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3D SIMULATION OF POLYMER INSULATOR WITH DIFFERENT FILLERS USING ANSYS SIMULATOR AND MATLAB

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Abstract— *An insulator gets contaminated under wet and polluted conditions which are reported in coastal environments and in industrial areas. Polymer insulator is a type of insulator which features good hydrophobicity and adhesive property to improve or maintain the flashover voltage. The disadvantage of polymer insulator is that it is costlier compare to other insulating material. This disadvantage can be overcome by using silicon rubber with fillers like ATH, Silica, Silicate, Alumina etc. The work proposed is to compare electrical characteristics of different Polymer insulator filled with different fillers using ANSYS simulation software and Matlab.*

Keywords—*Room temperature vulcanized, silicon rubber insulator, simulation of polymer insulator, 3D simulation of Insulator, Simulation RTV insulator*

I. INTRODUCTION

Insulator is very important part of power system. It provides isolation from earth and other phase or circuit. Main properties of insulator are flashover voltage and life span of insulator. Major type of insulators are Ceramic insulator which is made of glass or porcelain, Polymer insulator which is made of SR or EPR, Composite insulator which is made of a glass fiber reinforced resin rod with crimped end fittings, which carry the mechanical load and it is covered with a polymer housing. Outdoor insulator gets contaminated due to deposition of water, snow, salt or other pollutants. Due to contamination flash over voltage and life span of insulator is decreased. Polymer insulator which is made of silicon rubber consist hydrophobic properties which repel water due to which contamination of insulator is decreased. Ceramic insulator is not consists such kind of property because of which it has low flashover voltage and life span compare to polymer insulator. Silicone rubber has been used for many decades as housing material for composite insulators and for the cable accessories due to its unique features like substantial stability at high temperatures, hydrophobic properties, good UV radiation resistance and high elasticity. In this paper polymer insulators which is already been tested in paper [1] and which are used for mathematical modeling in paper [2] is simulated using ANSYS software and in paper [6] four different polymer insulator is simulated using Ansys software out of which type B insulator is used here also type B insulator with different fillers is simulated and compared to the pure silicon rubber type B insulator and graph is plotted for insulator discs Vs voltage distribution, insulator discs Vs electric field intensity and insulator discs Vs current density.

II. SAMPLE

The sample is the short sample of FXBW- 500/160 dc SIR composite long rod insulators, which is denominated by Type B. The profiles and technical parameters of the sample are shown in following Table 1, in which *D*1 is the diameter of larger shed, *D*2 is the diameter of smaller shed, *h* is the arcing distance, *L* is the leakage distance, *d* is the diameter of rod, *S* is the ratio of the leakage distance to the arcing distance, *N*1 is the number of larger sheds and *N*2 is the number of smaller sheds.

Table 1 Dimensions of insulators

Type	D1/D2(mm)	h(mm)	L(mm)	d(mm)	N1/N2
B	164/125	2290	7588	32	27/27

III. RESULTS OF SIMULATION

- **Pure Silicone Rubber**

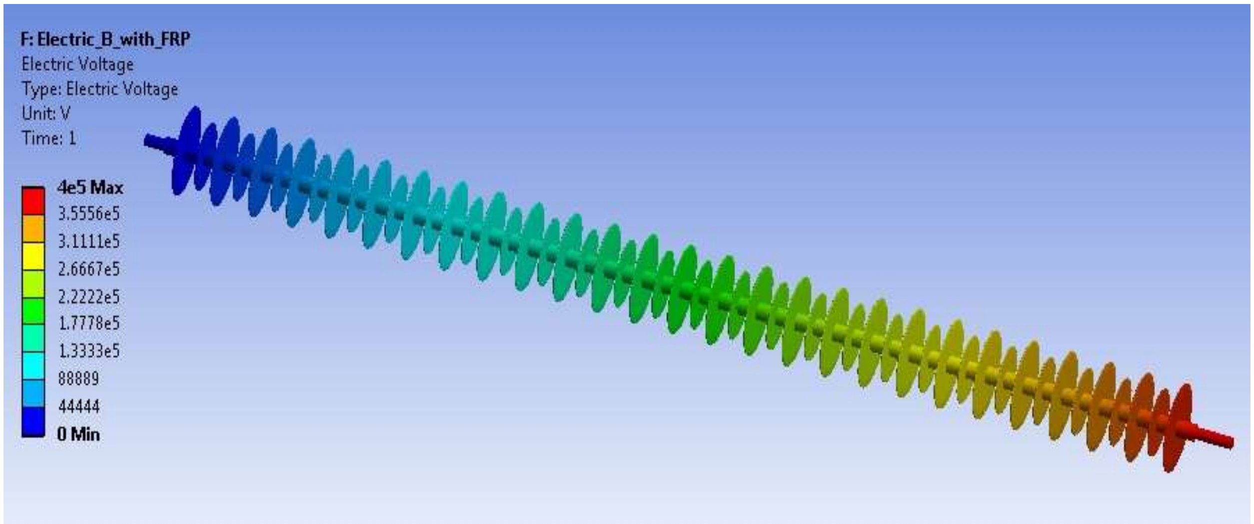

Figure 1 Voltage distribution in type B pure silicon rubber insulator at 400KV

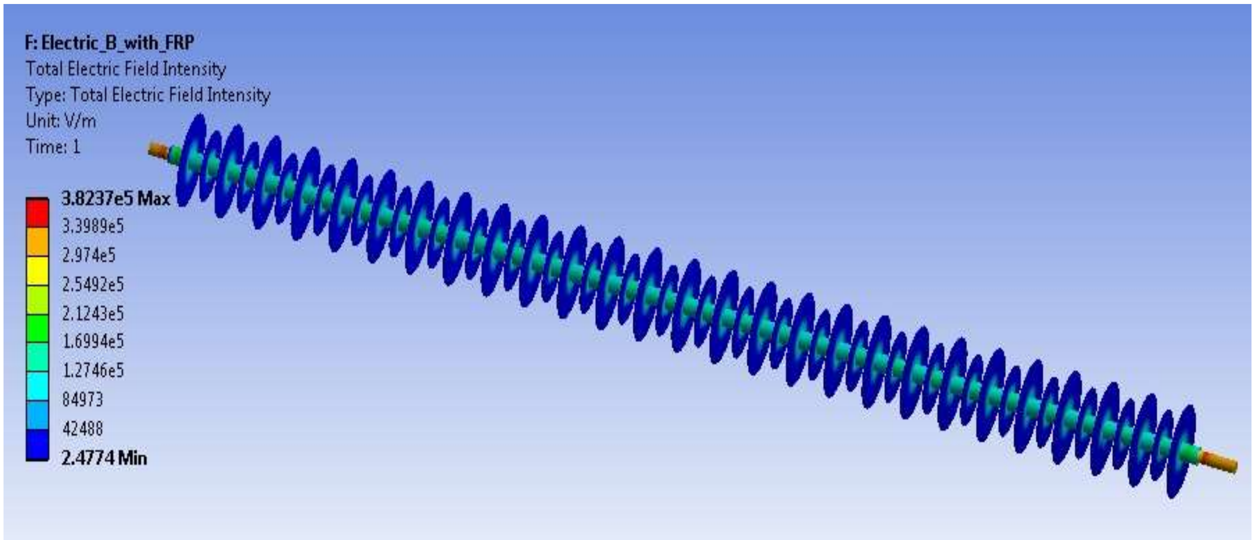

Figure 2 Electric field intensity of type B pure silicon rubber insulator at 400KV

