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Analysis of Electric field and stress control on 33 kV bushing

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***Abstract:** Electric field distribution is the one of the important factor for the life span of Bushing. In this paper, the Electric field and Electric potential along the bushings are simulatedand Analyzed. At first, the bushing is modeled and the electricalperformance of 33 kV bushing is analyzed.Second the E-field analysis of bushing with arcing horn was analyzed using Finite element method.*

***Index Terms**— Arcing horn, Bushing,Electricfield,Electric potential, Finite Element Method, Porcelain.*

I. INTRODUCTION

Bushing is the major part of a power transformer, which is used to insulate the center conductor from the grounded transformer tank. This is also used to make a connection between the transformer winding and the supply line. Mean while, bushings are the weakest components of transformers from the reliability point of view and one of the main reasons of transformer outages is the bushing failure. The performance characteristics of bushings are done by using artificial pollution test. The major parameters that affects the bushing are moisture ,soluble and non-soluble contaminations. While designing bushing the major criteria to be considered are Electrical stress and mechanical stress. Corona will occur on the surface of the materials because of high electric stress [1].Bushing is the important part of the transformer which ,may located in different place like coastal area,industrial polluted area that may affect he insulation around the bushing [2]. When pollution is wetted by rain or fog, there is an unwanted flow of current over the surface of the insulating material of bushing is called leakage current. An electrical discharge occurs between the live end of the bushing and another end of the bushing which cause reduction of flashover voltage in the bushing. The electrical stress can be reduced by using the corona Ring[3]. The electric field and electric potential distribution depends on Design, operation and performance of the HV bushing.. To improve the electrical performance various techniques are used, such as providing arcing horn, corona ring, and shed, end fitting design. partial and corona discharges occur in the insulator, because of non uniform E-field distribution. The following factors are responsible for generating heat in electrical insulator.

Heat is generated in the electrically stressed insulation, due to loss and conduction. Heat is imparted to insulation by the neighboring current carrying parts [4]

To avoid partial discharge and corona discharge the shape of bushing must be well designed. To analyze the electric stress is very much needed to investigate the Electric potential and E-Field distribution around the bushing[5]. The various numerical methods are used to calculate the field distribution, such as Finite difference method (FDM), Finite element method (FEM), and Boundary element method (BEM) and Charge simulation method (CSM).

Condenser body in the center is insulated with high quality insulated paper and it is act as an active part. Combination of paper stripes wound over the center tube with aluminum foils are helps in external flash over and internal puncture strength. Potential lapping and Adjustable arcing horns can be provided on the bushing against specific requirements[6].

Bushings sometimes fail due to partial discharge. This is sometimes due to the slow and progressive degradation of the insulation over many years of energized service; however it may also be a rapid degeneration which destroys a good bushing in a matter of hours. At present, there is great interest by the electricity supply industry in monitoring the condition of high voltage bushings[7]. Some of the Bushings are get failed early due to the lack of maintenance and Default problem in manufacturing. Arcing horn plays a major role in the protection of bushing during flash over. Over voltage on Transmission Line may occur due to various reasons like lightning strike, sudden load variation, fault etc[8]. Due to this high voltage a flash over may take place which will shatter the bushing. To prevent bushing from such an occurrence, it is very important that flash over do not take place through the bushing. While using an Arcing horn Flash over takes place in the air medium and Rescue the Bushing from High voltage. Arcing Horns are normally paired on either side of the bushing, one connected to the high voltage side of Insulator and the other to ground [9].

