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Analysis of Surge Arrester using FEM

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Abstract —*This paper presents the voltage distribution study of zno surge arrester. Based of the idea of using the FEMM 4.2 software whci work on the environment of finite element method. Here FEMM 4.2 software package is used for analyze voltage distribution along the zno varistor column of the surge arrester. In this paper is effect of grading ring on distribution of voltage along the zno column of 230 kv surge arrester is investigated using the finite element method based software. In a zno oxide surge arrester, the voltage distribution, between the high voltage and ground connections, is not uniform along the discs column. So by the use of grading ring voltage distribution is made uniform. Simulation results shows that using grading voltage distribution can be made as uniform as possible.*

Keywords- *zno surge arrester, voltage distribution, grading ring, finite element method based software FEMM 4.2, simulation.*

I. INTRODUCTION

When considering the electrical design of any high voltage equipment, its voltage distribution is a key aspect. Also to evaluate voltage distribution by employing testing is much costly. For correct performance of the arrester the voltage distribution along zno disc column is very important, in reducing the stability and reliability it may be a significant factor and therefore the lifetime of surge arresters. In practice non-uniformity is observed in the voltage distribution in the arrester. So because of this, discs near the top flange having high voltage are stressed more compare to the other discs of the zno disc column of surge arrester. As a result the discs at the top having faster thermal ageing. Efforts are made towards uniform distribution of voltage as possible as. In this paper finite element method based software is helpful for grading ring design and analysis of its performance for zno surge arrester.

Over voltages are classified into two groups. First one is originated from internal factors such as switching operations and the second is originated from external factors such as lightning discharges. Over voltages limits the design of the high voltage systems. A direct or indirect lighting stroke on a transmission line produces a steep fronted voltage wave on the line. The voltage on this wave may rise zero to peak value about in 1 µs and decay to half about in 5 µs. Such kind of wave will cause the travelling waves to travel in both the directions of the transmission line having velocity which depends on the inductance and capacitance of the line. Travelling waves due to lighting produced surges will make the insulators to shatter. Travelling waves due to lighting strikes generator or transformer winding, it can cause damage. Any kind of sudden change in electric charge in the windings is opposed by the winding inductances. Therefore, electric charges "piles up". So it results in the pressure between windings which may cause the breakdown if insulation and because of that arc produced. This cause the severe damage of the machine. The arc in electrical power system is initiated because of the lighting strikes, will result in severe disturbing types of oscillations in the transmission line. Due to this kind of oscillations may damage other important equipment that connected to the transmission line.

1.1 SURGE ARRESTER

The electrical power system is subject to transient over voltages due to lightning discharges and switching operations. Surge arresters are applied to limit the over voltages to values that can not cause damage on the important substation equipments and transmission lines. The voltage surges due to the lightning discharges and switching operations are limited by nonlinear resistive elements we can call them as metal oxide discs. Earlier in conventional surge arrestors silicon carbide elements were used and to prevent the continuous flow of leakage currents, spark gaps are required. As compare to that the modern metal oxide discs have low leakage currents that gaps are not necessary. Surge arresters are usually fitted with grading rings in order to have a more uniform voltage distribution along the height of the arrester. This ensures that some internal discs are not more severely stressed than others. Simply it is explained that the main task of a surge arrester is to protect important substation equipments and transmission lines from the effects of over voltages that are mainly caused by lighting discharges and switching operations. During normal operation, an arrester should have no negative effect on the power system. In other words it acts like an insulator. Moreover, without incurring any damage the surge arrester must be able to withstand typical surges. Location of surge arrester is normally to be as near as the important power equipment to be protected against the undesirable effects of voltages surges.

1.2 RATING OF SURGE ARRESTER

While there is selection of rating of surge arrester it is suggested to determine the lowest surge arrester rating that will ensure satisfactory operation. This is the effective and efficient solution because the selected surge arrester will not only provide the greatest margin of insulation protection but also be the most economical choice. It is advantageous to increase the rating of surge arrester above the minimum it increases the ability of surge arrester to survive during potential system contingencies, but compromises the protection of equipment insulation. The process of selection of rating should begin with consideration of the maximum system operating voltage. The maximum power frequency voltage expected under normal system conditions (line to- ground) should not exceed the selected arrester's maximum continuous operating voltage (MCOV). For ungrounded systems, systems which utilizing high impedance or resonant grounding and other systems where the line-to-ground voltage may be reached to line-to-line voltages for extended periods, arresters having an MCOV equal to line-to-line voltage may be required. The voltage rating of the arrester ranges between 75% to 105% depending upon the neutral grounding condition.