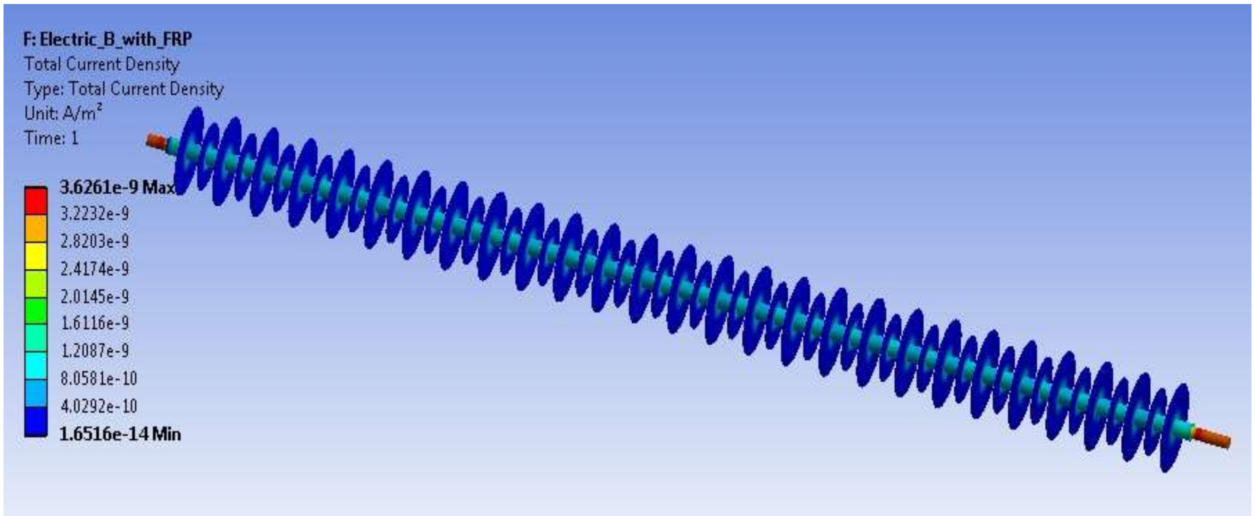

Figure 3 Current density of type B pure silicon rubber insulator at 400KV

- **Silicon Rubber + ATH 5%**

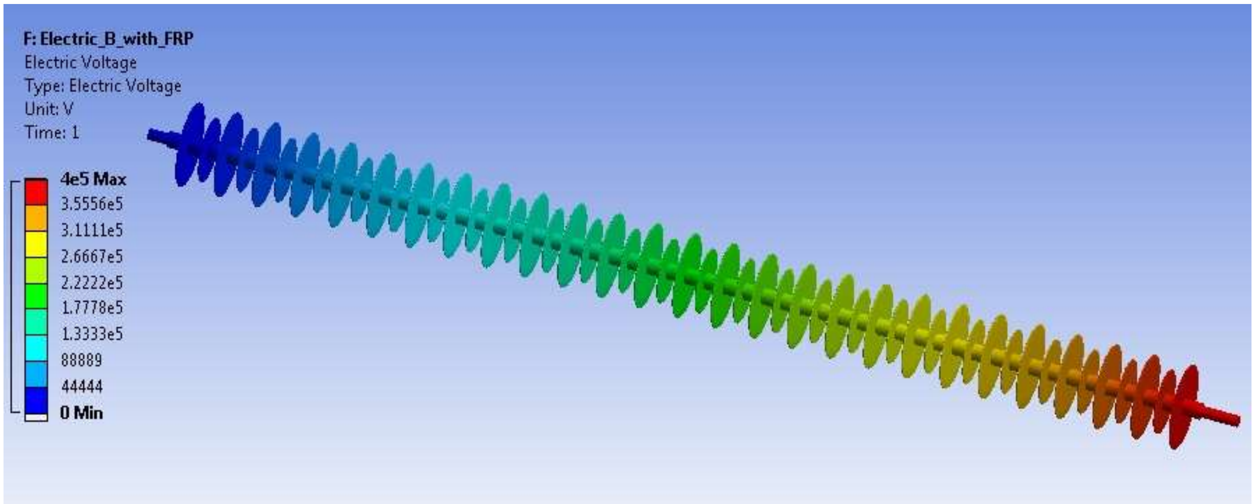

Figure 4 Voltage distribution in type B silicon rubber+5% ATH insulator at 400KV

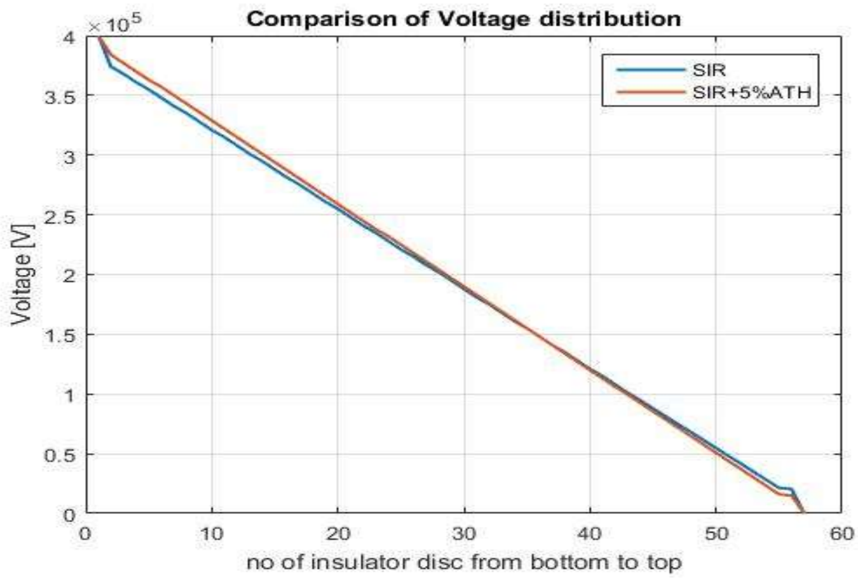

Figure 5 Comparison of voltage distribution between pure silicon rubber and silicon rubber+5%ATH type B insulator

