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Estimation of Breakdown Voltage for Silicon Rubber under Various Salinities

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--***ABSTRACT:***--
Due to the importance of polymeric materials for other traditional insulating materials such as glass and porcelain, as well as they are widespread in the manufacture of electrical insulators. It would have been better to find the values of the breakdown voltage of polymer by experimental method and study the effect of weather on the breakdown voltage to choose the optimal value from the filler. The silicone rubber was chosen which has good insulating properties. ATH filler added to the silicone rubber material at different rates 0%, 10%, 15%, 20%, 25%, 30% and 35%, respectively. These samples are tested for the break down voltage to determine the optimum ratio of ATH to be added to the silicon rubber. Thispaper considers the natural phenomena that are exposed to the insulation in working life so it exposed to different temperatures (0, 25 and 70 ° C) at dry and wet condition. Also the samples exposed to saline water with different salinities5000, 20000 and 54000 µS/cm.

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I. INTRODUCTION

Polymeric insulators are increasingly being accepted by the electric utilities worldwide the tremendous growth in the application of polymeric insulators is due to their substantial advantages compared to porcelain and glass insulators. Outdoor insulators made of a polymer such as silicon rubber (SIR), ethylene propylene rubber (EPR) and polyvinyl chloride (PVC) filled with a filler such as silica and alumina tri-hydrate (ATH) are being in practice despite the fact that these polymer materials are being proven good for high voltage application, [1]. No one base polymer materials alone has all necessary properties for high voltage insulating material in service, insulating materials are subjected toenvironmental stresses which lead the degradation to occur in order to minimize the degradation process on the materials the fillers are add to the materials compound in high voltage polymeric materials[2]. ATHplays an important role in improving surface tracking and erosion resistance. It reduces part of the polymer which then decreases thermal decomposition products because of endothermic dehydration [3].Amount of ATH filler material in SIR plays a significant role in the performance of the insulator material [4].The advantages of usage of the composite insulator are high mechanical strength, light weight and easy operation and maintenance. Silicon rubber not only provides excellent electrical performance but also prevent the pollution flashover effectively. The excellent hydrophobicity are the main features of silicon rubber materials which is significantly different with other insulation materials [5-7].There are very few reported works on estimation or prediction methods of the insulation strength. Most of these methods are based on graphical approach [8, 9].

II. EXPERIMENTAL SET-UP AND TECHNIQUES

A. Material Specimen

Specimens have been prepared from mixture the silicon rubber and the ATH filler. Specimens were fabricated in the form of disc with diameter 5cm and thickness 2mm. The ATH filler has been added to silicon rubber ATH filler has been used with different concentration, the composition of the specimens is given in table 1.

Table 1: Mixing Formulations for Specimens

Blend symbol	ATH percentage%
S1	0
S2	10
S3	15
S4	20
S5	25
S6	30
S7	35

B. Test Apparatus

The A.C. high voltage obtained from a single-phase high voltage transformer (100KV-5KVA). The output voltage of the transformer is controlled smoothly by a (0-220 V) variance regulating panel, the voltage applied to its primary winding. The electrodes were made of copper with 1cm diameter. The electrodes were fixed to the specimens, one at the top and the other at the bottom and should be centered to the specimen carefully to satisfy a good contact.

C. Results and Discussion

Break down voltage had been recorded for composite samples under dry, wet, and salty wetconditions.