Suppose the surge arrester for the protection of 230kv system is provided. The earthing is such that line to earth voltage of un-faulted phase in occurrence of earth fault is 80% of the line to line voltage. With the 5% permissible over voltage during normal operating conditions, root mean square operating voltage of the surge arrester will be 230*1.05*0.80 = 193.2kv. The close for it the available standard rating is 198kV.

II. FINITE ELEMENT METHOD

Finite element method the field between electrodes is divided into discrete elements as in FDM. The shape of these elements is chosen to be triangular for two dimensional representation and tetrahedron for three dimensional field representation. The shape and size of these finite elements is suitably chosen and these are irregularly distributed within the field. It is to be noted that wherever within the medium higher electric stresses are expected e.g. corners and edges of electrodes, triangles of smaller. The finite element method is useful for estimating electric fields at highly curved and thin electrode surfaces with composite dielectric materials especially when the electric fields are uniform or weakly non uniform and can be expressed in two dimensioned geometrics. The method is normally not recommended for three dimensional non uniform fields.

In the finite element method the relevant field region is sub divided into a rectangular or triangular mesh, respectively. The potentials at the node points are solved numerically, taking into account the boundary conditions. Here simulation is done using FEMM 4.2 software package which works for analysis in 2- dimensional domains.

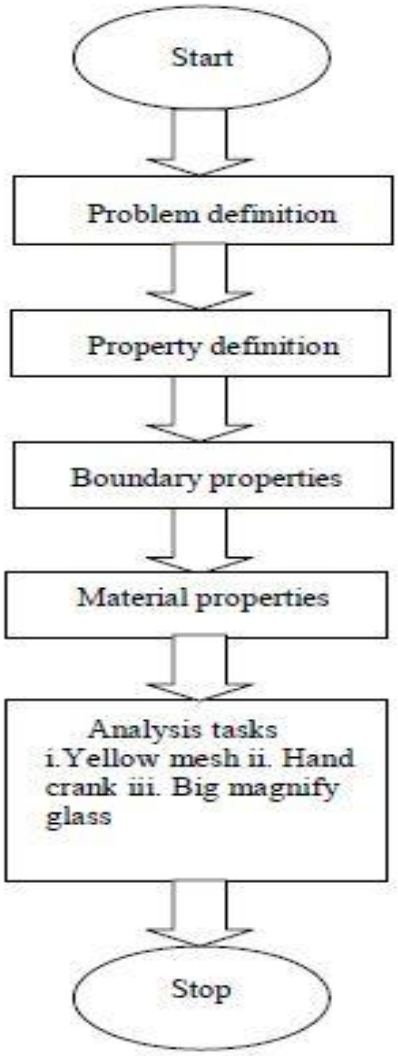

Figure 1 Flow Chart of Femm 4.2 Software.

III. TECHNICAL DATA OF ZNO SURGE ARRESTER USED FOR SIMULATION

IDENTITY	*VALUE*
Nominal voltage	***198 KV***
Maximum continuous operating voltage	***158 KV***
Creepage distance	***7650 mm***
Arcing distance	***1705 mm***
Height of surge arrester	***2205 mm***
Height of disc coloumn	***2000 mm***
Number of zno discs	***36***

Here relative permittivity of zno disc is 789 while the relative permittivity of porcelain is taken 6.

3.1 SIMULATION MODEL IN FEMM 4.2

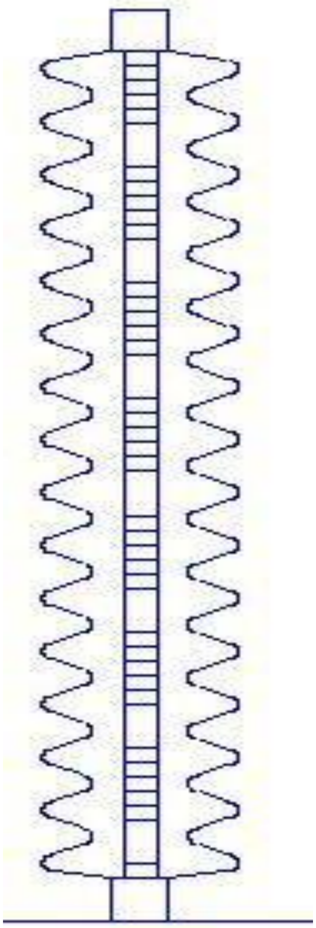

Figure 2 Surge Arrester Without Grading Ring.

