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STUDY ANALYSIS OF TEMPERATURE RISE TEST FOR TRANSFORMER

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Abstract *:* The aim of this paper is to present the analysis of the temperature rise test conducted on a power transformer rating 15 MVA, 50 Hz, 66/11.55 KV, 3-phase, Dyn11. During the process of testing transformers, there are three main steps that are utilized to analyze the behavior of the transformers: measuring the no-load loss and magnetic current, measuring the load loss and impedance, and measuring the temperature rise. The results of the transformer temperature rise tests showed an HV winding temperature rise of 40.14ºC and an LV winding temperature rise of 46.39ºC, which was an indication of overheating. To address this issue, the transformer radiator and cooling duct size were increased, resulting in a successful test of the transformer, with an HV winding temperature rise of 39.5ºC and an LV winding temperature rise of 42.35ºC. This demonstrated that the increase in radiator and cooling duct size resulted in an improvement in the transformer's temperature rise improved.

Index Terms – Temperature Rise Test, Power Transformer. Iron Losses, stray losses

I. INTRODUCTION

A static device called a transformer is used to increase or decrease voltage without affecting frequency. The power transformer is a typical component of the power system. Various tests that are carried out on the power transformer are conducted in this. The various exams include type tests, regular tests, and special tests. The transformer can be tested to determine its current, temperature, etc. tolerate capacity. Windings, oil level, and insulation. After being certified to be operated, all the parameters are tested.

figure 1.power transformer

Rating	15 MVA
Voltage Class	66/11.55 kV
Type of winding	3 phase 2 winding
Vector Group	Dyn11
HV Connection	Delta
LV Connection	Star
HV Current	131.22 Amp
LV Current	749.83 Amp
Tapping Range	+/- 15 % @ 1.25%
Cooling Type	ONAN

1.1 Pre-Commissioning Test

- Type Test
- Routine Test
- Special Test

Type Test

This kind of type test determines whether the processor's services adhere to the specifications of the contract, regulation, contract clauses, and technological standards.

1) Temperature rise test.
2) Impulse voltage withstand test.
3) Short circuit withstand test.

Routine Test

Each and every manufactured product is subjected to this routine test. This is done primarily to confirm that each unit in the production lot is operating at peak efficiency.

1) Measurement of voltage ratio and check the vector relationship.
2) Measurement of No load loss and magnetizing current.
3) Measurement of Load Loss.
4) Measurement of insulation resistance.
5) Measurement of winding resistance.
6) Ten Delta test.
7) Oil BDV test.

Special Test

In this test Special, the test is conducted in accordance with customer specifications in order to gather data that will be helpful to the user during operation or maintenance.

- Dissolve gas analysis of oil filled transformer.
- Sweep frequency response analysis.

This all tests are performed with reference Indian standards. (IS 2026 is preferable for most of thesetests

2. Methodology

1.2 Measurement of no-load loss and magnetizing current

Procedure :

- Provide the appropriate tap on the LV side of the phase terminals with the rated voltage and frequency.
- The neutral terminal is earthed and the HV side is opened.

- At 90%, 100%, and 110% of Un, the no load loss and current measurements must also be taken. Utilize a power analyzer to measure voltage, current, power, and frequency.

