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The exploration characteristic of long flashover arrestor (LFA) with different ring's breadth by using 1.2/50 microsecond positive and negative impulse voltage

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Abstract

This paper presents the estimation and comparison characteristics of long flashover arrestor (LFA) by varying the breadth of ring components under the 1.2/50 microsecond positive and negative impulse voltages. The breadth of the ring was various sizes at 0.25cm, 0.5cm, 0.75cm, 1.0cm, 1.2cm5 and 1.5cm. The gap space for specimen was fixed at 0.5cm with a diameter of 2.2cm. When applied the 1.2/50 microsecond positive and negative impulse voltage to 9kV to 150 kV. The results showed that at the level of 0kV to 60kV the LFA with different ring's breadth have the same flashover length. The flashover length of LFA under 1.2/50 micro positive impulse voltage was longer than negative impulse voltage when adjusted the applied voltage level more than 81kV and the explicit difference of flashover lengths increased when increased the positive and negative impulse voltage to 130kV.

Keywords: Arching, Breakdown voltage, Lightning arrestor, surface flashing, Surge protection

1. Introduction

Overhead power line's outages owing to lightning over voltage (lightning strokes) are one of the principal causes of deficiency of electric supplies, uneconomic and make the power system utilities to bad results. Nowadays, there are many types of lightning protection equipment was used. Most of the lightning protection system used pole-top metal oxide arresters. It can protect a distribution line versus induced over voltages. Nonetheless, the using top metal-oxide arresters had main problem that can be destroyed by a direct lightning with high maintenance cost [1-2].

Long flashover arrester (LFA) was designed for modifies and adaptation to reduce that problem. The LFA consist of a surface in the flashover and the discharge (insulator and ring conductor) was uncomplicated discharge circuit. The main determinant using LFA to protect overhead transmission line was the limiting value of power arc follows (PAF). The likelihood of PAF acutely reduced with a reduction of the value of Dielectric Field Stress (E, kV/m) [2]. The value of dielectric field stress level should be 7-10 kV/m in order to decrease the PAF close to 0 or without the Power Arc Follow occurred. E factors depend on the phase voltage (Uph, kV) and the length of flashover (L, m); if L increase PAF will be fast reduce [2].

To protect against lightning voltage, the new LFA could improve by increasing the length of flashover on specimen [3]. The LFA must be used a characteristic of surface flashover to increase the flashover length. The length and speed of flashover travelling was still defendant on the magnitude of over voltage, under the identical breakdown voltage, the different gap spacer of LFA have different length of flashover that depending on the gap spacer and level of voltage. [4-5]. LFA can protect overhead transmission line against direct lightning strokes and overvoltage [6].

This paper presents the estimation and comparison of the characteristic's distinction of LFA by varying breadths of ring that consisting of ring's breadth that utilizing aluminum conductor size: 0.25cm, 0.5cm, 0.75cm, 1.0cm, 1.25cm and 1.5cm, especially the flashover length of the specimen that was tested under 1.2/50 microsecond positive and the negative impulse voltage level of 9kV to 150 kV.

2. Experiment setup

Specimen: The specimen for this research paper was consisting of two main parts. The first was the conductor part (ring) was made by the thin aluminum thin sheet. The ring's breadth of the specimen was designed and variable vary size of 0.25cm, 0.5cm, 0.75cm, 1.0cm, 1.25cm and 1.5cm. The second was the insulator part that was made by tube Polyvinyl Chloride (PVC) thickness 0.18cm with diameter 2.2c. According to equipment actual size, gap was fixed to 0.5cm [3] and used thin aluminum thin sheet to reduce the thickness condition of the experimental. The specimens were experimented under the 1.2/50 microsecond positive and negative impulse voltages level from 9kV to 150kV was applied. The LFA model was showed in Figure 1.