II. DISTRIBUTION OF ELECRIC FIELD AND DISTRIBUTION OF ELECRIC POTENTIAL

The strength of electric field is heavier in high voltage side and ground side. The E-Field distribution along the bushing is not uniform. While designing bushing calculation of electric field distribution is the most significant.[5] The distribution of Electric field in bushing depends on the following parameters, such as voltage applied, shed design and phase spacing etc. To reduce the discharge and stress in bushing, the Electric field distribution must be uniform

To analyse the simulation results of bushing conductivity and permittivity are one of the parameters. A voltage of 33 kV is applied to top of the electrode and bottom electrode is connected to the ground. Based on the number of domain in the geometry model, the material properties of the model will be imposed.Here we can differentiate the end result of the bushing with and without Arcing Horn. Conductivity and permittivity are the material property to simulate bushing

A. Simulation Results

Different types of meshes are selected depend on the boundary condition and its shape. In this we use 2D axial symmetry for the design of insulator. According to FEM the element is subdivided into triangular element.

From using the Arcing horn, the arc produced is tolerable for it and time can be enhanced to detect the fault and This arc can be also cleared by remote sensing control. The geometry of Arcing horn is Designed in such a way that the Arc is migrate away from the bushing ,as it heats the surrounding air. As a result ,the length of the arc increases, Electric field can be reduced and cause the arc to vanish away. This arrangement also called as magnetic blowout. The normal electric field distribution is disturbed by the presence of arching horn due to their significant capacitance. Fig.1 shows the 2D symmetrical normal bushing.Fig.2 shows the 2D symmetrical bushing with arcing horn

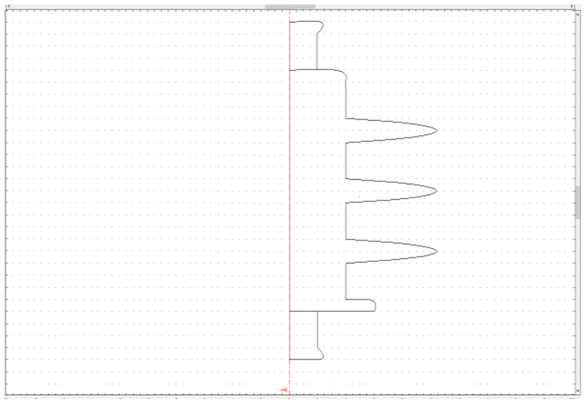

Fig 1. 2d Model Normal Bushing

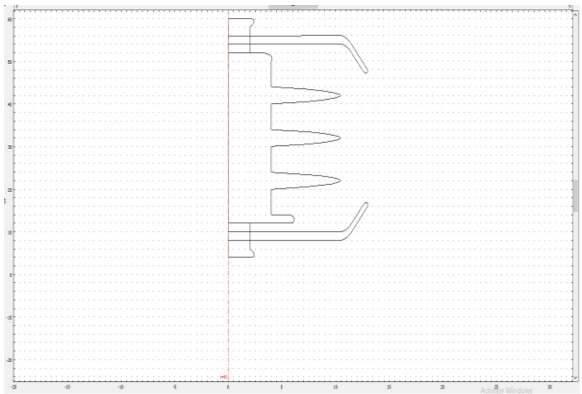

Fig 2. 2d Model Bushing With Arcing Horn

B. Analysis of Electric potential and Electric field distribution along the bushing

In this method we can measure Distribution of Electric potential and distribution of Electric field along the arc length of the bushing. The arc length measured on the Porcelain surface of the bushing from HV to ground end. Fig 3 and Fig.4 shows the variation along the bushing without and with arcing horn

