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Electric Field Behavior of Water Drop due To Change in Contact Angle on the Insulator Shed Surface under DC Stress

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ABSTRACT

Water droplets play several roles in the pollution flashover and ageing of insulators. The presence of a water drop on the insulator surface increases the electric field flux or intensity along the insulator surface and it may lead to electrical breakdown. As we all know composite insulators for distribution and transmission lines are being used for many years. Surface corona discharges from water droplets accelerate the flashover. The behavior of the insulator when water droplets accumulate on the insulator surface is one of the important parameters to be determined. Conductive particles dissolved in the water change the existence of the electric field. The electric field is intensified at the triple point junction between water droplet, air and insulation material. The erosion may take place due to the existing local high electric field. As per the theory, the contact angle between the insulator surface and water drop has an impact on the electric field. So much research has already done on this aspect for AC. No research has done for DC. The objective of this work is to study the effect of angle between water drop and insulator surface under DC stress. This study has been done by investigating electric fields by changing the contact angle.

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INTRODUCTION

Ansys Maxwell software with DC Conduction solver is used to simulate the water drop on the insulator surface. At first the insulator is modeled in Ansys and then a water drop is placed on the first shed, then the contact angle between the water drop and insulator surface is changed in several steps.

Composite insulators are made of organic materials. Silicon rubber has become the material of choice for the casings of high voltage composite insulators because of the hydrophobicity. After some years in service there is a possibility that the hydrophobicity decreases. The water drops on the insulator sheds can have an effect on the electric field and lead to partial discharges. There are some literatures (Guan, 2005; Cheng, 2003) which tell about the electric field behavior under AC stress.It is necessary to study the behavior of water drops on the composite insulator sheds under DC stress.For this purpose the following insulator model has been created to understand the water drop behavior over the insulator shed surface.

To avoid complexity in modeling and simulation a simple structure of composite insulator with only two sheds is considered in the investigation of water drop. First a fiber reinforced plastic rod with diameter of 10mm and height of 100mm has been considered. Then silicon rubber sheds with radius of 35mm are modeled and joined to the FRP rod.

Simulation of Water Drop at Different Contact Angles:

Four different angles are considered and observed in the simulation results. At first the angle between the shed surface and the water drop is maintained at 30 degrees. Then it is changes to 60, 90 and 120 degrees. These are shown in the figure 3.

Finally aluminimum flanges with radius of 30mm are modelled and joined at the top and bottom of the FRP rod. The fully created model is shown in figure 2.

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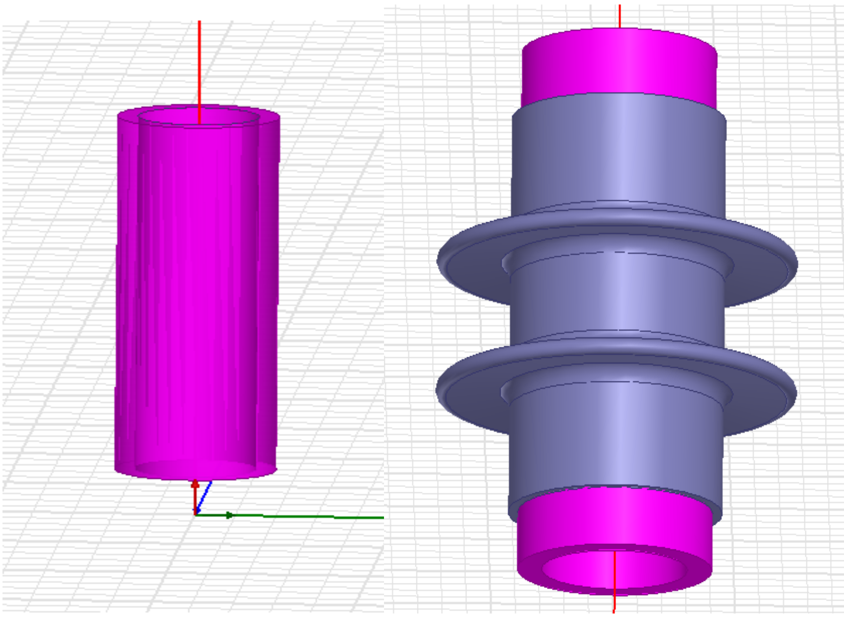


a) Without sheds b) with composite sheds

Fig. 1: Composite insulator modelled in Ansys Maxwell .

