Space Charge Accumulation between Different Insulating Materials Simulated Cable Joint for HVDC

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ABSTRACT

We measured space charge distribution in LDPE, XLPE and filler added polyethylene under DC high voltage. As the results, it was found that the amount of charge accumulation was reduced in the filler added materials. The measurement was similarly performed on double layered samples of polyethylene and EPR. A large amount of charge was accumulated and the electric field increased significantly in laminated samples with non-filler polyethylene. However, it was not observed charge accumulation and electric field distortion in laminated samples with filler added polyethylene. From the above results, it is suggested that the filler added material has excellent DC performance even in laminated samples.

KEYWORDS

Space charge, Double layered sample, Cable joint, PEA, Filler

INTRODUCTION

Recently, the power supply using renewable energy has attracted attention as electric power demand increase. The long distance power transmission from far away is necessary for this plan and it is efficient to use DC power transmission. As present, XLPE (Cross linked polyethylene) which is one of maintenance-free polyethylene based insulating materials is widely used as an insulating material of an AC electric power transmission cable. Although XLPE has high insulating performance in AC power transmission, accident such as breakdown is concerned when it is applied to DC power transmission.

According to a recent research report, it is known that adding a filler to a material suppresses space charge accumulation and reduces the risk of breakdown [1] [2]. However, the XLPE cable still has some issues. In long distance power transmission, because multiple cable is connected and used, many joints exist. The cable joint has double layered structure of dissimilar insulating materials such that the rubber material covers the polyethylene material. It is expected that space charge accumulation characteristics will be complicated in such interface of double layer with dissimilar insulating materials. In the case of DC power transmission, space charge accumulates at such an interface and electric field is distorted, so the voltage sharing of each material may be different from the state assumed by the design. Further, when a LCC (Line commutated converter) is applied in DC power transmission, it is necessary to invert the polarity of the voltage applied to the cable system in order to invert the power transmission direction. However, it is considered that the space charge behaviour in the materials becomes complicated at the time of polarity reversal.

There are few reports on investigation of the space charge accumulation characteristics when the polarity of the applied voltage at the cable joint is reversed. Therefore, it is necessary to investigate the space charge behaviours and the electric field distribution in the material when the polarity of the applied voltage is reversed for the laminated samples of dissimilar insulating materials.

In this report, we have investigated the space charge accumulation characteristics when the polarity of the voltage applied to the sample laminated with dissimilar insulating materials is reversed using the PEA (Pulsed Electro Acoustic) method [3]. For the investigation, we experimented general samples and samples which enhanced insulating performance under DC electric field by adding fillers to insulating material [1] [2].

MEASUREMENT SYSTEM

Figure 1 shows a schematic diagram of PEA (Pulsed electro acoustic) measurement system. In the PEA method, a sample is sandwiched between a high voltage SC (Semi conductive layer) and a grounded Al electrodes, and a pulse voltage is applied on the high voltage electrode side. As a result, a pulsed electric field is applied to the sample, and an elastic wave generates from the space charge accumulated in layers in the sample by the electrostatic stress. The elastic wave propagates from the inside of the sample to the Al electrode, and it is converted into a voltage signal by a piezoelectric sensor put on the back surface of the grounded electrode. The traveling time of the elastic wave between the position of charge layer and the piezoelectric sensor is corresponding to the distance

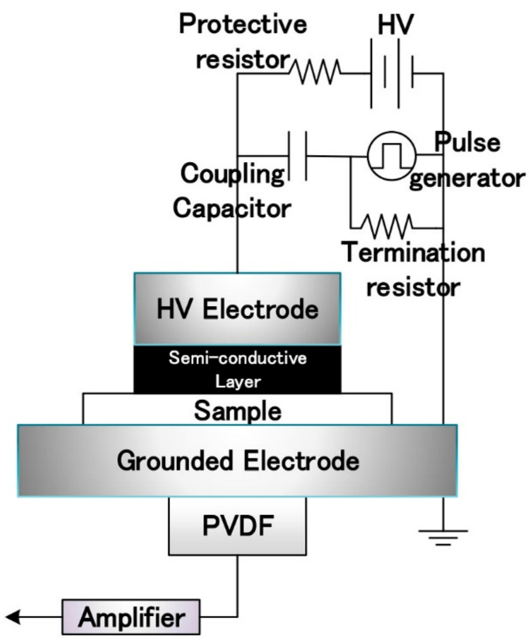

Fig.1 Schematic diagram of PEA measurement system