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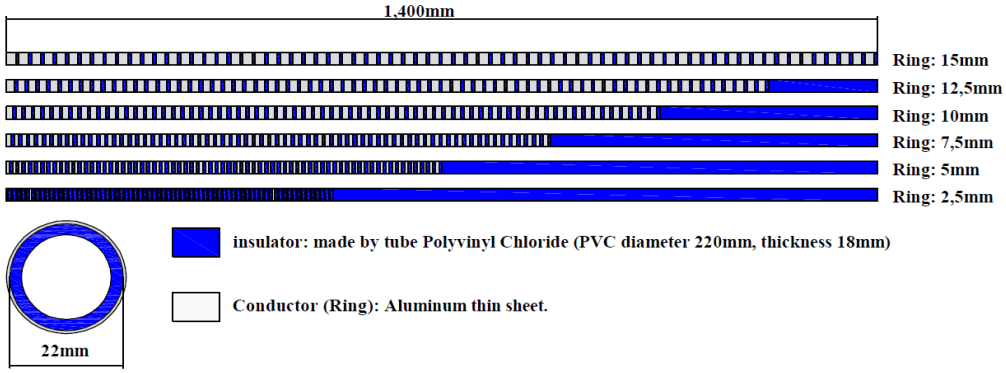

Figure 1 Long flashover model various the breadth of the aluminum ring

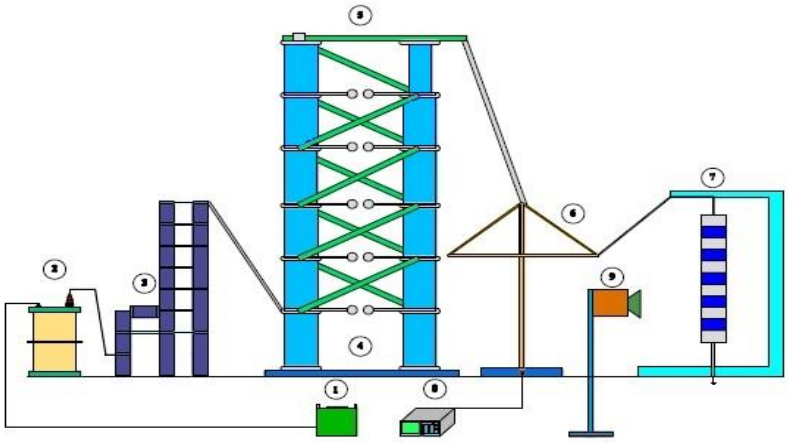

Figure 2 Circuit diagram for testing LFA models under 1.2/50 microsecond positive and negative impulse voltage

Circuit diagram: The circuit diagram for this test experimenting is consisting of mains equipment such as. AC slide voltage regulator transformer 0 – 220 V was used to control input voltages, after that the voltage was increased by stepping up transformer 220V/15 kV and applied to the Cockcroft-Walton circuit DC generator 0-100 kV. The Cockcroft-Walton circuit supplied DC voltages to Impulse generator 0-375 kV (Negative and Positive polarity). The series resistor was used to limit the current level for safety. Impulse voltage divider (Foster) ratio 1:1000 is utilized to reduce voltage for measuring the level of impulse voltage. The impulse voltage level was showed on Oscilloscope screen (Tektronix 2212). High speed camera was used to record the flashover distance of the under specimen, the circuit diagram was showed in Figure 2.

1. AC slide voltage regulation transformer 0 – 220V, 2. Step up transformer 220V/15 kV, 3. Cockcroft-Walton circuit DC generator 0-100 kV Positive /Negative, 4. Impulse generator 0-375 kV (negative and positive polarity), 5. Series resistor, 6. Impulse voltage divider (Foster) ratio 1:1000, 7. Long flash over arrestor (LFA), 8. Oscilloscope (Tektronix 2212) 9. High speed camera

Process of experiment: The process of experiment starts after setup circuit is already. Either specimen was tested under 1.2/50 microsecond positive and negative impulse voltage level of 9kV, 18kV, 27kV, 35kV, 42kV, 52kV, 60kV, 71kV, 81kV, 90kV, 99kV, 105kV, 112kV, 120kV, 130kV, 135kV, 145kV and 150 kV.