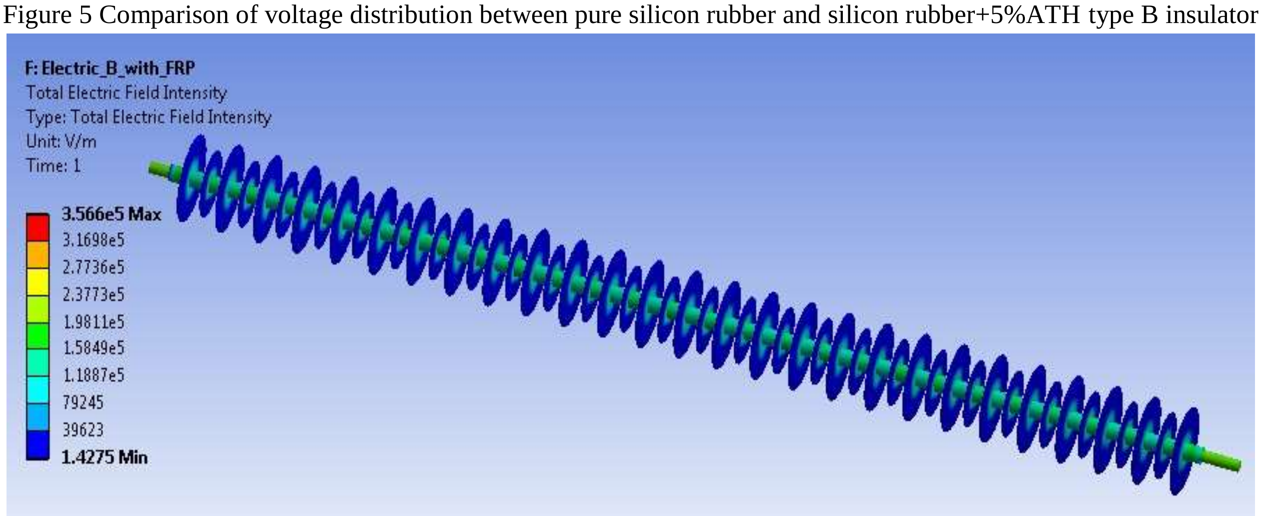

Figure 6 Electric field intensity of type B silicon rubber+5% ATH insulator at 400KV

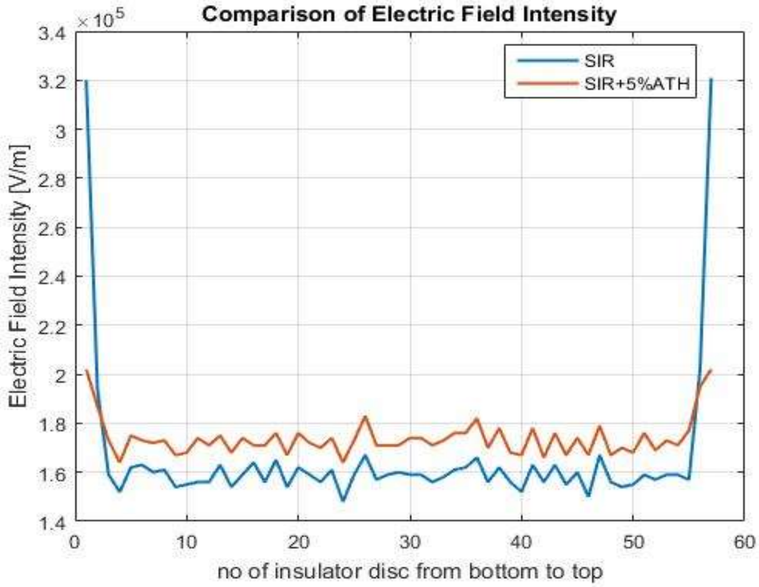

Figure 7 Comparison of Electric field intensity between pure silicon rubber and silicon rubber+5%ATH type B insulator

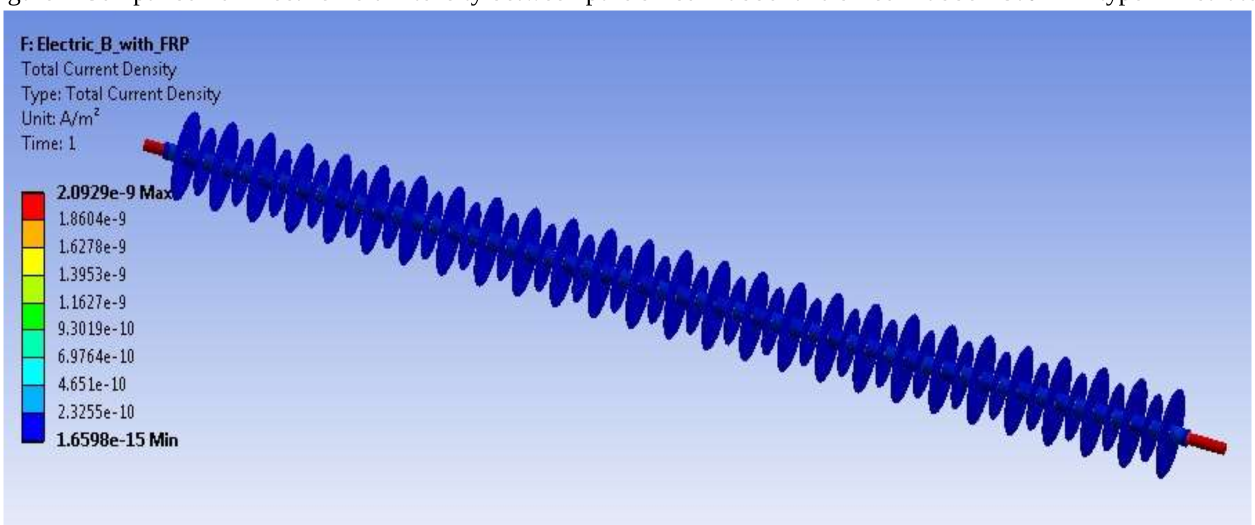

Figure 8 Current density of type B silicon rubber+5% ATH insulator at 400KV

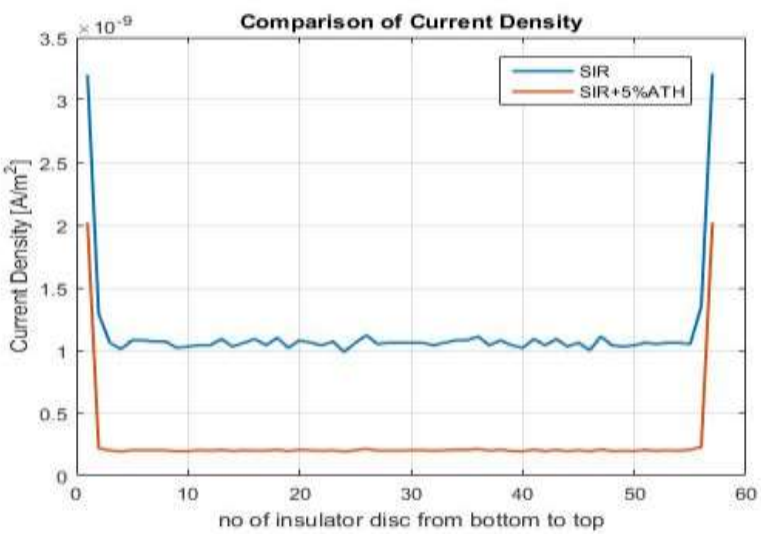

Figure 9 Comparison of Current density between pure silicon rubber and silicon rubber+5%ATH type B insulator

