Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol.14 , Issue 3 (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Online Preventive Maintenance of HT Switchgear with Ultrasound Inspection

Dr. Heena Mishra[1]*, Mayank Jain[2]

[1*]Assistant Professor,Bhilai Institute of Technology, Durg, C.G,India, heena.mishra@bitdurg.ac.in

[2]DGM, Bhilai Steel Plant, CG, India

*** Corresponding author:**

Dr. Heena Mishra

Cite this paper as: Dr. Heena Mishra, Mayank Jain (2025) Online Preventive Maintenance of HT Switchgear with Ultrasound Inspection. Journal of Neonatal Surgery, 14, (3) 412-415

ABSTRACT

Partial discharge (PD) in insulation of equipment is prevalent cause of breakdown in switchgear. Even PD slowly deteriorate the insulation, and it take years before breakdown though it was difficult to detect PD in early stage. By combination of the basic characteristic of PD (radiate ultrasound waves) and advancement of technology to detect and quantify ultrasound noise, we have devised a preventive maintenance methodology to detect PD.

In BSP we have history of breakdowns due to Partial Discharge. Some breakdowns cause interruption in production from only one equipment where some breakdowns cause interruption in whole plant. One such breakdown is on 5th Aug 2012, where failure of end termination of 11KV feeder from MSDS-2 to SS-15 caused production loss of around 8 hours in whole 4 MT area of the plant. Financial loss of this breakdown will cross 8 digit figure.

We needed an online preventive maintenance policy to detect these faults in early stage to plan shutdown and rectify faults before any breakdown. Ultrasound inspection is the solution for our problem...

Keywords: *Partial discharge, preventive maintenance, ultrasound monitoring, switchgear, online electrical fault detection...*

INTRODUCTION

In medium voltage switchgear, many electrical failures are caused by gradual degradation of Insulation of equipment such as insulators and cable end joints. In Bhilai Steel Plant (BSP) such failure of insulation in our 6.6KV and 11KV unearthed system not only causes breakdown in affected equipment but elevated voltages of other phases can cause multiple breakdowns and degrade insulation of the whole system [1],[2],[5].

In continuous process industry like BSP, interruption of power supply for a few minutes or a small voltage dip interrupts production for hours. This increases severity and loss of these breakdowns many fold.

Although this degradation of Insulation, which generally have partial discharge, is a very slow process but we were unable to detect these faults in early stages [3],[4]. We were able to detect these faults only when this insulation degradation reaches to last stage and start audible or visible partial discharge. As all the switchgear panels are covered and In BSP we have about 1800 HTswitchgear Panels with more than 30,000 insulators and 4000 cable end termination., To see and hear this partial discharge was a difficult task and sometime it goes undetected and leads to a breakdown.

ULTRASOUND MONITORING: A PREVENTIVE MAINTENANCE METHODOLOGY

Partial discharge in electrical insulators gradually degrades insulation level and eventually leads to complete breakdown of insulator and unscheduled downtime of equipment. These partial discharges can produce ultrasound waves which can be a good indicator of detritions of insulation. Monitoring Ultrasound on switchgear can detect fault on early stage, this will give time to plan and execute preventive maintenance of equipment and prevent breakdown and unscheduled downtime.

This ultrasound can be heard with a good ultrasound data collector. An expert can differentiate from corona, arcing, and tracking by the sound alone. Indoor applications require the general area to also be scanned for competing parasite noises.

In Bhilai Steel Plant we use an ultrasound data collector (SDT-170 model). To detect ultrasound waves. We put ultrasound sensor on any small hole in switchgear panel and if there is an air channel between sensor and location of partial discharge, Sensor detects the ultrasound waves and gives us a signal of the fault. This method has the following advantages.

....:

Early detection of faults. This give us time to plane shutdown of equipment and avoid unscheduled downtime

Detect fault in acoustic line of sight (i.e. an air channel), no direct contact needed.

Very safe to use as no contact with live line is needed.

On-Line testing:

No shutdown is needed for inspection.

More reliable as detect faults on real operating conditions.

Pin point fault: We can accurately pin point the location of partial discharge as this point has maximum intensity of ultrasound waves.

Improve quality of maintenance: A thorough inspection before shutdown will give us anides about the the points of week insulationand will plan in advance to attack weak points during maintenance.

ACHIEVEMENTS:

We have started ultrasound monitoring in Bhilai Steel Plant on 31st August 2012 and in short span of just five months:

Financial saving:

Savings from avoided production loss is Rs 2,50,40,000

Savings from avoided damage to switchgear equipment Rs 5,75,000

Total saving Rs 2,56,15,000

Partial discharge/ Degraded insulation was identified at 35Locations.

157 number of Insulator changed.

7Cable end termination are replaced.

Preventive maintenance of 3 number 11KV Sectionswere carried out.