Connection Diagram

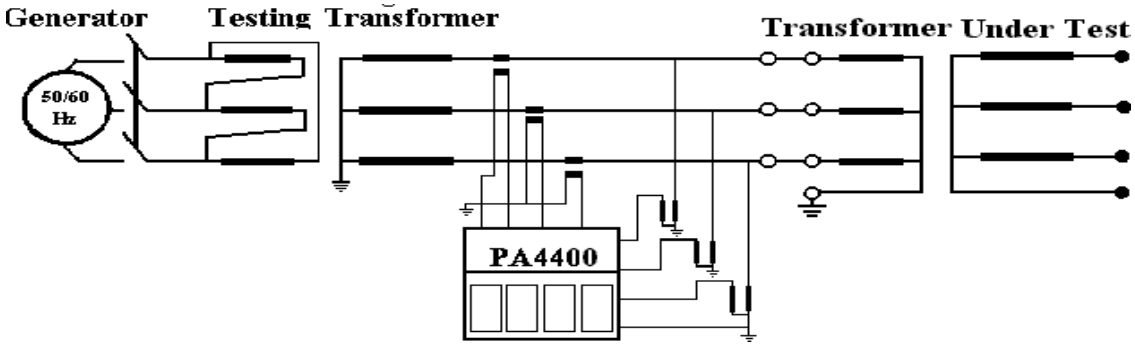

figure 2. connection diagram of no load test

Instruments

Power supply 50 Hz from synchronous generator set, adjusted by exciting and variable testingtransformer.
Power Analyzer, with 3-independent channel
Current Transformers & Voltage Transformers

Acceptance criteria

As per customer requirement and Indian standards.

1.3 Measurement of load loss and impedance

Procedure :

For three phases, supply the HV side on all three terminals; for single phase, supply the HV side between HV phase and HV Neutral with the rated frequency and current for the appropriate tap. On the LV side, every terminal is shorted.
By using a Power Analyzer or one of the three W-meter methods, measure voltage, current, power, and frequency.
Measurement and recording of the oil's top and bottom temperatures are required.
The computed values will be raised to 75 C.

Connection Diagram

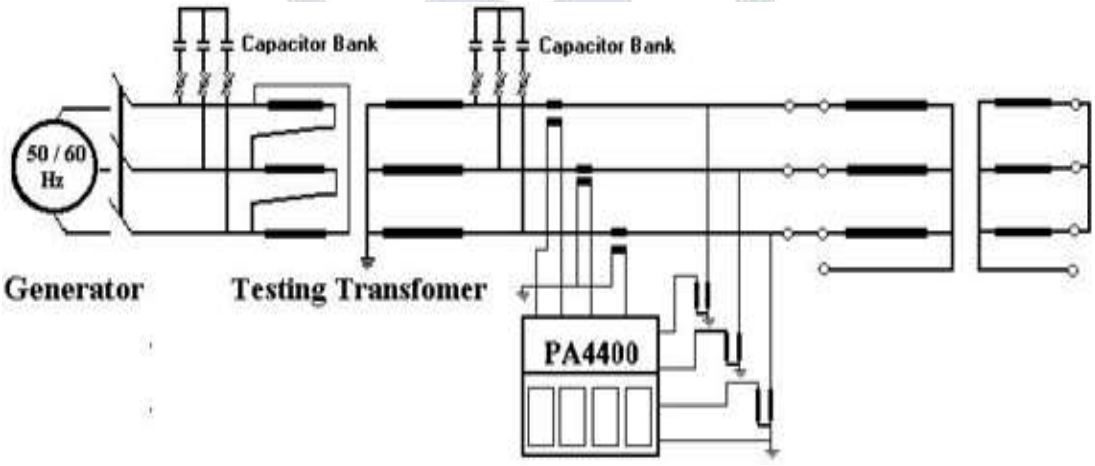

figure 3.connection diagram of load loss test

Instruments

Power supply 50 Hz from synchronous generator set, adjusted by exciting and variable testing transformer.
Power Analyzer, with 3-independent channel
Current Transformers & Voltage Transformers

Acceptance criteria

Load loss as per customer requirement.
Short Circuit Impedance (%Z) = 10% (IEC TOL) at principal tap

1.4 Measurement of Temperature rise test

Temperature rise tests at rated power
Procedure :

Provide the transformer with the maximum total loss (no-load loss plus the total of the two windings' short-circuit losses), which is linked in short-circuits. Three-phase, 50 Hz power is fed into the transformer's high voltage side.