1) Break down voltage of dry specimen at different temperatures

Effect of different concentrations of ATH filler (0, 10, 15, 20, 25, 30 and 35%) on the electrical performance of composite insulators under dry condition and different temperature (0, 25 and 70℃) is showing in figure 1.The figure shows the relationship between breakdown voltage (kV/mm) for SIR samples and the filler percentage (%). From the figure it can be seen that the breakdown voltage of the specimen which formation from pure SIR and 0 ATH was 43.3, 41.2 and 33.6kV/mm at 0, 25 and 70 °C respectively. When the specimen formation was 90% SIR and 10% ATH the breakdown voltages were44.8kV/mm,42.3kV/mm and 35.1kV/mmat 0, 25 and 70 °C, respectively. The third specimen which contained 85% SIR and 15 % ATH had breakdown voltages46.4, 43.9 and 36.6kV/mmat 0, 25 and 70 °C, respectively. But when increase the percentage of ATH filler to 20 % the breakdown voltages were46.4, 43.9 and 36.6kV/mmat 0, 25 and 70 °C, respectively. Also the result showed that the break down voltage was 51.6 kV/mm at 0 °C, 48.2kV/mm at 25°C and 42.8 kV/mm at 70 °C for the percentage of 25% ATH. The peak values was achieved when the ATH percentage was 30 % because the values of break down voltage for the temperatures 0, 25 and70°C were 55.3, 52.4 and 47.4 kV/mm, respectively. But when the percentage of ATH filler increased to 35% the results of the break down voltage for the specimen were decrease and the results reached to 52.2 kV/mm at 0 °C, 48.9 kV/mm at 25°C and 43.6 kV/mmat70°C..

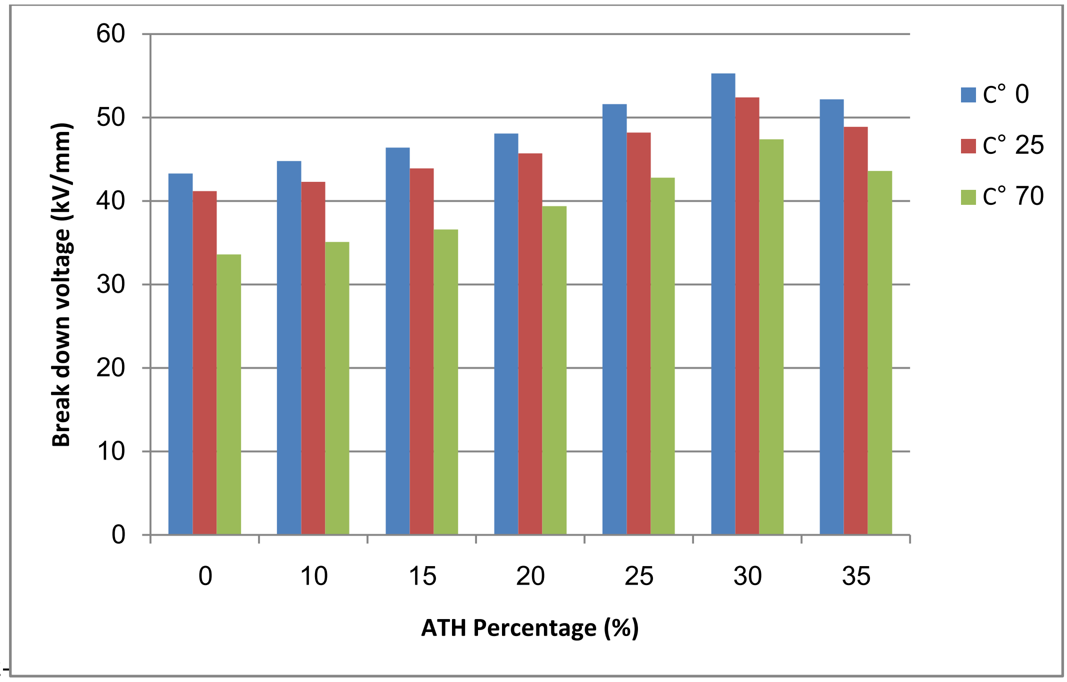

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Figure 1.Breakdown voltage for SIR with different percentages of ATH under various temperatures at dry condition

