Particle Shape Effect on Corona Discharge Mechanism in the Presence of Metallic Floating Particle under AC Voltage

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1 INTRODUCTION
It is well known that free-metallic particle can seriously reduced the insulation strength of a Gas Insulation System (GIS). The inevitable particles in GIS have arbitrary shape and size. In our previous research using symmetrical metallic particle i.e. ellipsoidal shape particle, it was found that, the corona discharge of floating metallic particle represents the interference of positive streamer and Trichel pulses from both tips of particle[1]. We suggest that the corona discharge characteristic due to electric field change on the particle tips is affected by shape and size of particle. In this study the effect of particle shape on the corona discharge mechanism is experimentally investigated. The particle size effect on the corona discharge mechanism is explained in another report[2].

2 EXPERIMENTAL SETUP AND METHOD
Details of electrode system and the experimental setup are described in the ref.[1]. The experiments were conducted in laboratory air with an aluminum cone-hemispherical particle as shown in Fig. 1. The tested particle has 0.1mm in cone radius, 0.5mm in hemispherical radius and 10mm in length. The cone tip of particle is directed toward the Grounded Electrode (G.E.) and the distance between the cone tip to the G.E. is denoted by d. A 60Hz AC voltage was applied to the electrode and increased at a constant rate of about 1kV/s. Corona onset (V_c) and breakdown (V_b) voltages were measured by changing the particle position.

3 EXPERIMENTAL RESULTS AND DISCUSSION
The V_c and V_b characteristics as well voltage region corona mechanisms are shown in Fig.2. The V_c at d=35mm is minimum and at d = 0mm as well as the other position, the V_c is almost equal, i.e. the effect of particle position to V_c is negligible along these positions. As the applied voltage increase above the V_c, single polarity of corona current pulse due to the polarity of cone tip was observed near the peak value of applied voltage. This mechanism is denoted as corona mechanism type 1 in the figure. If the applied voltage is raised from the type 1 region, the superimposed of Trichel pulses on the wave tail of positive streamer pulse was observed at the positive half cycle however at the negative half cycle only Trichel pulse from the negative cone tip was observed and express as corona mechanism type 2. Furthermore the superimposed of Trichel pulses on the wave tail of streamer pulse was observed at both half cycles if the applied voltage is further increased and denoted as corona mechanism type 3. Moreover, as the time is elapsed the corona discharge occurs before the peak value of applied voltage. This phenomenon is derived from electric field enhancement at the particle tip due to corona discharge occurrence in the previous half cycle.

The cause of difference in corona mechanism with applied voltage is explained as follows. From the electric field calculation, it was found that the electric field at the cone tip is higher about three times than the hemispherical tip and results in easiness corona generation from the cone tip. Due to this consideration, at the lower voltage the corona occurs only on the cone tip of particle and the field enhancement at the hemispherical tip due to charge flowing in the particle generated by corona at the cone tip is not high enough to trigger corona at the hemispherical tip. As the voltage rise, in positive half cycle, the electric field change due to corona at the cone tip satisfy the corona onset criteria at the hemispherical tip, therefore the Trichel corona start to occurs at the hemispherical tip and interfere with the positive corona from cone tip. As the applied voltage is further increased, the field change at the both tips of particle is high enough to trigger the positive streamer as well as the Trichel coronas at the both particle tips in both half cycles. Model of corona mechanism according to applied voltage can be seen in Fig. 3.

The V_b becomes high due to corona stabilization effect when the particle is attached to the electrode and decrease until a critical value as the particle distance to either of the electrodes is increased. Then it gradually increases until the gap centre. If the particle in vicinity of the electrode, V_b is almost equal to V_c. Moreover the interference of positive and negative coronas also occur on the both tips of particle at the moment of breakdown occurrence. The V_b characteristics are similar to the one using symmetrical particle[1].

4 CONCLUSION
The obtained results can be summarized as follows:
1. With an unsymmetrical particle, the particle trigger corona discharge mechanism is different from that with symmetrical one and also changes with applied voltage.
2. The minimum V_b appears if the particle is in vicinity of the electrode.

REFERENCES