Maintain a constant input. The input data, including the electrical quantities delivered, top oil, cooler inlet, cooler exit, oil, and cooling air temperatures, must be recorded (logged) every half hour.

The test must immediately proceed with the test current reduced to the suitable tapping current once the peak oil temperature rise has been established with saturated temperature for at least 4 hours (less than 1 Deg .C rise in two consecutive hourly rises). This state is sustained for an hour. After a quick supply cutoff and several short circuits, the resistance of the windings is measured at the conclusion of this hour.

As per IS-2026-PART-2, ascertain the liquid temperatures and temperature increases. By using the resistance method, determine the windings' temperature and temperature rises in accordance with IS-2026-PART 2.

Calculate the growth in hot-spot winding temperature in accordance with IS-2026-PART 2. The oil and winding time constants will be computed from the temperature increase experiments.
At the end of the ONAN rating rise, oil samples will be collected for the DGA test prior to the test.

Instruments

The instrumentation is same as at Load Loss test.
Acceptance criteria
As per customer requirements.

3. .Temperature rise test results.

Transformer Temperature rise test readings on tap no 1. And rated 15 MVA (ONAN). HV winding voltage and current 66 KVA, 131.22 Amp.LV winding voltage and current 10972.5 volt, 789.27 Amp. No load losses and load loss 9248.42Watt, 53191Watt and total losses 62439.42.Temperature rise test started time 01:30 AM to 10:30 AM, so, 5 hour reading are concluded. and top oil temp 60.6ºc and top oil rise in 09:30 AM 35.33ºc .radiator temperature top and bottom 57.1ºc and 44.3 ºc.
After shutdown transformer and reduced to rated current than HV and LV winding temperature. Top oil temperature 60.3ºc and top oil rise 34.8ºc.radiator temperature top and bottom 57.1ºc and 44.3ºc.

3.1 Measurement of HV winding resistance after shutdown.

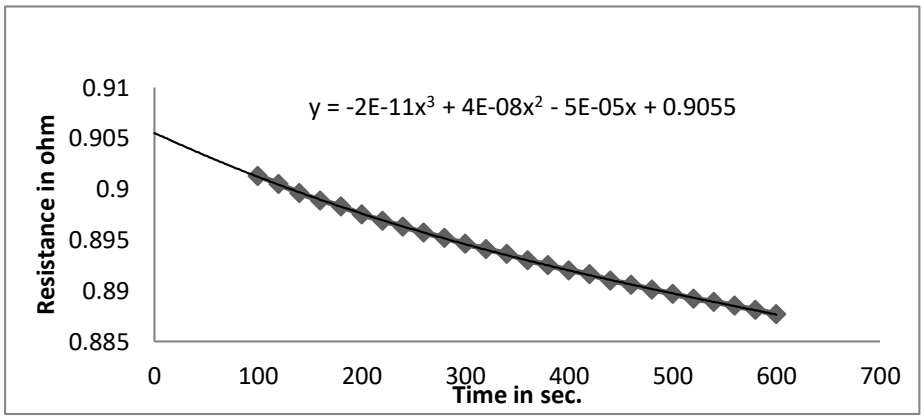

Figure 4.relation between resistance and time

HV winding "0" minute resistance is 0.9055 ohms.
R1=Cold resistance at 32.60ºc 0.8077 ohm between 1V1W
R2=Hot resistance at 25.47 ºc 0.9055 ohm between 1V1W

Table 1.HV winding TRT results

Drop in mean Temperature Is As Under.	
Mean Oil Temperature Corresponding To Final Oil Temperature Rise	24.93°c
Mean Oil Temperature at Time Of Measurement Of HV Resistance	24.13°c
Drop In Oil Temperature	0.8°c
Final HV Winding Temperature Rise	40.3322286°c

