TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 11427 - 11431

Condition and Monitoring of Distribution Transformer using Thermal Imager

[1]T.Mariprasath, [2]K.Ramamohan Reddy, [3]Neerati Siddhik , [4]K.Kalyan Kumar
[1],[2],[3] KSRM College of Engineering (Autonomous)
[1]mariprasath@ksrmce.ac.in,[2]ramamohanreddy@ksrmce.ac.in, [3]ns@ksrmce.ac.in,
[4] kalyankumark13@gmail.com

\

Article Info
Volume 82
Page Number: 11427 - 11431
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 21 February 2020*

Abstract
Globally, uninterrupted electrical supply is required for smooth running of industries and day to day life activity. Because of the few minutes of outages causes huge revenue loss, poor quality and major accidents. To prevent these phenomena, a continuing condition and monitoring technique is required. In this paper, we propose a method to assess the state of the machine without interjecting the production or service. This is achieved by thermal imager. It is capturing the thermal image of the electrical machines which is used to access the state of the machine. According to the color of thermal image of the machine we can easily find weather machine is working satisfactory or not. Also, before going to burn out or damage we can make a preventive based maintenance very easy manner. The paper we conducting condition monitoring of transformer by using thermal imager. From the case study we can found that thermal imager is best tool for asses the transformer status very effective manner.

Keywords: *Distribution Transformer, Condition and monitoring, Thermal image, fault identification*

I. INTRODUCTION

The transformer is a critical apparatus in transmission and distribution systems. It increases the voltage level in a generating station and step down the voltage at distribution network. Apart from this very long transmission system, transformer act as a booster to increase the voltage level at the desired point for compensating transmission and distribution loss. Due to transmission line internal resistance, capacitance and inductance effect respectively. A few minutes of outage of transformer brutally affect the whole networks, which depend on particular transformer. Therefore, Condition and monitoring (CM) are a technique has been used for monitoring the status of the machine. This technique prevents the machine before going burnout.

Distribution transformer has insulating medium which is acts as cooling medium as well as insulation medium. Adding to, a solid insulating material such as press board and kraft paper has been used. As shown figure which shows the internal assembly of transformer. Since, solid insulating materials composed with an insulating oil offer very good withstand ability under electrochemical and thermal stress. Several studies found that insulation degradation is strongly depends on the temperature rise. Because of transformer always operating with certain temperature. When this temperature goes above the limit it may cause insulation damage on the transformer. Perhaps, insulating oil observes the heat and dissipate such heat through convention principle through the radiator. The function of radiator conducts the oil heat into the atmosphere by convention principle.

Several studies proved that insulation degradation is the primary causes of transformer failure for

January - February 2020
ISSN: 0193 - 4120 Page No. 11427 - 11431

an example, see figure 2 winding burnout occurred which is due to deterioration of Kraft paper. As provide insulation between adjacent turn. Conversely, press board provide between each

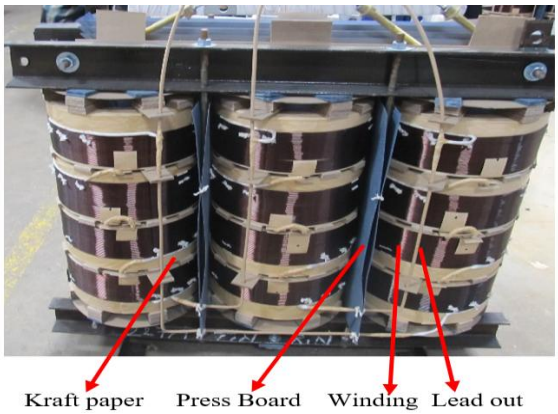

Fig 1. Internal Assembly of Transformer

phase winding and high voltage stress areas. This is because of withstanding ability of press board is higher that of other.

Traditionally, the transformer is monitored by oil level indicator and oil testing. The testing is namely electrical, physical and chemical properties of oil samples.

Fig 2. Insulation Burnout

These tests are required standard testing equipment as well as expert person to interpret the results, also this test takes considerable time. For oil level indication, only possible to access the level of oil, which is interpret the how much of oil is available transformer.

Hence various authors introduced new CM methods such as Frequency response analysis, Sweep Frequency Response analysis, impulse voltage method, etc. These methods are required to de-energies the transformer. The manuscript has proposed a hotspot indication method which is used to access the conduction transformer without affecting services of the transformer, which is achieved by thermal imaging camera.

The manuscript has following sections such as section 1 delivers the introduction about the necessity of condition and monitoring technique, section 2 review of existing popular methods, section 3 real time case study and its inference included finally section 4 conclusion which establishes main finding of the article.

