International Journal of Electronic and Electrical Engineering.
ISSN 0974-2174, Volume 7, Number 2 (2014), pp. 129-134

http://www.irphouse.com

Condition Assessment of Busbar Insulation System Subjected to Hazardous Fire Using Dielectric Technique

C. Viswanatha[1], AR. Sreenivasan[2], GP. Vittal[3], R. Arunjoti[4] and V. Mohan Babu[5]

[1,2,3,4,5]*Central Power Research Institute, Bangalore.*

Abstract

Recently new design of sandwich busducts is available for power delivery applications to conserve space & compact design. Invariably dielectric material is employed to sustain thermal electric stresses besides mechanical fire hazardous. In this context, it is imperative for utilities of electrical network to ascertain fire survival of critical components such as electrical cables & busducts. The models have been designed considering sandwich busduct which are intended for underground as well as high rise buildings. The models have been subjected to fire resistant test as per international practice. The conductor of bus of each phase, insulation resistance of busducts & Dielectric dissipation factor have been monitored before and after fire survival test, the assessment of state & condition of busduct has been determined taking into account the data generated and its analysis..

Keywords: Busduct, Dielectric measurement, fire resistanant, Dielectric dissipation factor, insulation condition, resistance, polarisation index.

1. Introduction

The increase in demand for high rise buildings, constraint of space & mass transit underground rail system has brought about new designs of electrical network components such as electrical cables, busducts & others. Accordingly new design concepts for the components such as busducts which are compact, space saving besides fire resistant have resultant in the development of sandwich type busducts which are supposed to survive in fire hazards and also to prevent fires for further propagation. However there are at present no standard references to assess the condition of busducts because the impact of fire brings about vast damage to the buildings and electrical components.

For standardisation purpose, a number of parameters responsible for functioning of sample in specific applications such as fire model, design considerations, economical aspects are required to be considered[1].The dielectric materials are employed in many applications including several electrical equipments such as busbar systems. Recently new design of sandwich busducts is available for power delivery applications to conserve space & compact design. In this context, it is imperative for utilities of electrical network to ascertain fire survival of critical components such as electrical cables [1,3]& busducts.

2. Experimental Work

The laboratory models of busducts containing five busduct conductors each of which is for three individual phases, neutral & grounding systems. All these conductors except grounding bus are covered with insulating material of thickness of about 2mm approximately. The cross section of each phase and neutral conductor is 120 X 4 mm, whereas the grounding busbar / conductor is 80X3 mm and it is made of copper material of high conductivity and high purity. These five conductors are moulded with suitable spaces in a metallic enclosure of length 1.5 metres and square cross section 125mm X 185mm.

The dielectric measurements are carried out on a fresh model of busduct. The conductor resistance has been measured for all the conductors of the busduct using micro ohm meter. The experimental setup has been shown in Fig 4.

Fig. 1: Test setup of IR & PI measurement

Fig. 4: Test setup for - Conductor resistance measurement

The insulation resistance has been determined by means of insulation resistance which is shown in the Fig 1 at constant DC voltage of 500V. The experimental setup has been shown in Fig 2. The dielectric dissipation factor also called as tandelta is measured with standard bridge circuit at voltage of 1kV. In this test both capacitance and tandelta have been measured at 500V & 1kV for each phase of the busduct with respect to insulation system of enclosure of the busduct. The experimental setup has been shown in Fig 3.

Fig. 2: Test setup of IR & PI measurement

Fig. 3: Test setup of Capacitance & tanδ measurement

The new busduct with all bus conductors, neutral and ground plate with clean surface is shown in fig 5 & 6. The busduct has been subjected to fire survival test [1,4]. The procedure for conducting the test has been adopted as per international specification. The experimental result after the fire survival test is shown in fig 7 & 8.

Fig. 5: Busduct before Fire Survival test

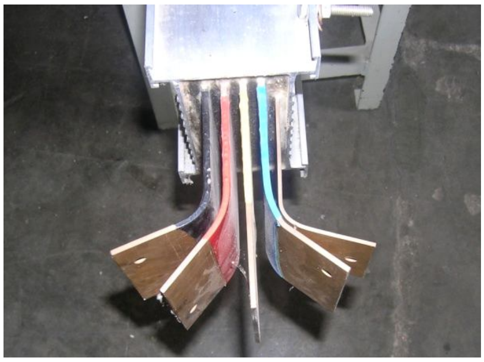


Fig. 6: The terminal ends of busduct models with dielectric envelope for new busduct model

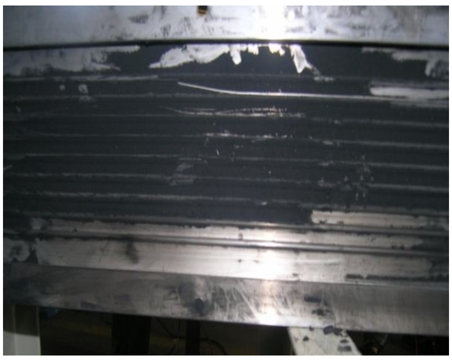


Fig. 7: Busduct after Fire Survival Test

Fig. 8: The terminal ends of busduct model with dielectric envelop after fire survival test

3. Results and Discussions

The two models of samples have been subjected to fire survival test has described in previous paragraphs. The sample 2 model busduct has shown heavy carbon deposit on the envelope of the enclosure as well as deposits of carbon on conductor surfaces of the bus, breakdown of insulation. The fig 5 shows the carbon deposits formed on the busduct. Fig 8 depicts the terminations of the busducts with insulation damage. Fig 7 shows the terminal ends of busducts which as survived from fire resistant test, the dielectric parameters also supports the condition of the busduct. In the case of sample 2 busduct model, there is enormous increase of dielectric dissipation factor to the extent of 10 to 15% of the magnitude. The insulation resistance values of the busduct showed abnormal low values of few mega ohms compared to initial healthy condition of sound insulation of order of a few giga ohms, this conclusively proves the extensive damage of insulation, high concentration of contaminants which require immediate remedial measurement for restoration of electrical network with proper, healthy well insulated busduct.