➢ **Silicon Rubber + Silica 5%**

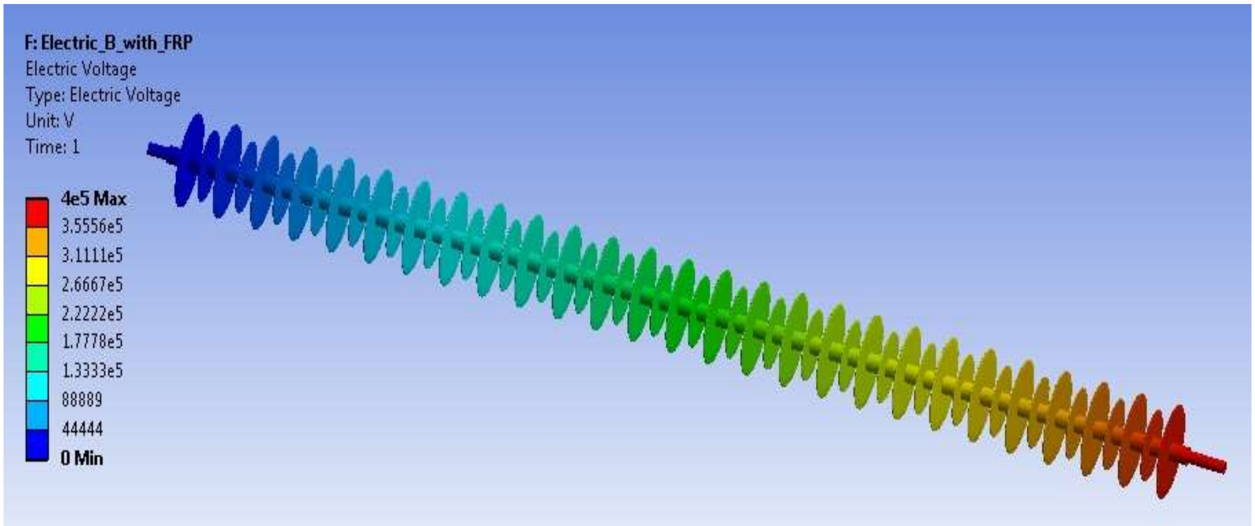

Figure 10 Voltage distribution in type B silicon rubber+5% Silica insulator at 400KV

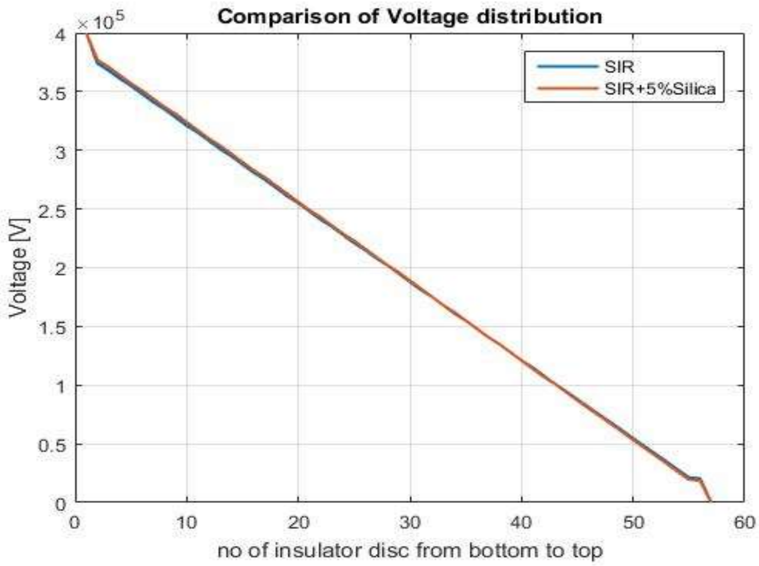

Figure 11 Comparison of voltage distribution between pure silicon rubber and silicon rubber+5% Silica type B insulator

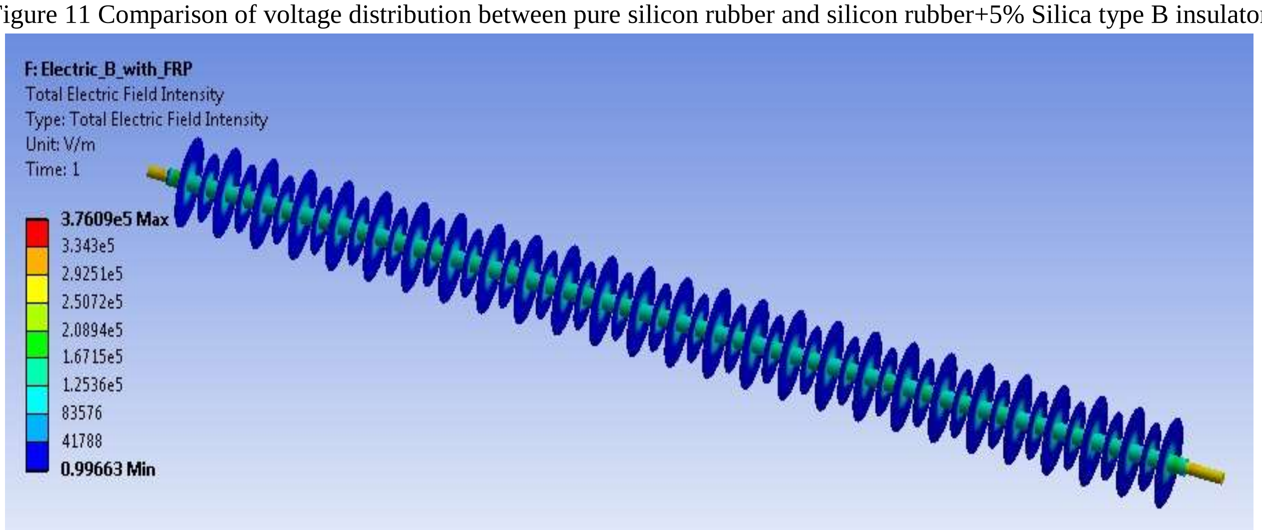

Figure 12 Electric field intensity in type B silicon rubber+5% Silica insulator at 400KV

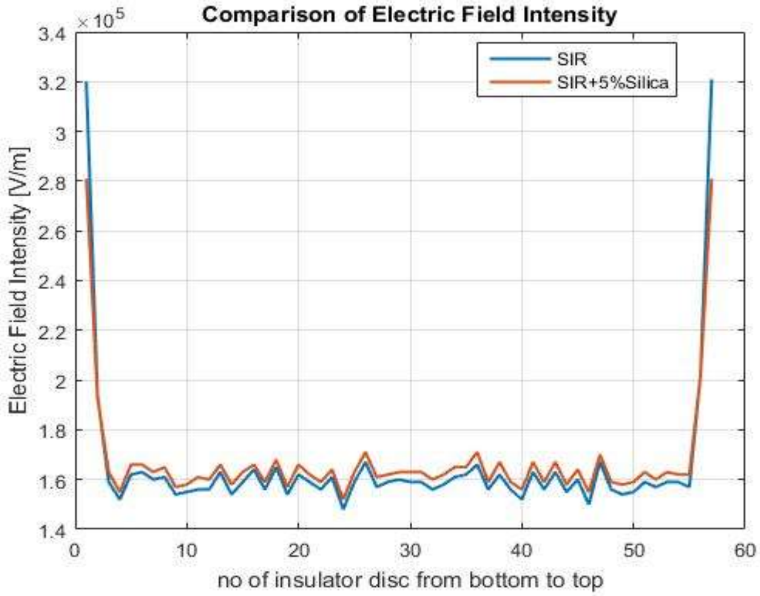

Figure 13 Comparison of Electric field intensity between pure silicon rubber and silicon rubber+5% Silica type B insulator