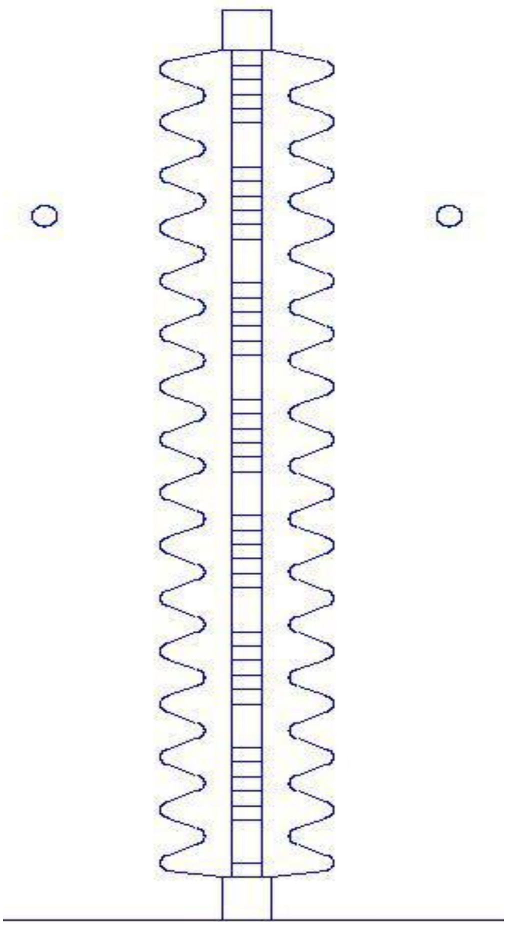

Figure 3 Surge Arrester With Grading Ring.