This clearly confirms the effectiveness of dielectric measurements for assessing the state of busduct in operation, this technique of measurement can be suitably employed in variety of site conditions. The table 1 indicates the values of conductor resistance measurement. The table clearly indicates distinct indications for poor / faulty busduct.

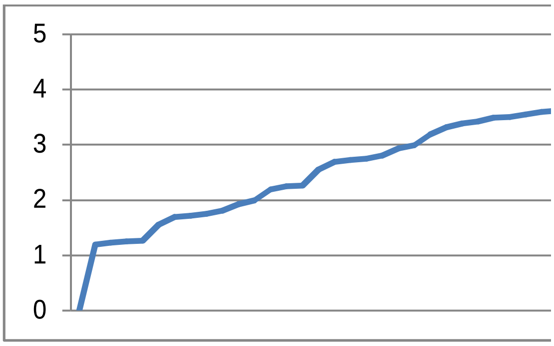
Table 1: Conductor resistance measurement.

Busbar	Resistance values of Sample 1 in μΩ	Resistance Values of Sample 2 in μΩ
R-phase	63.60	62.6
Y-phase	62.80	62.6
B-phase	62.20	62.6
Neutral	62.2	62.2
Ground	124.4	127.2

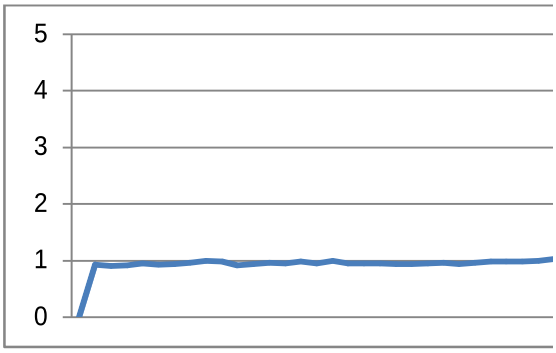
The table 2 shows the result of measurement for insulation resistant measurement for model samples 1& 2.

Table 2: Insulation resistant measurement.

Phase of Busbar	Insulation Resistance of values sample 1 in GΩ	Insulation Resistance of values sample 2 in MΩ
R-phase	59.40	48.80
Y-phase	53.30	31.80
B-phase	69.20	88.10



Plot of PI measurement for sample 1



Plot of PI measurement for sample 2

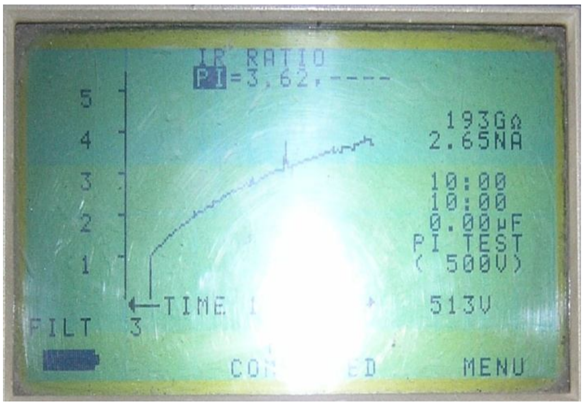


Fig. 9: The Oscillogram generated for polarisation Index test for busduct model.

Table 3 indicates the data obtained for tandelta measurements carried out on model samples 1& 2. It can be seen that there is heavy losses of insulation at voltage of 1kV in the case of failed sample 2 to the extent of 10 to 15% of tandelta. This determines severe faulty condition of insulation system of busduct in operation.

Table 3: Tandelta measurement.

Phase of Busbar	**tanδ values @ 1kV of sample 1 in %**	**tanδ values @ 1kV of sample 2 in %**
R-phase	5.25	> 10.00
Y-phase	5.20	12.68
B-phase	5.54	40.29

The above summary shows that there is a need for dielectric measurements on busduct system employed in various locations. It will help to monitor the state & condition of the busduct in-service before eventual failure occurrence. These measurements can be employed as periodical tools for routine maintenance of electrical network. The maintenance and operation of electrical network can be ensured to provide efficient and smart power delivery to the utilities.

4. Conclusion

The studies highlighted the following important points for Operation and maintenance of busducts used in electrical network which form the crucial components of the system.

1. The safe operation of functionality of busduct can be periodically monitored by dielectric parameters such as Insulation Resistance,Polarisation Index,lossfactor measurements. These parameters ensure smooth condition and state of the insulation of the Busduct.
2. The insulation condition of the busduct can also be diagnosied in the case of Busducts that are likely to be subjected and are subjected to hazardous environement such as Fire,chemical,thermal,mechanical stresses using the dielectric parameters.
3. The effect of Fire survival of Bus ducts can also be monitored.

5. Acknowledgement

The authors are thankful to the management of Central Power Research Institute, Bangalore for their support and consenting to publish this research work.

References

[1] Arunjothi R,"Techniques for evaluation of cables under fire conditions", Workshop on Insulation Engineering in the design of power cable systems Feb,2014.
[2] "High Voltage engineering", M S Naidu and V KamaRaju.
[3] "Fire Resistant test", IEC 60331,1999.
[4] "Fire survival test ",BS 6387,1994.