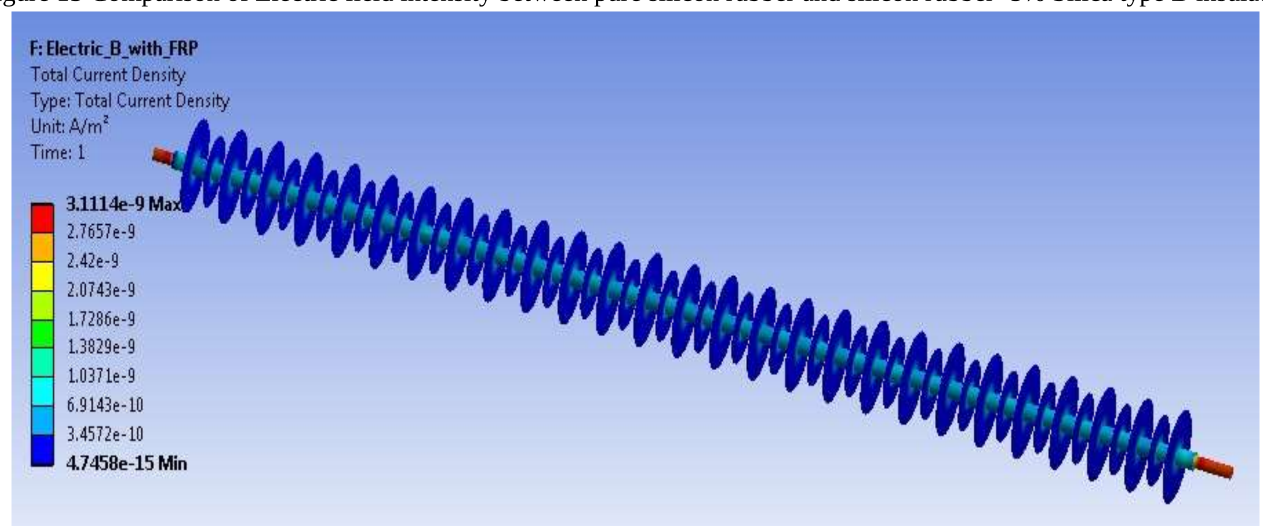

Figure 14 Current density in type B silicon rubber+5% Silica insulator at 400KV

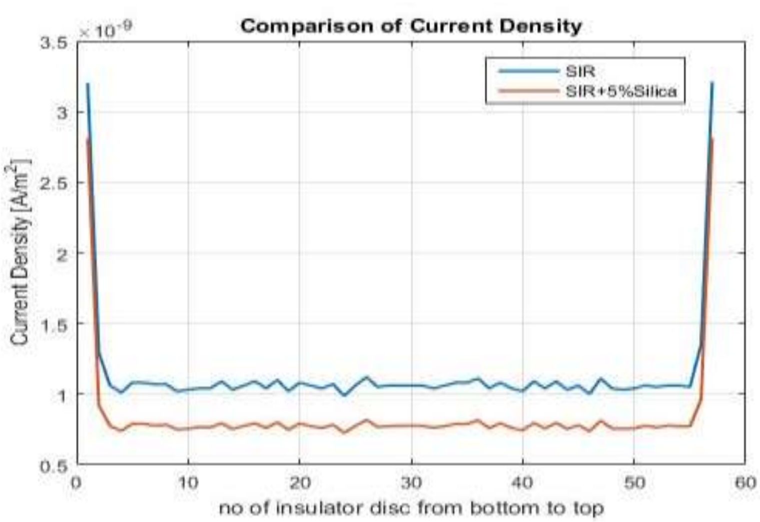

Figure 15 Comparison of Current density between pure silicon rubber and silicon rubber+5% Silica type B insulator

➢ **Silicon Rubber + Silicate 5%**

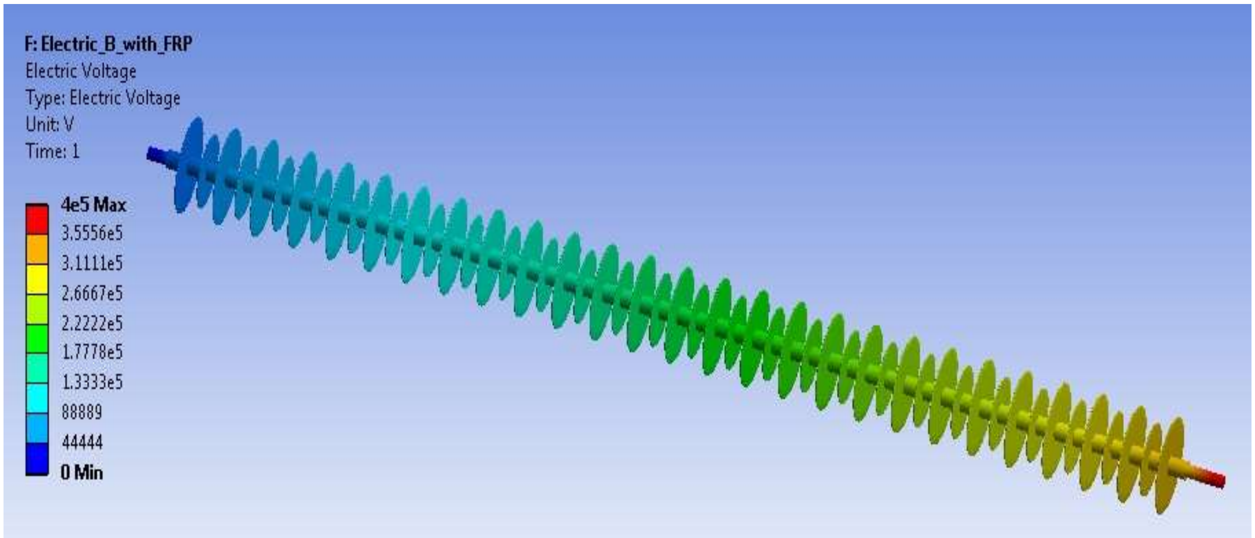

Figure 16 voltage distribution in type B silicon rubber+5% Silicate insulator at 400KV

