. This inclusion could improve traction drive efficiency as much as by 25%, which improves whole driving range. Now in order to minimize weight, size & cost of system, proper bidirectional DC-DC converter topology might be chosen so as to optimize design performance. This paper is going to review & study of basic bidirectional DC to DC converter topology. This paper is presenting comparative advantages & disadvantages in case of arriving at proper design decision in case of Electric Vehicle traction application.

Selim Koroglu (2016) "Case Study of Fault Detection in case of Power Transformers

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Using Dissolved Gas Analysis & Electrical Test Methods".

This research presents methodologies for power transformer fault diagnosis using dissolved gas analysis & electrical test methods. Dissolved gas analysis test provides fault diagnosis of power transformers. On other hand electrical test methods are used for detection of root causes & fault locations & they provide more specific information about faults. Objective of this work is to detect faults that are recorded in Turkish Electricity Transmission Company power systems. Because of this four specific cases have been considered & analyzed with electrical testing and dissolved gas analysis methods. These real cases of measurements have been analyzed with both methods in detail. Assessment results showed that a single method cannot yield accurate enough results in some specific fault conditions. Therefore it was concluded that cooperation of both methods in assessment of fault condition gives more trustworthy results.

[3] IDEAL TRANSFORMER

Load impedance which is connected to ideal transformer's secondary winding generally shows conservation of apparent. It is according to law of conservation of energy. It is real & reactive power consistent with eq. (4).

The ideal transformer identity shown in eq. (5) has been considered as a reasonable approximation in case of typical commercial transformer with voltage ratio. The winding is going to turn ratio both being proportional inversely to corresponding current ratio.

By Ohm's law & ideal transformer identity:

1. the secondary circuit load impedance could be expressed as eq. (6)
2. Primary circuit has been derived in eq. (7) is apparent load impedance that is equal to turns ratio squared times secondary circuit load impedance.

Equations of Ideal transformer

By Faraday's law of induction:

$$Vs=-Ns\frac{d\varphi}{dt} \quad \text{.....(1)}$$

$$Vp=-Np\frac{d\varphi}{dt} \quad \text{.....(2)}$$

Merging ratio of (1) & (2) results in

$$=\frac{Vp}{Vs}=\frac{-Np}{-Ns}=a \quad \text{.....(3)}$$

for step-down transformers, a > 1
for step-up transformers, a < 1

Apparent, real as well as reactive power are conserved in input as well as output using the law of conservation of energy.

$$S=IpVp=IsVs \quad \text{..... . . (4)}$$

Merging equation (3) & (4) with this endnote results in ideal transformer identity

$$\frac{Vp}{Vs}=\frac{Is}{Ip}=\frac{Np}{Ns}=\sqrt{Lp/Ls}=a \quad \text{.....(5)}$$

Ohm's law & ideal transformer identity represents that

$$Zl=\frac{Vs}{Is} \quad \text{..... . (6)}$$

Apparent load impedance Z'_L which is primary

$Zl=Vp/Ip=aVs\backslash Is=a^2$

$Vs/Is=a^2Z_l$ .....(7)

[4] REAL TRANSFORMER

The ideal transformer model is going to ignore linear aspects in case of real transformers which has been discussed as follow:

(a) Core losses is considered as as magnetizing current losses it consist of

1. Hysteresis losses because of nonlinear application of voltage applied in transformer core.
2. The current losses of Eddy because of joule heating in core. It has been

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proportional to square of transformer's applied voltage.

(b) The process of windings in a real transformer is having resistances that are non zero. The inductances associated with following:

i. Losses of joules because of resistance in case of primary as well as secondary windings
ii. Leakage flux which is escaping from core. It go through one winding result in primary as well as secondary reactive impedance.

Leakage flux

It is ideal transformer model that assumes that all flux generated by primary winding. They link all turns of every winding considering itself. The Leakage flux is responsible for energy being stored in alternately. It gets discharged from magnetic fields in every cycle of the power supply.

[5] EQUIVALENT CIRCUIT

A practical transformer's physical working might be represented with the help of an equivalent circuit model referring to diagram. It could incorporate an ideal transformer.

Losses of winding joule as well as leakage reactance's have been represented. It has been made using following series loop impedances of model:

1. Primary winding: R_P, X_P
2. Secondary winding: R_S, X_S.

R_C & X_M are defined as magnetizing branch of model. The Finite permeability core needs a magnetizing current I_M. It is required in order to maintain mutual flux in core.

[6] BASIC TRANSFORMER PARAMETERS & CONSTRUCTION

Polarity

Transformer circuit diagrams need dot conventions. It is also needed in nameplates or terminal markings in order to explain relative polarity of transformer windings. Current that is positively increasing instantaneous enters primary winding's dot end. It induces positive polarity voltage as well as exiting secondary winding's dot end.

The Effect of frequency

The effect of frequency of a transformer at a given flux is going to increase with frequency. Transformers might be more compact. This is because core is usually able to transfer power without reaching at the saturation point. It is done by operating at higher frequencies. The fewer turns have been required to achieve common impedance.

Energy losses

Transformer energy losses have been dominated by winding & core losses. The Transformers' efficiency is going to improve with increasing transformer capacity.

[7] SCOPE OF RESEARCH

The power generation capacity of Transformer energy is more than power generation capacity of individual system. Energy shaped by mixture of solar-hydro, solar- wind, wind-hydro; is much better in comparison to single systems. Hence on combining all three systems output is expected to be much greater than corresponding two stage Transformer energy. Transformer energy systems would in turn be used for charging batteries.

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