Outcome: Comparison of past and present

We have implemented this preventive maintenance methodology on 31st Aug 2012, just before the monsoon season. In monsoon season, High moisture content in air causes more breakdowns of insulation and end termination. Significant reduction of breakdowns in this season will represent success of new preventive maintenance methodology. These three graphs show the breakdowns in peak monsoon season (October to December i.e. second quarter of financial year).

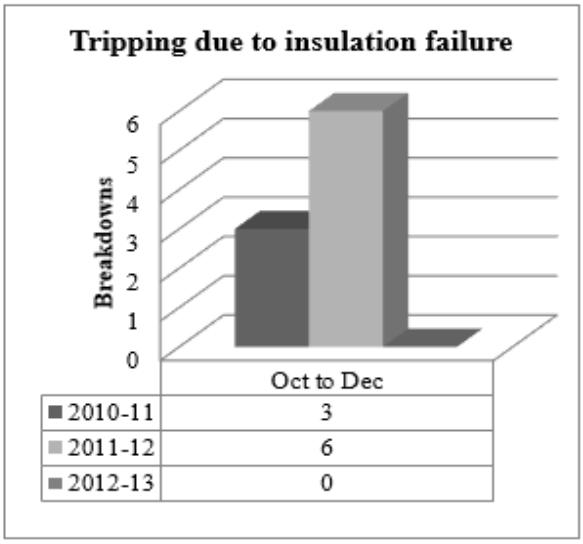


Chart No. 1

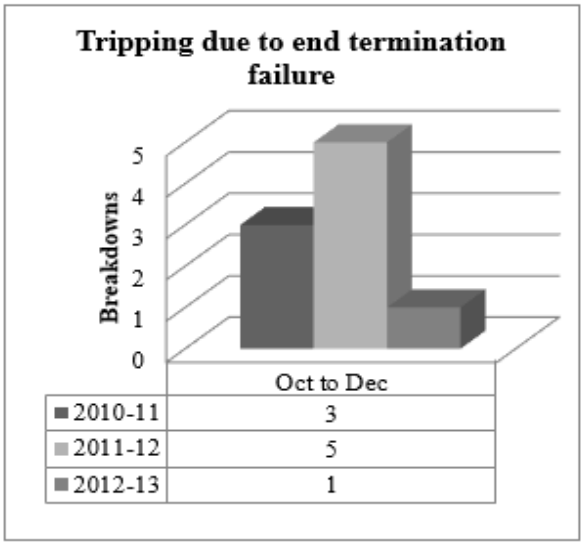


Chart No. 2

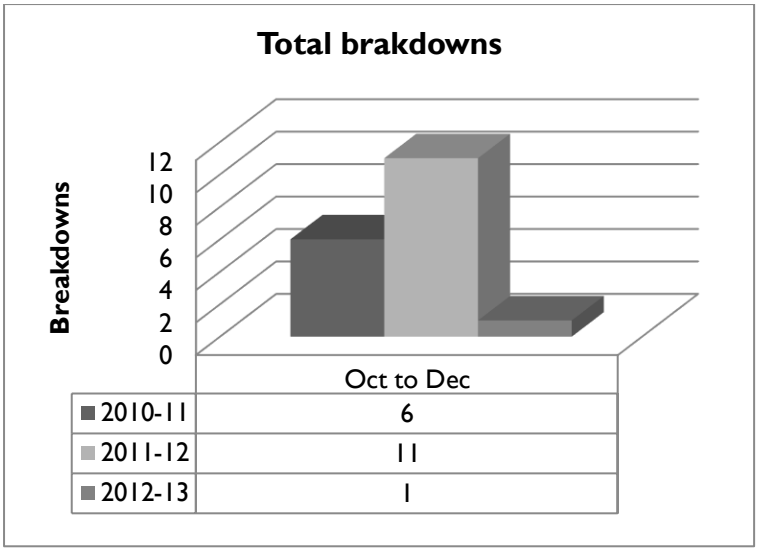


Chart No. 3

After implementation of ultrasound inspection we have nearly 90% reduction in number of break downs as compared to same quarter of previous years.

LEARNING:

Partial discharge detected on Insulation of an equipment (It has two type of discharges)

Tracking on surface: This type of fault generates with the ageing of insulation of equipment. In early stage; Tracking can be removed completely with cleaning fromCRC cleaner spray than after 5 minute apply anti-tracking spray.

If damage due to tracking is visible, it is better to change the equipment.

If feasible it is always better to change equipment or its complete insulation.

Partial Discharge within Insulation: If any void is present Within insulator, this void cause voltage breakdown inside insulation and initiate partial discharge. This type of fault is generally irreparable, so it is recommended to change the equipment.

This type of fault are generally developed during manufacturing and rarely develop during normal life of insulation. Ultrasound monitoring on newly installed equipment will help us to identify week insulation supplied.