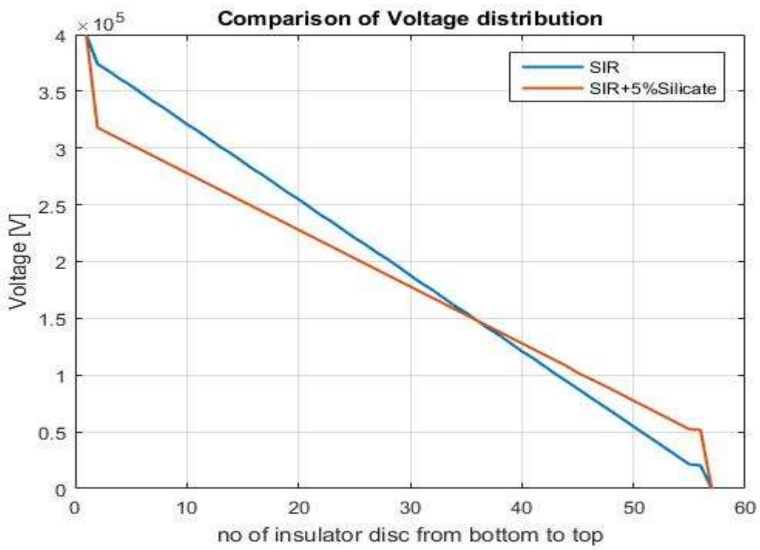

Figure 17 Comparison of voltage distribution between pure silicon rubber and silicon rubber+5% Silicate type B insulator

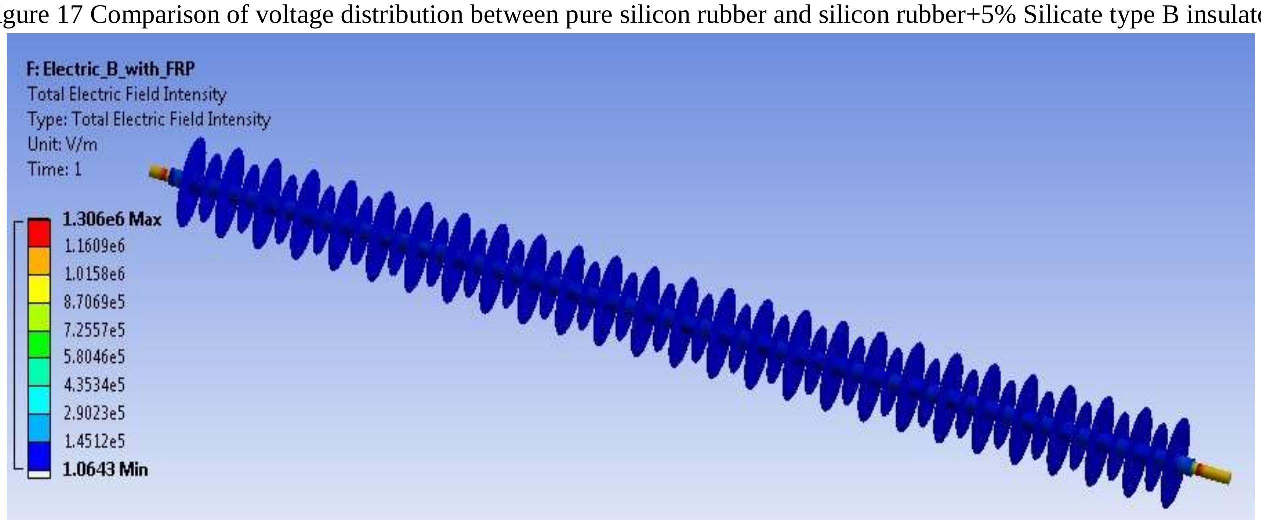

Figure 18 Electric field intensity in type B silicon rubber+5% Silicate insulator at 400KV

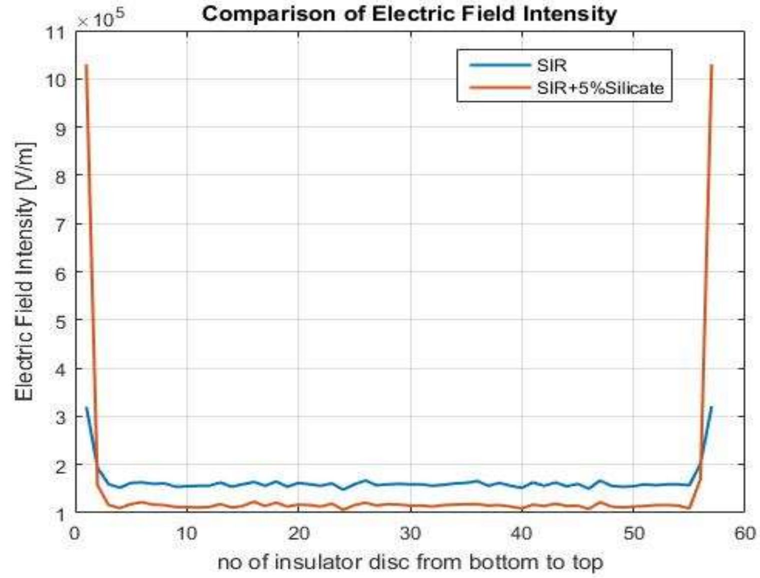

Figure 19 Comparison of Electric field intensity between pure silicon rubber and silicon rubber+5% Silicate type B insulator

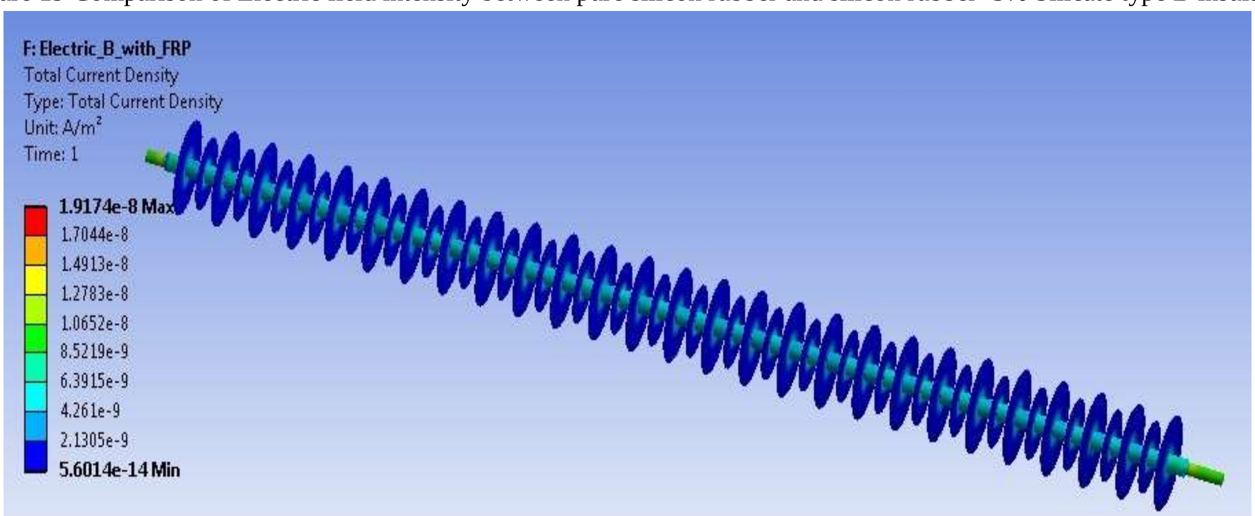

Figure 20 Current density in type B silicon rubber+5% Silicate insulator at 400KV

