International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-10, Jan 2019

A New Method for the Calculation of the Hot-Spot Temperature in Power Transformers

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Abstract - In the previous work of the authors, an original thermal model of transformers was developed. The model takes into account the influence of nonlinear thermal characteristics in transient thermal processes; instead of exponential functions and time constants, the numerical solution of differential equations is used. The model delivers one characteristic temperature in copper and one characteristic temperature in oil. In this paper the analysis the hot-spot temperature of the solid insulation by using easily measurable quantities. Then, the parameters of the model can be precisely determined from measurements and the model can deliver the hot-spot temperature. The experimental base of this research are the measurements on a 40 MVA,132/33KV with temperature sensors and winding sensors.

Index Terms- Hot-spot temperature, power transformer thermal factors, thermal modeling

I. INTRODUCTION

Many power and distribution transformers have already exceeded half of their expected service life of 35 years in the infrastructure the electric company. Therefore, it is anticipated that a high investment on transformer replacement happens in the near future. However, high renewable integration and demand response are promising resources to defer the investment on infrastructure upgrade and extend the lifetime of transformers and their impacts on the age of transformer are reported. Finally, the equivalent loss of net present value of transformer is formulated and discussed. This formulation gives major benefits to the distribution network planners for analyzing the contribution lifetime extension of the transformer. In addition, the provided model can be utilized in optimal investment analysis to find the best time for the transformer replacement and the associated cost. The simulations results show that hot spot temperature and lifetime of transformers. The standard insulation life at the situation temperature in hours is assumed to be 20 years. The percentage loss of life is appraised for different temperature situations as shown in different Tables which are produced by software program. It has been experiential that employing ONAF cooling arrangement during peak load period decreases the hot spot temperature to 98 deg. C. The cumulative loss of life is currently considered. This results in the saving in proportion loss of life as shown in Tables, day to day. The results acquired from MATLAB based program model may be used to estimate the remaining life assessment of the power transformer.

II. POWER TRANSFORMER SPECIFICATION

In imperative to validate the proposed method, data gathered under various transformer load situations from a real power transformer 40 MVA which are documented in the substation, have been used. In this thesis study, work has been conceded out in a power transformer situated at 132/33kV MP Power transmission line, gudher, Rewa transmission substation.

Rated voltage (HV)	132 KV
Rated voltage (LV)	33 KV
Rated Current (HV)	174.95 A
Rated Current (LV)	699.81 A
Current Density	2.6 A/mm2
No. of Phase	3
Frequency	50 HZ
Connection Symbol	YY11
Rated Top Oil temperature Rise	55 degree centigrade
Rated Winding temperature Rise	60 degree centigrade

III. HOT SPOT TEMPERATURE CALCULATION

In this technique the hotspot temperature have been planned as the top oil temperature supplementary to the hotspot temperature rise and ambient temperature.

Top oil Rise = Top oil temp. - Ambient temp.

Average oil temp. = Top oil - {Rad. I/L - Rad.O/L}/2

Average oil Temp. Rise = Average oil Temp.- Ambient Rise Average oil Temp. Rise Rated loss corresponding to total losses = ------------ x 6.3 (a) Losses fed Hot Resistance

Winding Temperature = ----------------- x (235 + T) - 235 Cold Resistance T = Top oil temp. during cold resistance measurement.

 DOI : 10.18231/2454-9150.2018.1320

Winding gradient above
average oil Temp. = { (6.4) - (6.2) }
Winding gradient corrected
I Rated to rated current = { -------- }Y x (6.5)
Y= 1.6 for natural & forced non directed oil circulation.
Y= 2.0 for forced directed oil circulation.
Winding Temp. Rise = { (6.6) + (6.3) }
Hot spot Temp. Rise =1.1 x Gradient + Top oil temp.

IV. SIMULATION AND ANALYSIS

The hot spot insulation temperature represents the most important limiting factor of a transformer loading. The hot-spot temperature has to be under a prescribed limit value. A cumulative effect of insulation aging, depending on time change of hot-spot temperature, should be less than a planed value. That is why there exists an interest to know the hot-spot temperature in every moment of a real transformer operation in the conditions of variable load and ambient air temperature. Possible approaches are to measure the hot-spot The graphical representation of the hot spot temperature, all three methods for a day one to day three including the variation of the ambient temperature, the top oil temperature rise over ambient, and the Winding temperature over top oil is shown in below.

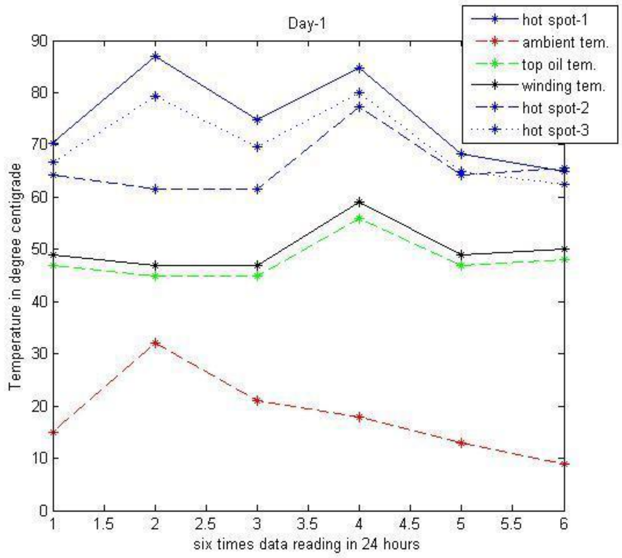

Fig.-the graphical representation of the hot spot temperature

V. CONCLUSION

This research work based on mat lab program for evaluation of hot spot temperature with its loss of life be contingent on temperature limit in transformer. There are three methods used for hot spot calculation, it can be detected that the result of suggested method is gives better response as compared to other two methods is obtainable with different input parameters. From the software created graph and result table for each three days it is clear that planned hot spot calculation method is gives better response as compared to other two methods is presented with different calculation and input parameters.

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