Any additional insulation above the faulty insulation cannot fill the void in the insulation so this cannot repair the fault. Ultrasound noise may subdue but partial discharge within insulation will continue and ultimately damage the equipment.

Partial discharge on HT Cable End Termination:

We have observed that most of the time cable end termination has some internal partial discharge and if it has some visible tracking on the any part of insulation it damages the insulation sleeve and generally it is irreparable so it recommended to change the end termination.

Ultrasound inspection is not very effective in places where some other dominant source of ultrasound is present or an air channel to access fault does not access.

Places where this method does not work.

Straight through joint in HT cable.

Any place where some source of ultrasound noise (Other than PD) is present.

Known sources of ultrasound noise in industries:

Any leakage from a high-pressure pipe.

Defective Chock of a tube-light. (Switch off light to remove this source)

Most of the rotating machines so this method is not very useful at shop-floor.

Most of the faults identified by the inspection are in our 11KV system and very few are in 6.6 KV system. If we check our tripping/ breakdown records we find that most of cases of insulation failure are found in 11KV network. This confimrs that partial sichargeincreses when voltage increases.

CONCLUSIONS

We have devised a preventive maintenance methodology with on-line inspection capability (no shut down is needed for inspection), which accurately pinpoint location of fault, very safe to use and detect fault in early stage. This method accurately detects partial discharges on insulators and cable end terminations and avoided breakdowns in 35 locations. Avoided production loss &avoiding damage to equipment saved Rs 2,56,15,000.

Success of this method is demonstrated by acute reduction in number of breakdowns due to insulation or end termination failure. We reduced number of breakdowns from 6 and 11 from 3rd quarter of financial year 2010-11 & 2011-12 respectively to just one breakdown in same quarter of 2012-13.

FUTURE WORK

Implement this preventive maintenance methodology in other plants of SAIL.

Partial Discharge in EHT equipment: Partial discharge in EHT (132 KV & 220 KV) equipment has similar ultrasound profile. This enables us to use Ultrasound inspection on EHT equipment.

Leakage from high pressure pipes also generate ultrasound wave. It is possible to detect leakage in high pressure pipes with ultrasound inspection.

Ultrasound noise is generated in rotating machines and other process in shop-floor of an industry.This noise decrease utility of ultrasound inspection and make it difficult to detect PD in shop-floor. There is a need to find some method to filter ultrasound noise in environment to make ultrasound inspection feasible at shop-floor...

REFERENCES

[1] IEC 60270: Partial Discharge Measurements - Advanced Test Equipment Rentals, accessed on July 14, 2025, https://www.atecorp.com/compliance-standards/iec/iec-60270

[2] Partial discharge - Wikipedia, accessed on July 14, 2025, https://en.wikipedia.org/wiki/Partial_discharge

[3] . H. Alshalawi and F. S. Al-Ismail, "Partial Discharge Detection Based on Ultrasound Using Optimized Deep Learning Approach," in IEEE Access, vol. 12, pp. 5151-5162, 2024, doi: 10.1109/ACCESS.2024.3350555

[4] Hong Liu, Zhixian Zhang, Zhiqing Shu, Jianxin Wang, Ruimin Song, Haoyuan Tian, Xuetao Duan, Wentao Zhang, Yuxuan Song, WeigenChen,Ultrasonic detection of partial discharge in oil-paper insulation based on fiber-optic dual-coupled F-P sensor,Measurement,Volume 263,2026,120172,ISSN 0263-2241, https://doi.org/10.1016/j.measurement.2025.120172.

[5] T. Boczar, S. Borucki, A. Cichon, and D. Zmarzly, “Application possibilities of artificial neural networks for recognizing partial discharges measured by the acoustic emission method,” EEE Transactions on Dielectrics and Electrical Insulation, vol. 16, no. 1, pp. 214–223, 2009.

[6] L. Lundgaard, “Partial discharge. xiii. acoustic partial discharge detection fundamental considerations,” IEEE Electrical Insulation Magazine, vol. 8, no. 4, pp. 25–31, 1992.

[7] M. Frigo and S. G. Johnson, “The design and implementation of fftw3,” Proceedings of the IEEE, vol. 93, no. 2, pp. 216–231, 2005.

[8] J. B. Allen and L. R. Rabiner, “A unified approach to short-time fourier analysis and synthesis,” Proceedings of the IEEE, vol. 65, no. 11, pp. 1558–1564, 1977.

[9] “Short-timefft,” 2019. [Online]. Available: https://www.mathworks.com/ help/dsp/ref/dsp.stft.html

[10] J. Gu, Z. Wang, J. Kuen, L. Ma, A. Shahroudy, B. Shuai, T. Liu, X. Wang, G.Wang, J. Cai et al., “Recent advances in convolutional neural networks,” Pattern recognition, vol. 77, pp. 354–377, 2018.....