II. METHODOLOGY

To increase the life span of transformer, several authors proposed a variety of CM techniques. That is discussing this section. Firstly, Acoustic Monitoring method, this method we continuously measure the transformer noise level. This can be achieved by a sensor mount on the transformer winding, it continuously senses the noise level. By manually or automatically process the noise level, then we find the transformer status. In this method cost is high. Also, special care must be taken to design of winding with the sensor. Dissolved Gas Analysis method, this method to predict the status of the transformer by analysis, gas which is exhibited during transformer operation called as on line DGA while take an oil sample and analyses in controlled laboratory called us off line method. This method care must be taken at the time of sample since moisture reacts with oil sample it causes misleading the condition.

Frequency Response analysis is used to detect the mechanical movement of windings. The movement or dislocation of winding detection is very crucial factor, since which causes marginal damage on winding. Because of the displacement of winding has been led to short circuit between winding or phase winding etc. In this method measures a response between current and frequency before installation of transformer it's called as reference signal and after

January - February 2020
ISSN: 0193 - 4120 Page No. 11427 - 11431

installation of transformer once again repeat same which is called actual once, then, a comparative analysis has been made. In case actual response is not matched with reference response means a fault happen. This method also called fingerprint method. Perhaps, recent days' sweep Frequency response analysis has been used to detect the wind movement. Since once compared to FRA this method has a wide range of frequency and better signal to noise ratio.

A high performance liquid chromatography used to detect the transformer condition. This spectroscopy estimates the transformer condition by analyzing the foreign content of transformer. Due to thermal aging the transformer solid insulation materials are degradation which is releasing the aging by product of oil samples such a product called foreign content. If forum content is a desirable limit means that transformer operating satisfactorily and its insulation health is good and vice-versa. Due to technology advancement an artificial intelligence also can be used to assess status of transformer. In comparison to all other traditional methods, the results are more accurate and reliable. Nonetheless, this technology is required numerous samples which used to train the neural network. According to the sample size is high, prediction are more accurate.

III. THERMAL IMAGE ANALYSIS

Fig 3. Hotspot on line joint

As shown in the Fig 3 it's a thermal profile of transformer which is taken by thermal imaging camera. Whereas, the spot temperature appears on the line joint which is may be losers line joint or corona appears on the conductor. The spot temperature is above 150°C so that transformer working very critical, hence it is necessary to take remedial action as soon as possible.

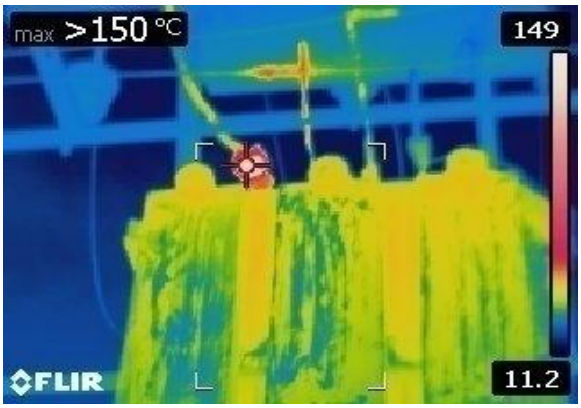

Fig 4. Hot spots on Top of transformer tank

Fig 4 shows that the major spots appear on top of the transformer tank Also, bushing of transformer is in a very hot position, hence it is necessary to check the level of oil in transformer tank. Also, check the connected load on transformer weather it is desired level or above. The above figure infers that, oil level may be low since lower part of transformer look like a mixed of yellow and green. The spot temperature of the above figure is 52.9°C

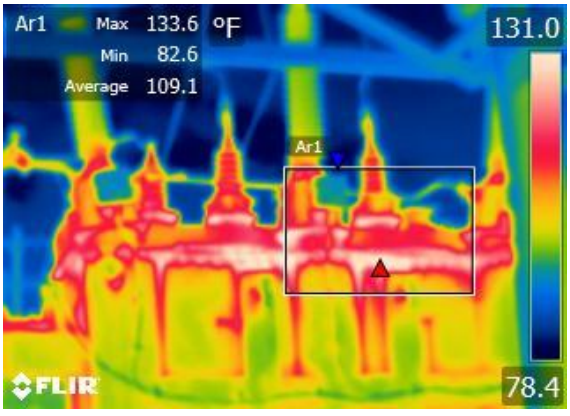

Fig 5. Hot spots on Top of transformer tank

As shown in above Fig 70% of transformer tank appears as greenish mixed with yellow, which means that it has the good quality of transformer oil. However, top of the transformer tank and busing, connection leads out areas are appearing as reddish, which may be connected load is high and quantity of oil in the transformer may be low. The hotspot

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 11427 - 11431

temperature is 133.6 °F heat so that check the oil level as well as connection lead out whether it will desired tighten or not.

As shown in the Fig 6 overall body of the transformer appears as reddish, which means that transformer oil deteriorates fully. That means the oil fluid flow questionable. Since, fluid flow of transformer oil depends on the viscosity and the contamination rate of oil. When fluid flow is low subsequently heat transfer from transformer to the atmosphere is very low. So that quality of oil is low.