3.2 SIMULATION RESULT

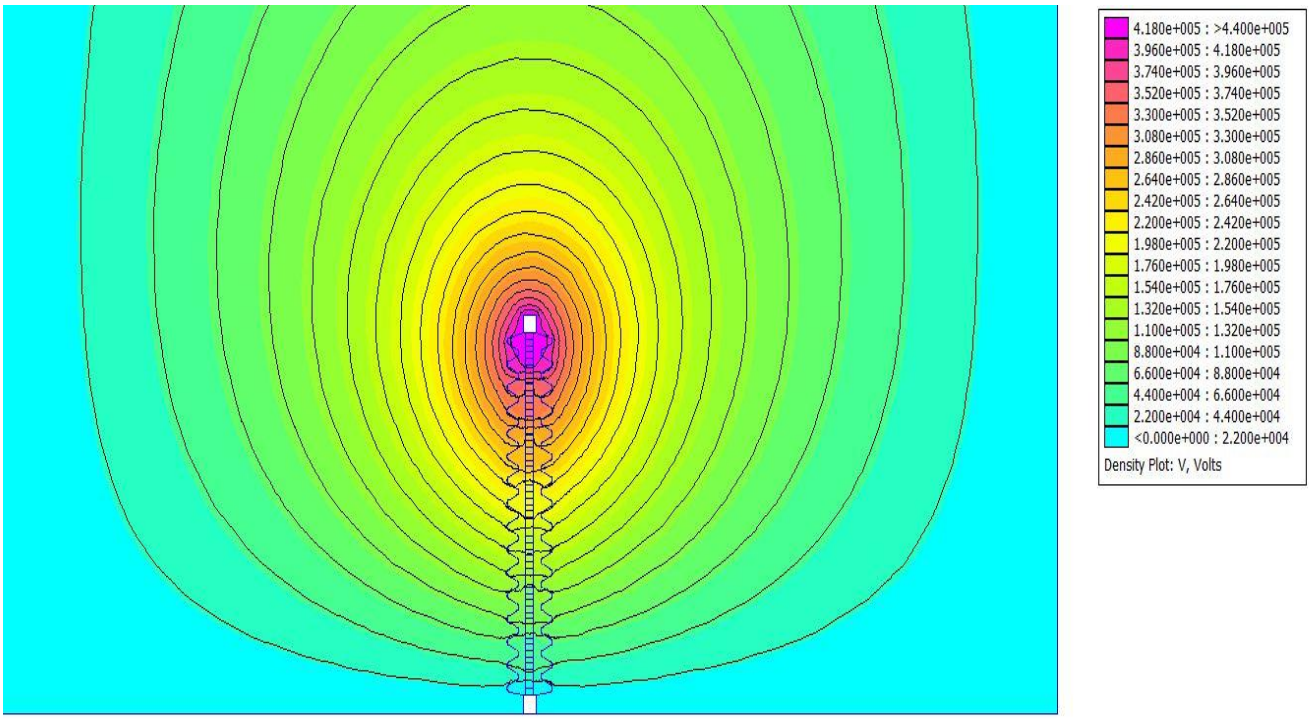

Figure 4 Voltage Distribution of Surge Arrester Without Grading Ring.

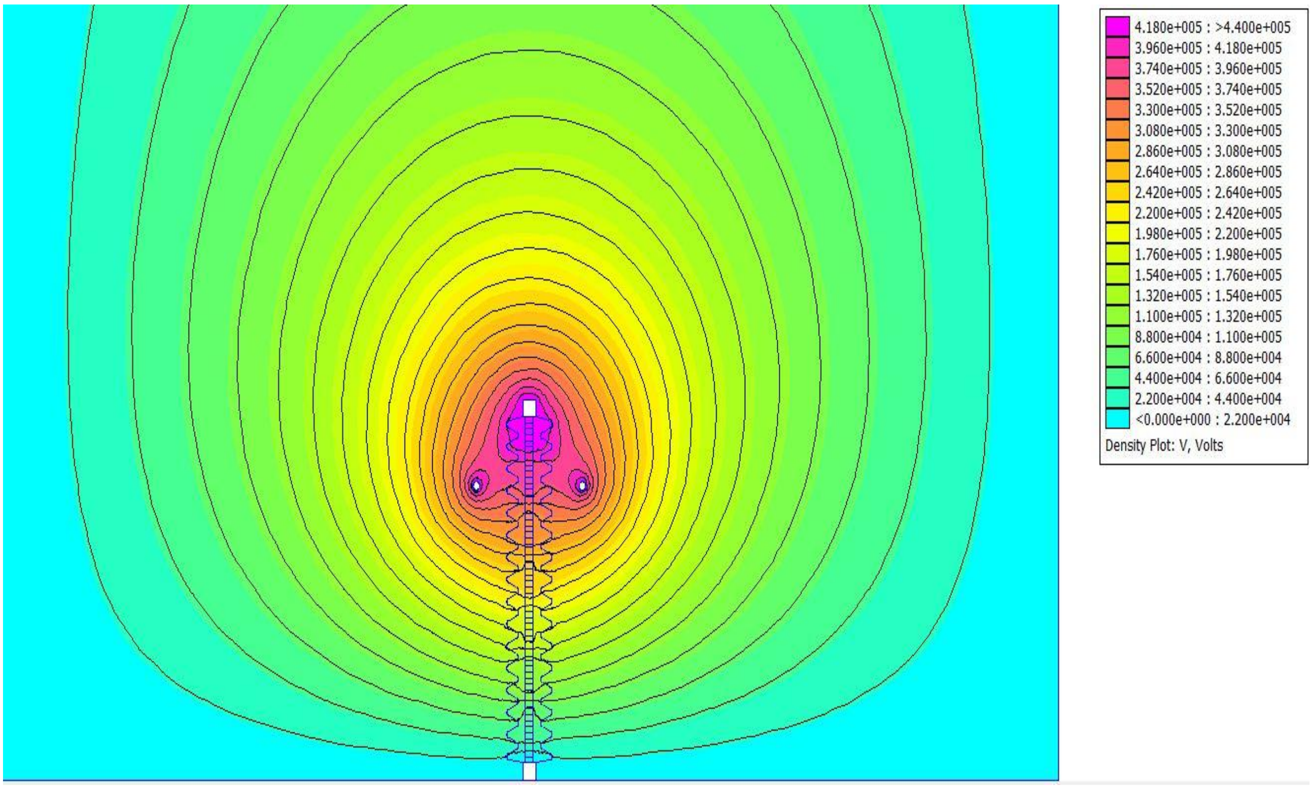

Figure 5 Voltage Distribution of Surge Arrester With Grading Ring.