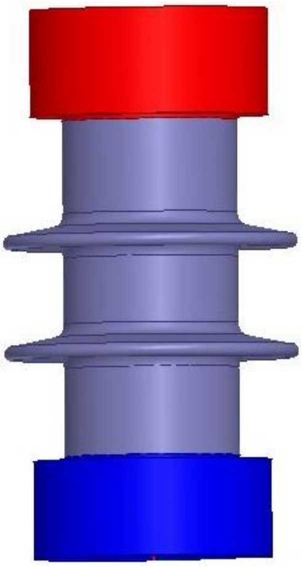
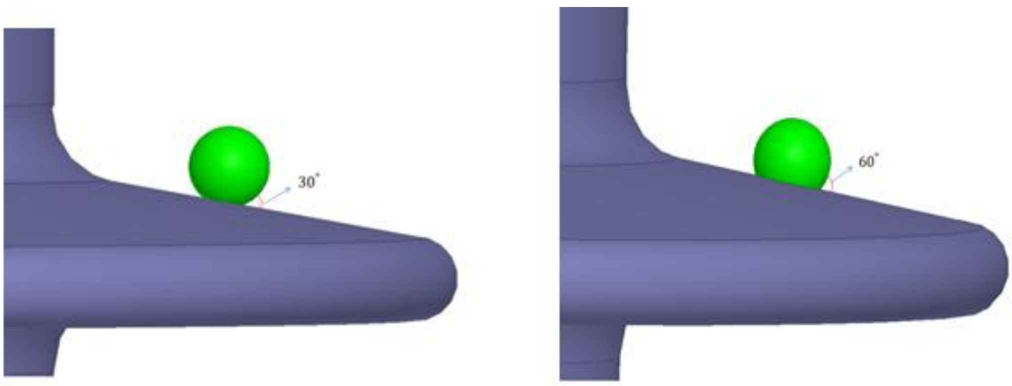
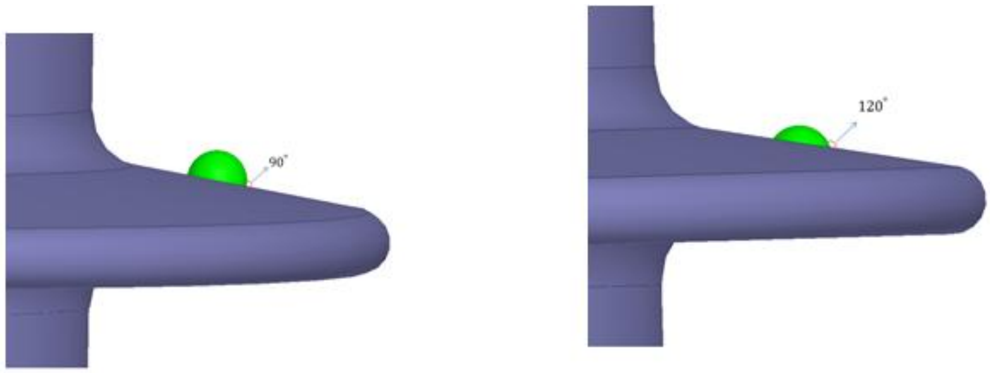


Fig. 2: Composite insulator model.



a) At 30 degrees b) At 60 degrees



c) At 90 degrees d) At 120 degrees

Fig. 3: Different contact angles between insulator surface and a water drop.

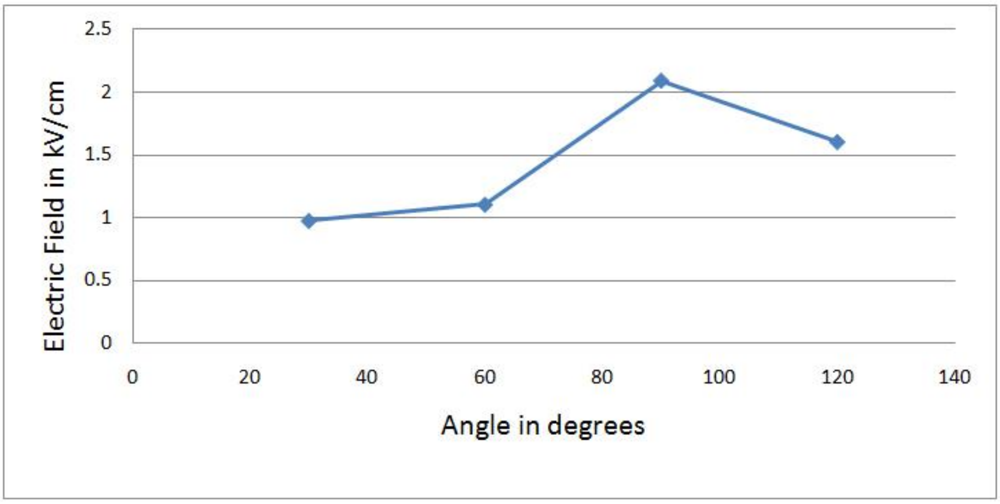


Fig. 4: Maximum electric field enhancement at water drops.

The electric field is measured at the contact angle between the shed surface and the water drop. Values of the electric field for each angle are represented in figure 4.

Conclusions:

The results show that there is an incresing value of the electric field while changing the contact angle from 30 to 90 degrees. Then there is a certain decrease at greater than 90 degrees. These results showed how the changing contact angle effects the electric field.There are many theories which tell that knowing the behavior of electric field on the polluted insulators (it includes the water drop behavior) is the main critera to design the insulators under DC stress. These results might be helpful in designing the insulators especially composites which are used under DC stress. There are possibilties to reduce the filed stress on the shed surface. One of the possibilties is by optimizing the insulator shed. this could be done by using genetic algorithm or some other technic. Further research has to be done on these issues to improve the design of the insulators to be used in DC.

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