Influence of Installation Position of 500kV Grading Ring for Composite Insulator towards Ice Flashover Process

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Abstract: This article analyzes influence of installation position of 500kV composite insulator grading ring towards insulator surface electric field and potential distribution through result of simulated calculation, as well as its influence during ice flashover process, provides instruction for 500kV transmission line composite insulator ice flashover prevention.

Key Words: Composite insulator; Grading ring; Ice-coated; ice flashover prevention

1. Function of composite insulator grading ring

Composite insulator electric field and potential distribution is uneven under conditions of clean insulator and normal atmosphere, thus grading ring plays a crucial role in voltage uniform distribution; Electric field and potential distribution are more uneven for ice-coated insulator, thus importance of grading ring is more evident. Meanwhile change grading ring installation position has more significant influence to electric field and potential distribution of composite insulator. This study applied simulated calculation to electric field, potential distribution change and maximum field strength change at high voltage end on condition of changing grading ring position while remaining length of icicles (8.2cm) on clean insulator, also studied average electric field change between high voltage end and the first large umbrella as well as between first large umbrella and second large umbrella.

2. Influence of grading ring towards electric field distribution

In order to study influence of installation position of composite insulator grading ring towards electric field and potential distribution on insulator surface, the study applied respective calculation of composite insulators under clean condition and when coated with ice (icicle length: 8.2cm).

On condition that composite insulator is clean, outer diameter of grading ring is dl=40cm, pipe diameter d2=4cm, position of high voltage end change from -15cm to +15cm, junction of fitting and insulator is set as zero point, fitting side as minus value, insulator side as positive value.

Relativeness of maximum value of electric field strength at high voltage end and grading ring position for clean insulator is shown on figure 1, relativeness of average electric field strength at high voltage end and grading ring position for clean insulator is shown as figure 2. As drawn from figure 1 and figure 2, value of electric field strength is highest when grading ring is positioned at -15cm junction, reaching 27kV/cm, minimum value appears when grading ring is positioned between 0~5cm, reaching approximately 16.5kV/cm. Average electric field strength between high voltage end and the first large umbrella dress declines from 7.2kV/cm at -15cm to 3.5kV/cm at 5cm along with increase of grading ring position, yet this value surge when grading ring position continues to rise. Value of average electric field strength between the first large umbrella dress and the second large umbrella dress increase slowly when grading ring is lifted from -15cm to a level between junction, and decreases between junction to 15cm.

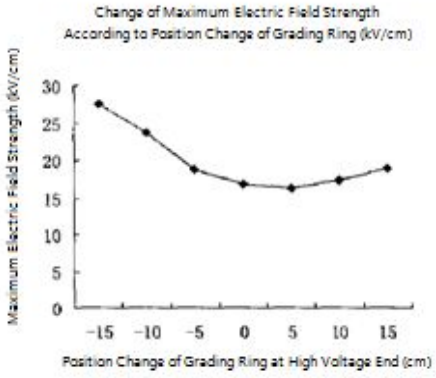

Figure 1 Maximum electric field at high voltage end with grading ring position change when insulator is clean

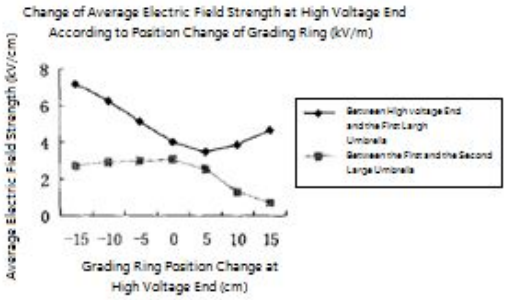

Figure 2 Variation of average electric field strength at high voltage end with grading ring position change when insulator is clean

When composite insulator is coated with ice, maximum electric field strength at high voltage end will vary along with change of grading ring position, figure 3 shows variation of maximum electric field strength at high voltage end when composite insulator is coated with ice, whereas figure 4 shows variation of average electric field strength change at high voltage end when composite insulator is coated with ice. Maximum electric field strength appears when grading ring is positioned at 15cm below junction, reaching 31.1kV/cm, minimum value appears when grading ring is positioned at zero point, reaching approximately 18.6kV/cm. Average field strength between high voltage end and the first large umbrella dress shows decline from 7.52kV/cm at -15cm to 4.6kV/cm at 0cm, yet begin to increase with grading ring position continue to go up. Average field strength between the first and second large umbrella dress at gradually increases when position of grading ring is lifted from -15cm to -5cm, yet appears sharp decline when grading ring position change from junction to 15cm. We can draw conclusion by comparing figure 3 and figure 4 that variation of average electric field strength between first large umbrella dress and second umbrella dress at high voltage end is significant after composite insulator is coated with ice, the reason for that is air gap between umbrella dress turns smaller as icicle becomes longer, thus average electric field strength between umbrella dresses increases. Average electric field strength between umbrella dresses exceeds average electric field strength at high voltage end when grading ring is positioned at -15cm to 5cm.

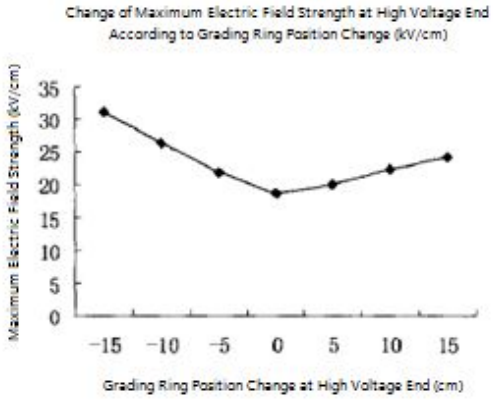

Figure 3 Variation of maximum electric field strength at high voltage end after changing grading ring position for ice-coated insulator

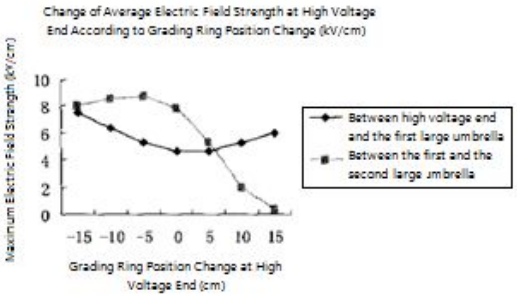

Figure 4 Variation of average electric field strength at high voltage end after changing grading ring position for ice-coated insulator

3. Conclusion

Insulator ice coat is a special contamination, and that insulator ice flashover is a special contamination flashover. If not installed with voltage-sharing device, voltage distribution on insulator surface will be uneven, causing partial discharge at high voltage end, shortening insulator creep distance, weakening

insulating property of the insulator thus fragile to flashover generation. In order to improve voltage distribution on insulator surface to make it more even and prevent partial arc discharge caused by over partial field strength, grading ring is necessarily installed at insulator high voltage end during operation and production. Recommended increase distance of grading ring at high voltage end h=0-5cm, maximum field strength at the interval between high voltage end and icicle near high voltage end is well balanced under this circumstance, meanwhile, lower impulse flashover voltage to ensure increase distance of insulator grading ring is no less than dry arc distance, vertical increase distance is set at 0cm, namely same height as junction.

Northwest Hubei Operation and Maintenance Division of State Grid Electric Power Company Maintenance Company in Hubei trimmed position of grading ring for composite insulator according to instruction above during ice prevention technical modification to 500kV transmission lines, meanwhile enhanced associated technical surveillance of composite insulator during operation with manufacturer, and achieved significant effect of ice flashover prevention.