3.3 VOLTAGE DISTRIBUTION GRAPHS

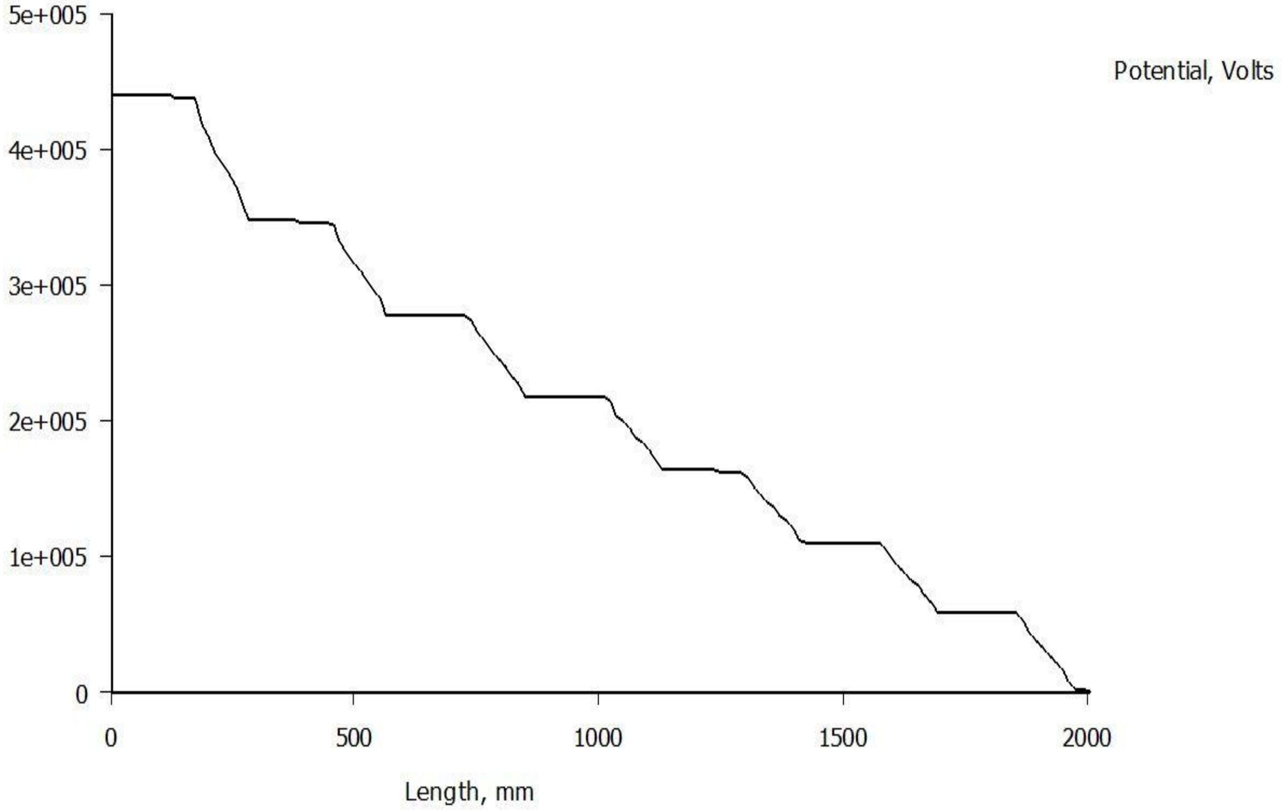

Figure 6 Graph of Voltage Distribution Along the Length of Surge Arrester.