3.2 Measurement of LV winding resistance after shutdown

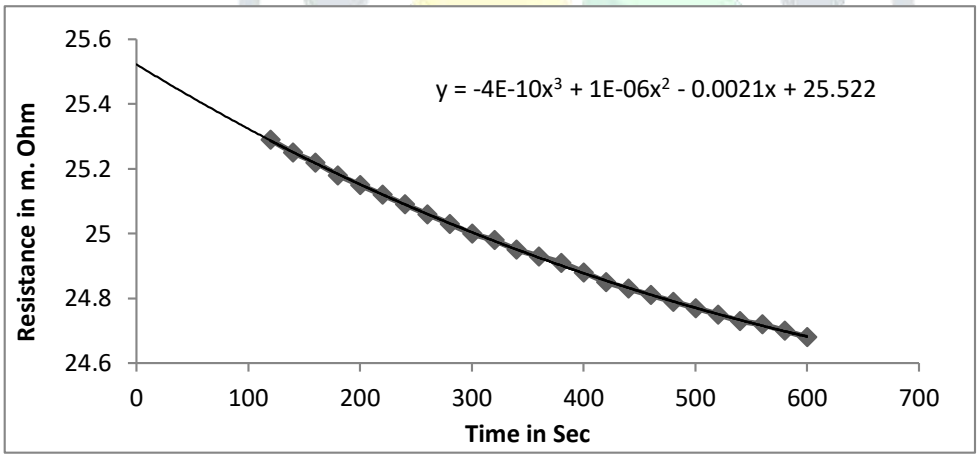

figure 5.relation between resistance and time

LV winding "0" minute resistance is 25.522 ohms.
R1=Cold resistance at 32.60ºc 22.300 m.ohm between 2V2W
R2=Hot resistance at 25.47ºc 25.521 m.ohm between 2V2W

Table 2. LV winding TRT results

Drop in mean Temperature Is As Under.	
Mean Oil Temperature Corresponding To Final Oil Temperature Rise	24.93
Mean Oil Temperature at Time Of Measurement Of LV Resistance	24.13
Drop In Oil Temperature	0.8
Final HV Winding Temperature Rise	46.594

3.3 HV and LV winding final results

Table 3.HV and LV winding

sr. no	Final temperature rise	Measured(°c)	Guaranteed (°c)
1	Oil temp. rise	35.33°c	35°c
2	HV wind. Temp. rise	40.33°c	45°c
3	LV wind. Temp. rise	46.594°c	45°c

LV winding températures are overheating. So, Design improvement are needed to overcome this phénoménal. By analyzing these results, the oil temperature rise and winding temperature rise of oil-filled transformers are reduced with improved design. Which can be improved the life of transformers.

4. Design improvement for temperature rise test:

4.1 Change in radiator size

By improving the radiator design, we can obtain better cooling in transformer.

Change in radiator size for design improvement:

Figure 6. Transformer radiator fines

Old Radiator Size:	Improved Radiator Size:
1600 x 520 x 20 x 10	1600 x 520 x 21 x 10

4.2 Change in cooling ducts

Transformer windings have cooling ducts that allow oil to travel between the windings. This is capable of transmitting heat from windings.
We can give batter circulation for oil, which may be used to supply batter cooling to the transformer, by expanding the size of the cooling ducts.

Figure 7. Transformer cooling ducts

Table 4. Change in cooling ducts size for transformer

	Old Cooling Ducts:	Improved Cooling Ducts:
Core to LV Winding	8 mm	11 mm
LV Winding toHV winding	12 mm	14 mm