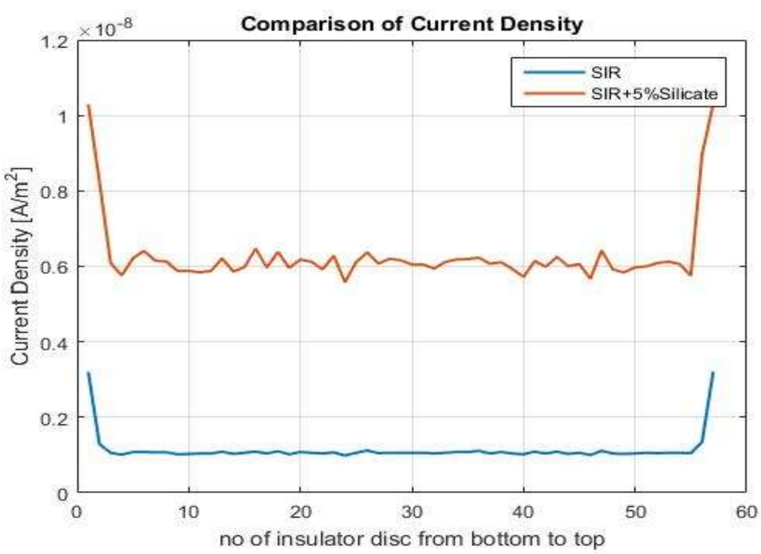

Figure 21 Comparison of Current density between pure silicon rubber and silicon rubber+5% Silicate type B insulator

➢ **Silicon Rubber + Alumina 5%**

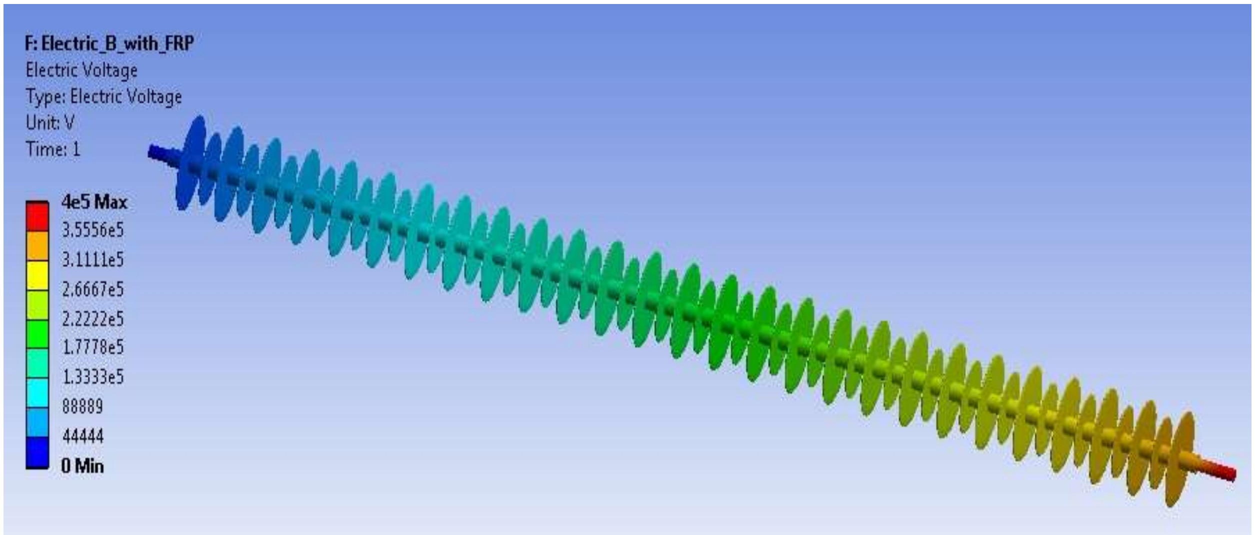

Figure 22 voltage distribution in type B silicon rubber+5% Alumina insulator at 400KV

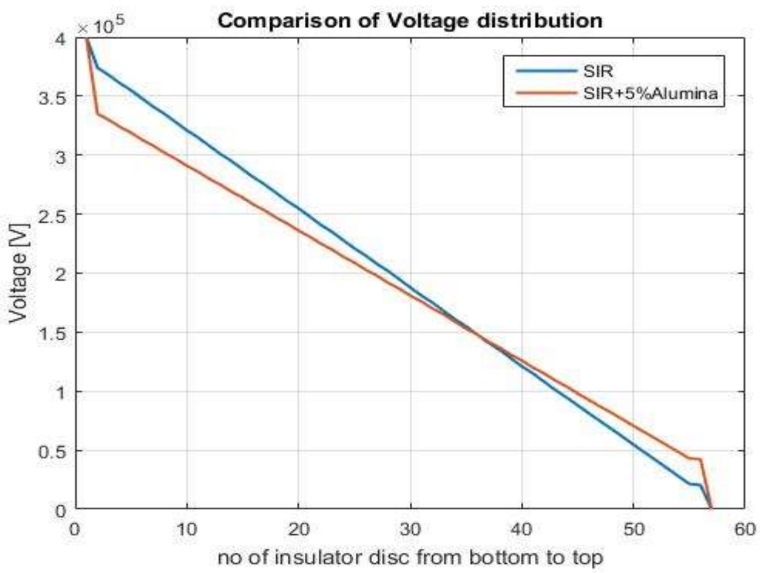

Figure 23 Comparison of voltage distribution between pure silicon rubber and silicon rubber+5% Alumina type B insulator

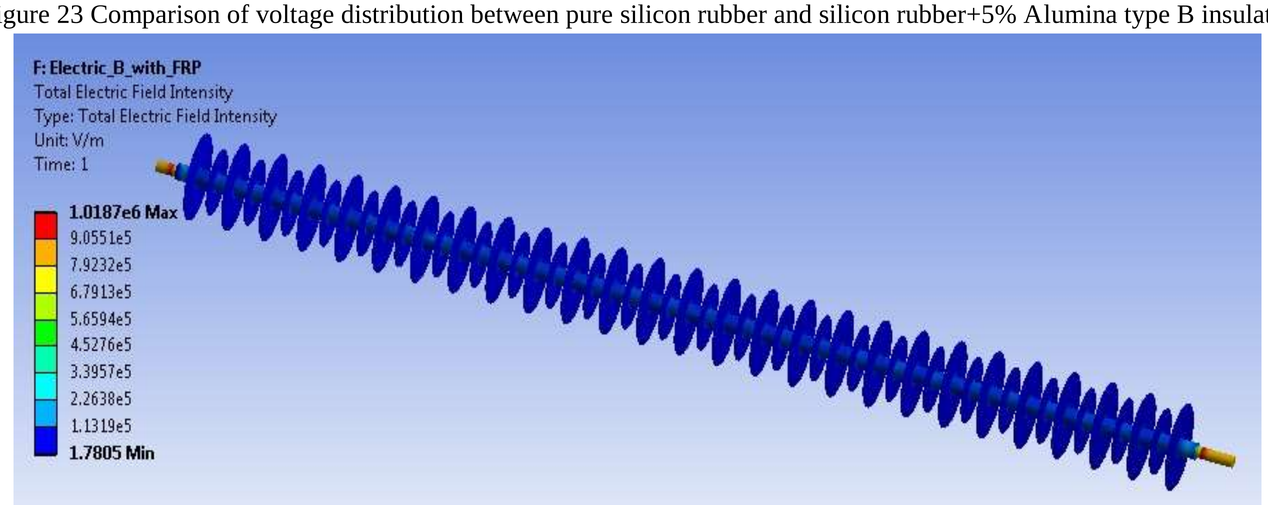

Figure 24 Electric field intensity in type B silicon rubber+5% Alumina insulator at 400KV