2) Break down voltage of wet specimen at different temperatures

Effect of different concentrations of ATH filler (0,10,15,20,25,30 and 35%) on the electrical performance of composite insulators under dry condition and different temperature (0, 25 and 70℃) is showing in figure 1 the figure shows the relationship between breakdown voltage (kV/mm) forSIR samples and the filler percentage (%). From the figure it can be seen that the breakdown voltage of the specimen which formation from pure SIR and 0 ATH was 35.1, 32.4 and 27.5 kV/mm at 0,25 and 70 °C, respectively. When the specimen formation was 90% SIR and 10% ATH the breakdown voltage was 35.9, 33.9 and 28 kV/mmat 0, 25 and 70 °C, respectively. The third specimen which contained 85% SIR and 15 % ATH had breakdown voltage 37.6, 35 and30.1kV/mmat 0, 25 and 70 °C, respectively. But when increase the percentage of ATH filler to 20 % the breakdown voltage was 40,37.1and32.4 kV/mmat 0, 25 and 70 °C, respectively. Also, the result showed that the Break down voltage was 42.1 kV/mm at 0 °C, 39.5 kV/mm at 25°C and 34.7 kV/mm at 70 °C forThe percentage of 25% ATH. The peak values was achieved when the ATH percentage was 30 % because the values of break down voltage for the temperatures 0, 25 and 70°C was 45.9, 43.6 and 38.1 kV/mmRespectively. But when the percentage of ATH filler increased to 35% the results of the break down voltage for the specimen was decrease and the results was 42.4kV/mm at 0 °C, 40 kV/mm at 25°C and 35.1kV/mm at70°C.

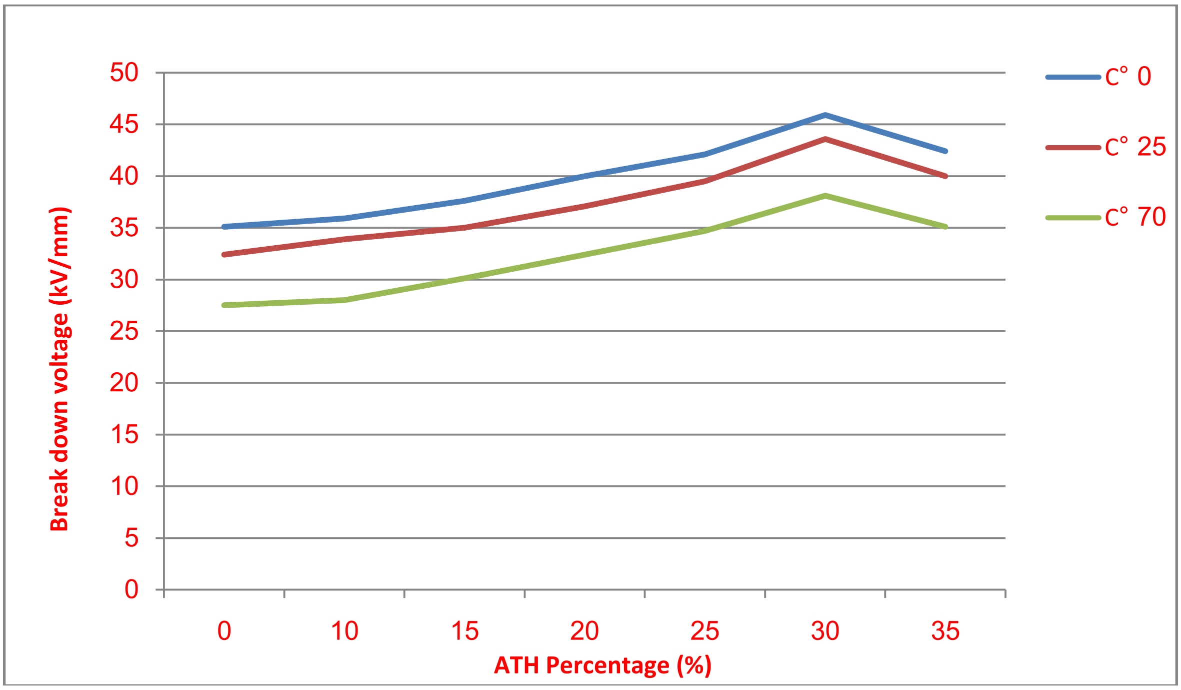

Figure2.Breakdown voltage for SIR with different percentage of ATH under various temperatures at wet condition

3) Break down voltage of salty wet specimen at different salinities.