5.1 Measurement of HV winding resistance after shutdown.

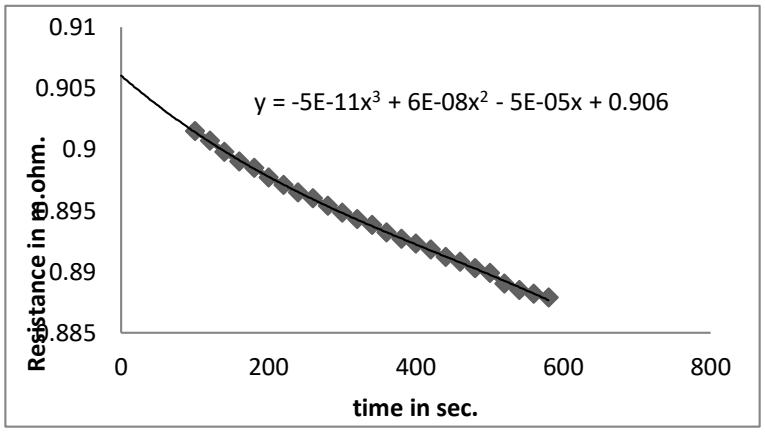

figure 8.relationship between resistance and time

HV winding "0" minute resistance is 0.906 ohms.
R1=Cold resistance at 32.60ºc 0.8077 ohm between 1V1W
R2=Hot resistance at 25.47 ºc 0.906 ohm between 1V1W

table 5.HV winding TRT results

Drop in mean Temperature Is As Under.	
Mean Oil Temperature Corresponding To Final Oil Temperature Rise	28.93°c
Mean Oil Temperature at Time Of Measurement Of HV resistance	28.033°c
Drop In Oil Temperature	0.897°c
Final HV Winding Temperature Rise	39.3°c

5.2 Measurement of LV winding resistance after shutdown

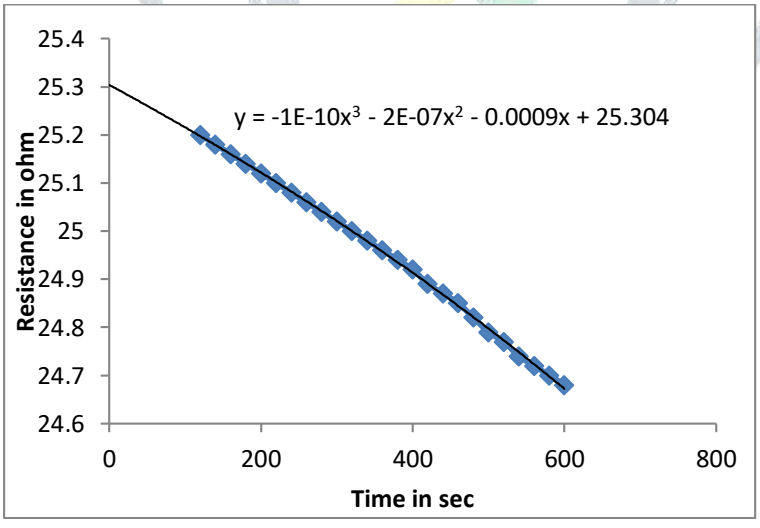

Figure 9. relationship between resistance and time

LV winding "0" minute resistance is 25.304 ohms.
R1=Cold resistance at 32.60ºc 22.300 m.ohm between 2V2W
R2=Hot resistance at 24.46ºc 25.304 m.ohm between 2V2W

Table 6. LV winding TRT results

Drop in mean Temperature Is As Under.	
Mean Oil Temperature Corresponding To Final Oil Temperature Rise	28.2°c
Mean Oil Temperature at Time Of Measurement Of LV resistance	28.03°c
Drop In Oil Temperature	0.8°c
Final HV Winding Temperature Rise	42.35°c

Table 7.HV and LV winding TRT results

sr. no.	Final Temperature rise	Measured (°c)	Guaranteed (°c)
1	Oil Temp.Rise	34.6°c	35°c
2	HV Wind. Temp Rise	39.3°c	45°c
3	L.V Wind. Temp.Rise	42.35°c	45°c

Table 8.comparison old and improved TRT results

Type of Oïl	Old	Improved
Oïl Rise (Degree Celsius)	35.33°c	34.6°c
HV Winding Rise(°c)	40.33°c	39.5°c
LV Winding Rise(°c)	46.59°c	42.35°c

7. Conclusion

In summary, it is possible to enhance the design of oil-filled transformers by analyzing these results and reducing the rise in oil temperature and winding temperature. That can lengthen the life of transformers. The Temperature increase in transformers is caused by LV winding temperature rising by 46.39 °C and HV winding temperature increasing by 40.14 °C. Heat is building up in the LV windings. It will need transformer design improvement to overcome this problem. As a result, the transformer's radiators and cooling ducts are made larger, which raises the temperature. A satisfactory test was conducted on the HV and LV windings of the 42.35°C and 39.5°C transformers.