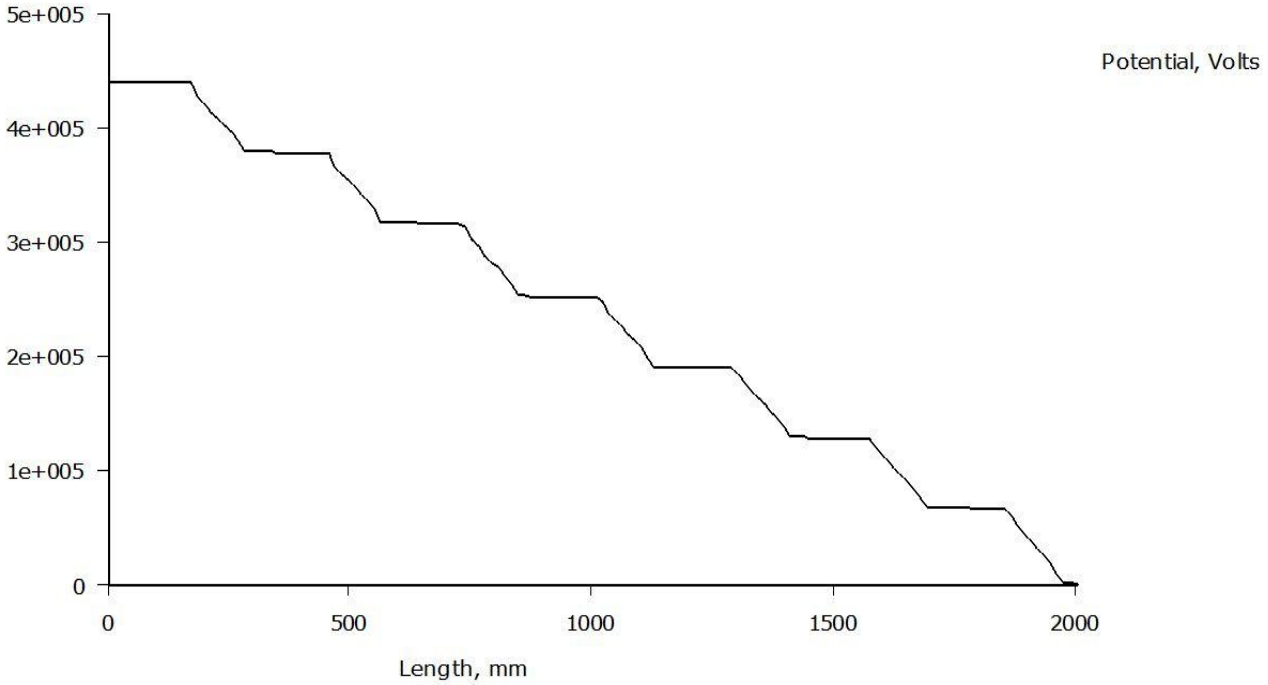

Figure 7 Graph of Voltage Distribution Along the Length Of Surge Arrester.

Here it clear that with the use of the grading ring the voltage distribution can be made uniform implies voltage stress on disc near the high voltage contact reduces and less the thermal degradation of the material that result in the increase life time of the surge arrester.

IV. CONCLUSION

In this paper simulation of surge arrester used of 230 KV system is simulated in FEMM 4.2 software without and with grading ring. It is important to note that grading ring is one of the most important factors in optimizing intensity of electrical filed of high voltage surge arresters and it makes the voltage distribution along the disc column as uniform as possible. So stress on the top discs near the top flange having high voltage is reduced. As a result of that the useful lifetime of surge arrester increases.

REFERENCES

[1] Amir hooshang vaez, Mehrdad movahedpoor and Seyed majid keshavarz : "Evaluating the effect of grading rings on distribution of electrical field enhancement of high voltage surge arrester of 230kv". scro research annual report vol. 2, pp. 140-144, 2014.

[2] R.Karthik Lecturer-EEE Dept, National Engineering College, Kovilpatti,Tamilnadu,India : "A Novel Analysis of Voltage Distribution in Zinc Oxide Arrester using Finite Element method". International Journal of Recent Trends in Engineering, Vol. 1, No. 4, May 2009.

[3] Chao Zhang, Jeffrey J. Kester, Charles W. Daley, and Stephen J. Rigby 2010 : "Electric Field Analysis of High Voltage Apparatus Using Finite Element Method". IEEE Annual Report Conference on Electrical Insulation and Dielectric Phenomena 2010.