Effect of different concentrations of ATH filler (0,10,15,20,25,30 and 35%) on the electrical performance of composite insulators under salty condition and different salinity (5000, 20000 and 54000 μS/cm) is showing in figure 1.The figure shows the relationship between breakdown voltage (kV/mm) for SIR samples and the filler percentage(%). From the figure itcan be observed that the breakdown voltage of the specimen which Formation from pure SIR without ATH was 31.9, 29.2 and 26.5 kV/mm at 5000, 20000 and 54000 µS/cm, respectively. When the specimen formation was 90% SIR and 10% ATH the breakdown voltageswere32.4, 30.6and27.5 kV/mmat5000, 20000and54000µS/cm respectively. The third specimen which contained 85% SIR and 15 % ATH had breakdown voltage34.1, 32.8 and29.5 kV/mmat5000, 20000 and 54000 µS/cm, respectively. But when increase the percentage of ATH filler to 20 % the breakdown voltages were 36.7, 34and31.2 kV/mmat 5000, 20000 and 54000 µS/cm, respectively. Also, the result showed that the break down voltage was 38kV/mm at 5000µS/cm, 36.2 kV/mm at 20000 µS/cm and34kV/mm at 54000 µS/cm for the percentage of 25% ATH. The peak values was achieved when the ATH percentage was 30 % because the values of break down voltage for the conductivity5000, 20000and54000µS/cm was 42.8, 40.1and 37.1 kV/mm respectively. But when the percentage of ATH filler increased to 35% the results of the break down voltage for the specimen was decrease and the results were38.3kV/mm at 5000 µS/cm, 37.4kV/mmat 20000 µS/cm and 34.2 kV/mm at54000µS/cm...

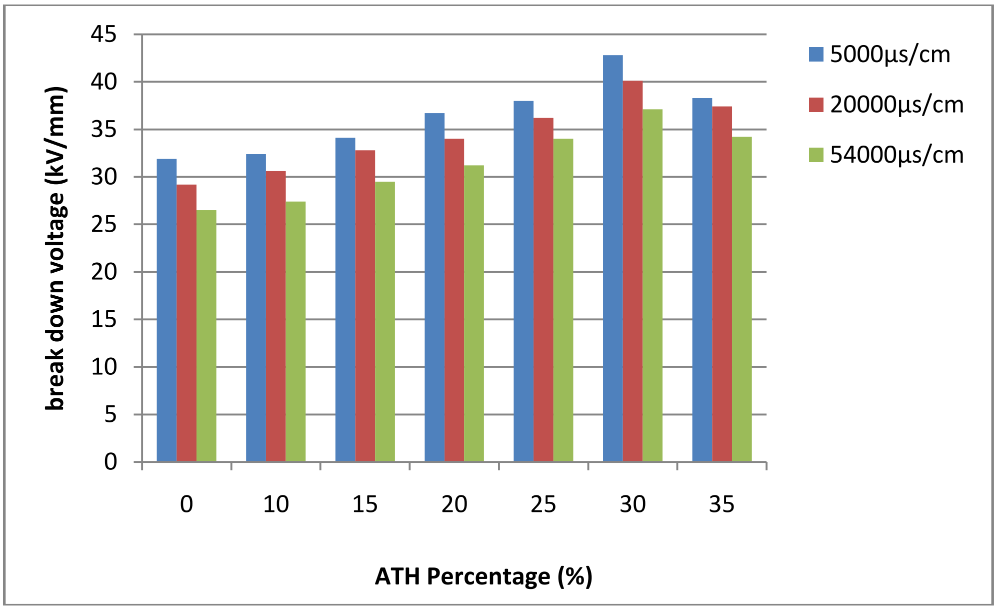

Figure 3: Breakdown voltage for SIR with different percentage of ATH under different salinities at salty wet condition

III. CONCLUSION

The experimental work can be concluded that:

- ATH is a good filler to improve the breakdown voltage of silicon rubber
- All the highest value occur when the percentage of filler is 30%
- Dielectric strength decreased in wet condition as compared with those in dry condition
- Dielectric strength decreased in high salinity condition as compared with those in low salinity condition
- Heat has a negative effect on the dielectric strength for specimens

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