References

[1] 1Nileshkumar Patel, 2, Pankti Shah, and 1,2 Electrical Department, Parul Institute of Technology,Vadodara,India, “Thermal Modelling of Power Transformers”.

[2] AEPL reference standards and documents.

[3] Apar Industries Ltd. And Savita Oil Technologies Ltd.

[4] Daniel J. Tylavsky, Senior Member, IEEE, Qing He, Student Member, IEEE, Jennie Si, and Gary A. McCulla, Member, IEEE, and James R. Hunt, Member, IEEE, “Transformer Top-Oil Temperature Modeling and Simulation”.

[5] Guerin C., Meunier G., ¨Surface Impedance for 3D Non-linear Eddy Current Problems – Application to Loss Computation in Transformers¨, IEEE Trans. of Magnetics, Vol. 32. No.3, pp. 808- 811, May 1996.

[6] https://cdn.standards.iteh.ai/samples/15221/c6a77584aa9145539aadd9eb505ea4c1/EC-60076-2-2011.pdf

[7] https://law.resource.org/pub/in/bis/S05/is.2026.1.2011.pdf

[8] https://law.resource.org/pub/in/bis/S05/is.2026.1.2011.pdf

[9] https://law.resource.org/pub/in/bis/S05/is.2026.1.2011.pdfhttps://law.resource.org/p

[10] https://webstore.iec.ch/preview/info_iec60076-1%7Bed3.0%7Db.pdf

[11] Jonathan W. Stahlhut, Member, IEEE, Gerald T. Heydt, Fellow, IEEE, and Nancy J. Selover, "A Preliminary Assessment of the Impact of Ambient Temperature Rise on Distribution Transformer Loss of Life".

[12] P. Georgilakis, N. Hatziargyriou, D. Paparigas, AI helps reduce transformer iron losses, IEEE Comput. Appl. Power 12 (4) (1999) 41–46.

[13] P.S. Georgilakis, N.D. Doulamis, A.D. Doulamis, N.D. Hatziargyriou, S.D. Kollias, A novel iron loss reduction technique for distribution transformers based on a combined genetic algorithm–neural network approach, IEEE Trans. Syst. Man Cybern. C 31 (February) (2001) 16–34.

[14] Power Transformers—Part 1: General, IEC Standard 60 076-1, 2000.

[15] Rizzo, Marisa, Antonio Savini, and Janusz Turowski. "Influence of flux collectors on stray losses in transformers." *IEEE transactions on magnetics* 36, no. 4 (2000): 1915-1918

[16] Sakellaris J., Meunier G., Brunotte X., Guerin C. and J.C. Sabonnadiere., ¨Application of the impedance boundary condition in a finite element environment using the reduced potential formulation¨, IEEE Trans. of Magnetics, Vol. 27. No.6, pp. 5022- 5024, November 1991.

[17] Sippola, Mika, and Raimo E. Sepponen. "Accurate prediction of high-frequency power-transformer losses and temperature rise." *IEEE Transactions on Power Electronics* 17, no. 5 (2002): 835-847.

[18] T. Renyuan, L. Yan, L. Feng, T. Lijian, ¨Resultant Magnetic Fields due to Both Windings and Heavy Current Leads in Large Power Transformers¨, IEEE Trans. of Magnetics, Vol. 32. No.3, pp. 1641-1644, May 1996.