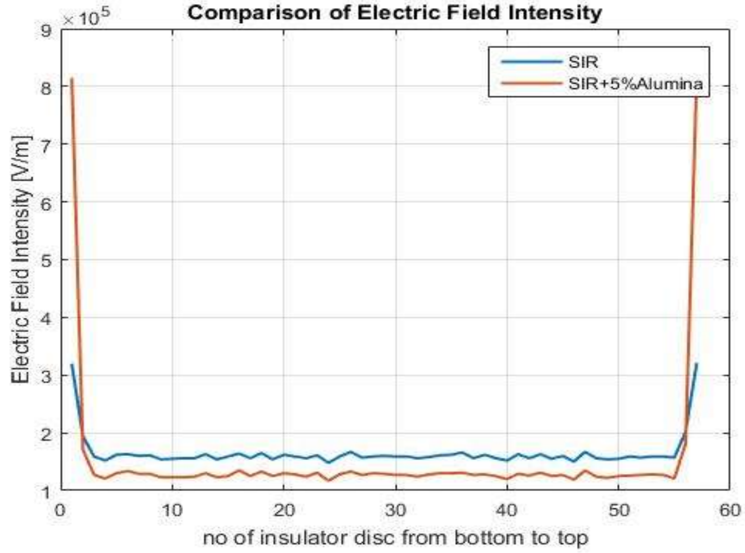

Figure 25 Comparison of Electric field intensity between pure silicon rubber and silicon rubber+5% Alumina type B insulator

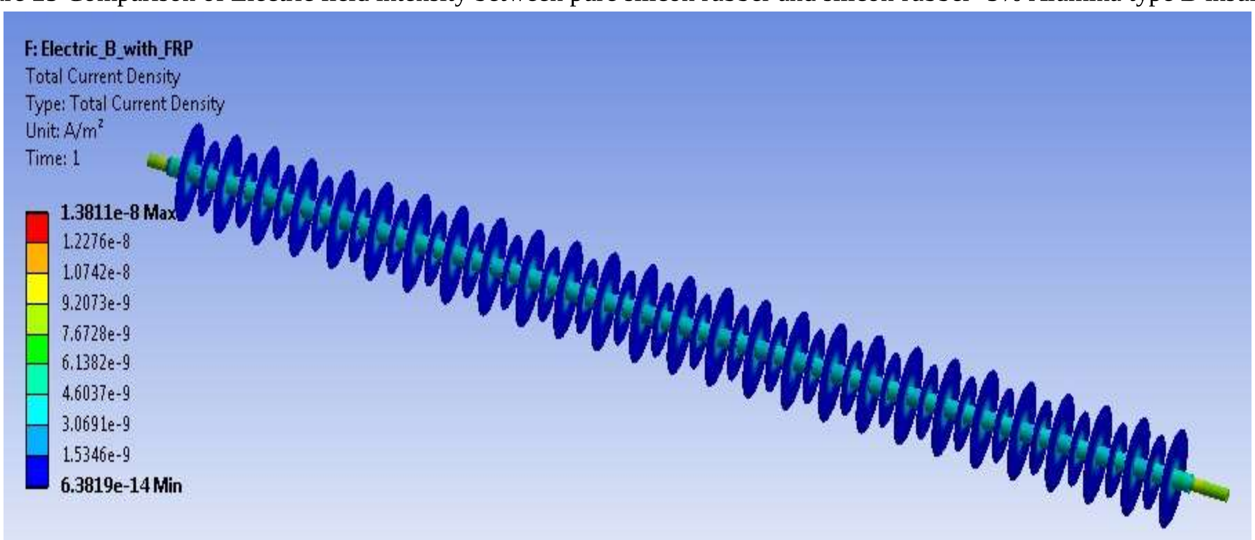

Figure 26 Current density in type B silicon rubber+5% Alumina insulator at 400KV

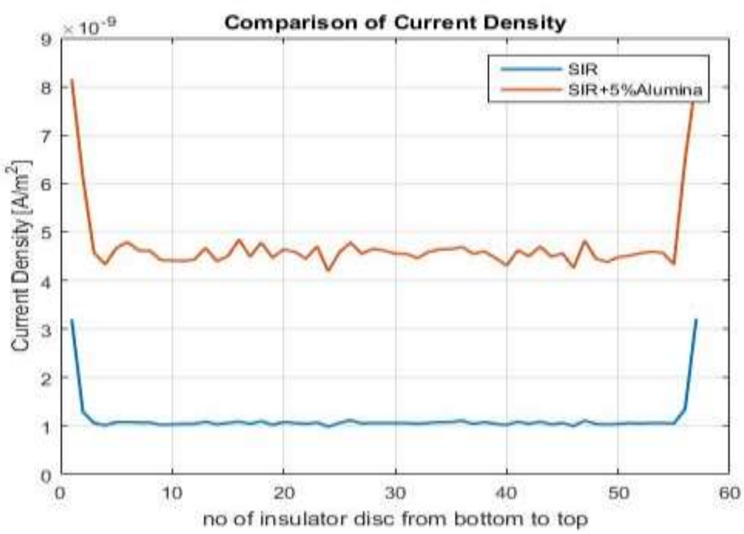

Figure 27 Comparison of Current density between pure silicon rubber and silicon rubber+5% Alumina type B insulator

IV. DISCUSSION OF RESULTS

Type B insulator and Type B insulator with different fillers are simulated at voltage 400KV results obtained are shown in above figures. In every simulation the bottom most part of the insulator is put on maximum voltage and top most part of the insulator is maintained at ground potential. The results that obtained for each type of insulators are voltage distribution, electric field intensity and current density. Also the graph is plotted for each result verses the insulator disc and compared with pure silicone rubber's result. From the simulation and graph of the voltage distribution of each insulator it can be seen that as we move from bottom to top of the insulator voltage is gradually decreasing. The electric field intensity of each insulator is also shown in above figures from which it can be observed that the field intensity is high at both ends of the insulator and equal in rest of the rod of the insulator. This is due to the capacitance effect and electric field intensity in the rod indicate the leakage current which is also observed in the figures of current density in insulators. This leakage current is very small and it can be ignored. Due to this leakage current there will be heat dissipation due to the high resistivity of silicon rubber which is also simulated and show in above figures. From figures it can be seen that as we add ATH or silica filler, insulation property is increased and as we add silicate or alumina filler, insulation property is decreased. From all the result it can be conclude that by adding fillers not only cost of the insulator is decreased but also the electrical properties of insulator can be changed as required by increasing the content of filler.

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