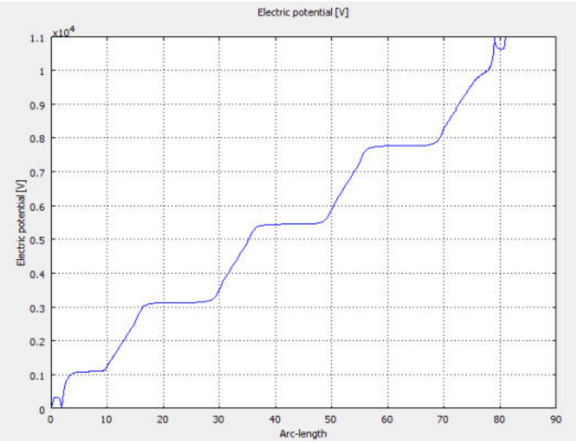

Fig. 3. Electric Potential Distribution Along Normal Bushing

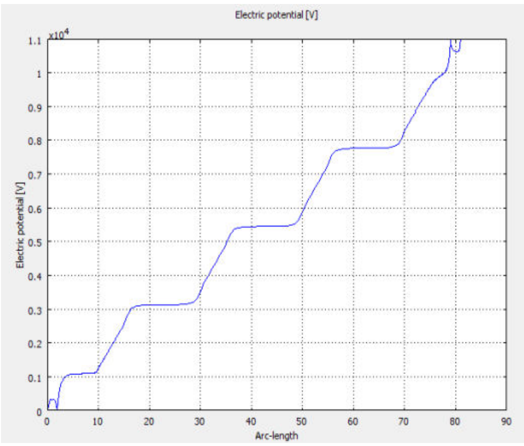

Fig.4. Electric Potential Distribution Along Bushing With Arcing Horn

Fig 5 and Fig.6 shows the variation of Electric field along the bushing with and without arcing horn. E-Field distribution is the major concern in bushing in normal bushing the electric stress occurs near the end fitting due this breakdown occurs in bushing to avoid the arcing horn is placed near the end Arcing horns are usually installed in bushing in order to protect it from the arc damage.When a high voltage

switch breaks a circuit, an arc is produced before the current can be interrupted.As the arching horns are placed in the bushing,the flash over takes place in air medium rather than the contact surface of the switch itself.

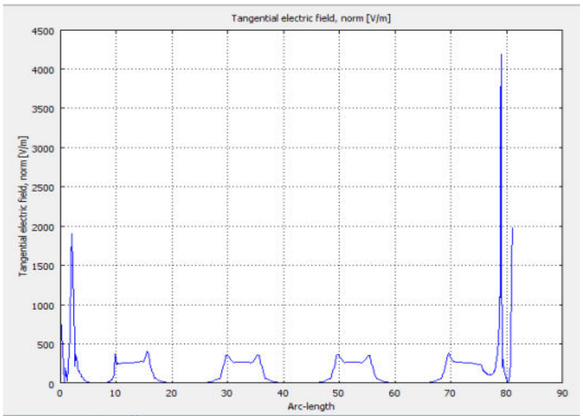

Fig. 5. Electric Field Distribution Along Normal Bushing

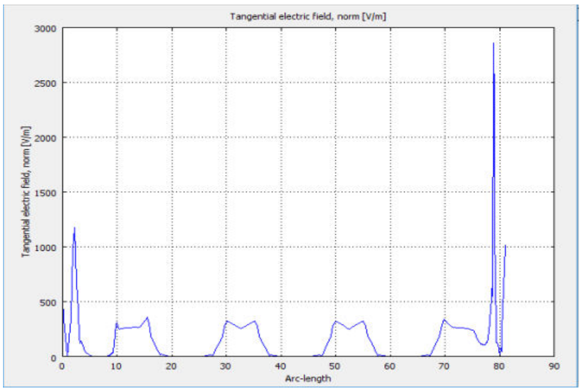

Fig. 6. Electric Field Distribution Along Bushing With Arcing Horn.

III. CONCLUSION

From the above simulation results the Electric Field distribution is analyzed, it is found that the electric stress is higher in end fittings and is distributed along the bushing. It is observed that the distribution of Electric field is highly influenced by the shape and structure of the bushing and the end fittings. The Electric Field plot of the different models shows us the electric stress on the bushing surface due to the voltage applied on the respective end fittings. The design principles for the proposed techniques are described and verified through a number of simulation scenarios .Different stress control configurations of the bushing with adequate geometry are analyzed .From the analysis, bushing with the Arcing horn on its end fitting results in the reduction of maximum E-field stress and it attains uniform E-field and potential distribution for Bushing.

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