Fig 6. Aged transformer

Also, it's very old transformer, therefore, its solid insulation also possible to degradation. Also, it's very old transformer, therefore, its solid insulation also possible to degradation. Also the spot temperature is above a hundred degrees Celsius, which means that corona appears. So that arc appears on the connection leads out. From above finding concluded that transformer condition is too critical, hence required remedial action must be take otherwise it leads to a major accident.

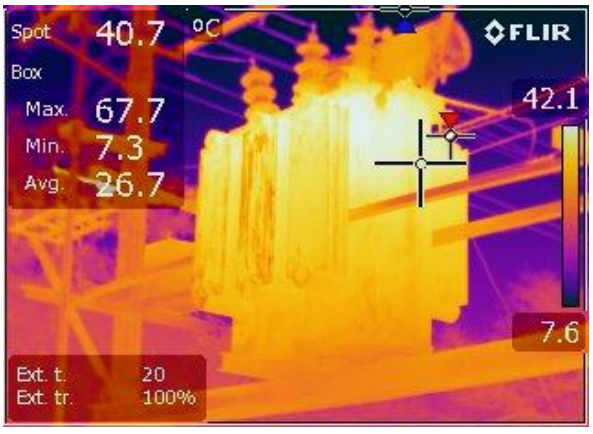

Fig 7. Aged transformer

As shown in above Fig 7 there is no hotspot the average temperature of the transformer is 26.7°C. Whereas, the spot temperature is 40.7°C. Which is infers that transformer working normal condition, respectively

IV. CONCLUSION

From the above real time analysis found that, thermal imaging camera produced very reliable results. By this approach we can easily monitor transformer status without its affecting the service, respectively. From the case study we can find that line jointing is more sensitive location that of others. Hence care must be taken in line joint and periodically check whether it lessen or not. Moreover, fluid flow physiognomies of oil have been checked periodically. Since, heat conduction ability is depending on it. Correspondingly, oil level within bushing has to be checked as all case studies the bushing of transformer appearing very hot. The article concludes with the help of thermal imaging camera we can easily access the state of transformer very efficient manner.

V. REFERENCES

[1] A.R. Sedighi, A. Kafiri, M.R. Sehhati,"Life estimation of distribution transformers using thermography: A case study", Measurement,Vol.149, 2020

[2] Ivan Pavičić,Igor Ivanković, Alan Župan, Renata Rubeša, Marko Rekić, "Advanced Prediction of Technical Losses on Transmission Lines in Real Time",2nd International Colloquium on Smart Grid Metrology, 2019

[3] T.Mariprasath, Kirubakaran, "A real time study on condition monitoring of distribution transformer using thermal imager",Infrared Physics & Technology, Vol. 90, pp.78-86,2018

[4] Junko Tokunaga, Hidenobu Koide, Kenji Mogami, Keizo Kawanishi, Tomoyuki Hikosaka, "Lifetime estimation of cellulosic insulation material in palm fatty acid ester for power transformers", IEEE Transactions on Dielectrics and Electrical Insulation, vol.24,pp. 1010 - 1017,2017

[5] T.Mariprasath,V.Kirubakaran, "A critical review on the characteristics of alternating liquid dielectrics and feasibility study on pongamia pinnata oil as liquid dielectrics, Renewable and Sustainable Energy Reviews",Vol.65, , pp.784-799,2016

January - February 2020
ISSN: 0193 - 4120 Page No. 11427 - 11431

[6] Bo Zhang,Ning Yan,Jianmin Du, Fangxu Han, Huan Wang "A Novel Approach to Investigate the Core Vibration in Power Transformers", IEEE Transactions on Magnetics, Vol.54, 2018

[7] Chenmeng Xiang,Zhengyong Huang, Jian Li, Quan Zhou,Wei Yao, "Graphic approaches for faults diagnosis for Camellia insulating liquid filled transformers based on dissolved gas analysis", IEEE Transactions on Dielectrics and Electrical Insulation, Vol.25,pp.1897-1903,2018

[8] K. Ludwikowski, K. Siodla, W. Ziomek "Investigation of transformer model winding deformation using sweep frequency response analysis", IEEE Transactions on Dielectrics and Electrical Insulation, Vol.19,1957 - 1961,2012

[9] T. Mariprasath, V. Kirubakaran, "Power Transformer Faults Identification using SFRA", International Journal of Scientific & Engineering Research, Vol. 5 (5), pp.81-87, 2014.

[10] Kamel Benhmed,Abdelniser Mooma, Abdunnaser Younes, Khaled Shaban, Ayman El-Hag, "Feature Selection for Effective Health Index Diagnoses of Power Transformers", IEEE Transactions on Power Delivery, Vol.33,3223 - 3226,2018