The maximum flashover length of either specimen was recorded after we increase the gap number step by step since the first gap until the maximum gap of flashing under either impulse voltage level. There are 216 cases were tested in this research paper. Either case was retesting more than 5 times.

3. Results

When we varied the breadth of aluminum ring by 0.25cm, 0.5cm, 0.75cm, 1.0cm, 1.25cm and 1.5cm under positive and negative 1.2/50 microsecond impulse voltage 9kV-150kV, then we are able to distinguish the characteristic as was presented in Figure 3. There were five cases for the results:

- At the breadth of ring 0.25cm: the larger elongation of flashover length lay in the impulse voltage range level of 144kV or more. The impulse voltage level of 150kV, the flashover length under negative impulse voltage was 18.5cm (37 gaps) shorter than that of the under positive impulse voltage 1.5cm (3 gaps).
- At the breadth of ring 0.5cm and 0.17cm: the larger elongation of flashover length lay in the impulse voltage range level of 130kV or more. The impulse voltage level of 150kV, the flashover lengths of ring's breadth 0.5cm and 0.17cm under negative impulse voltages was 20.5cm (41 gaps) and 25cm (50 gaps) shorter than that of the under positive impulse voltage 1.5cm (3 gaps).
- At the breadth of ring 1.0cm: the larger elongation of flashover length lay in the impulse voltage range level of 120kV or more. The impulse voltage level of 150kV, the flashover length under negative impulse voltage was 27cm (54 gaps) shorter than that of the under positive impulse voltage 1.5cm (3 gaps).

- At the breadth of the ring 1.25cm: the larger elongation of flashover length lay in the impulse voltage range level of 105kV or more. The impulse voltage level of 150kV, the flashover length under negative impulse voltage was 28cm (56 gaps) shorter than that of the under positive impulse voltage 2.0cm (4 gaps).

- At the breadth of ring 1.5cm: the larger elongation of flashover length lay in the impulse voltage range level of 90kV or more. The impulse voltage level of 150kV, the flashover length under negative impulse voltage was 31cm (62 gaps) shorter than that of the under positive impulse voltage 2.5cm (5 gaps).

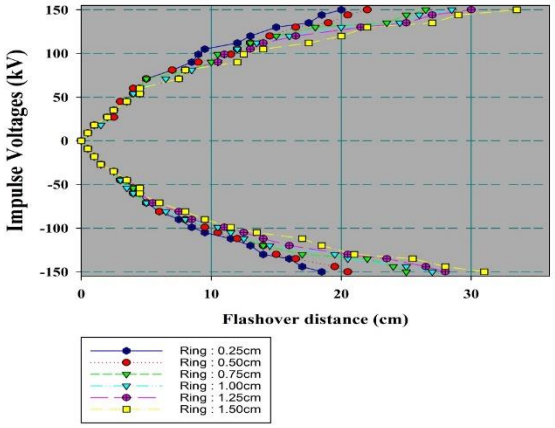

Figure 3 The experimental results comparisons of LFA under 1.2/50 microsecond from 0 to 150kV positive and negative impulse voltage

4. Discussion

The affectation of ring's breadth to the flashover length under 1.2/50 microsecond positive and negative impulse voltage can be summarized as showed below:

The LFA with different breadth of the ring have the exact same flashover length under 1.2/50 microsecond positive and negative impulse level same level limit of 0-60kV; At the 1.2/50 microsecond impulse voltage level of 7kV or more, the flashover length under positive impulse voltage was longer than that of the under negative impulse voltage; The breadth of the ring impact on the flashover length of LFA. If we increase the breadth of the ring, the flashover length was increased, if we reduce the breadth of the ring, the flashover length was also reduced. The increasing of flashover length forasmuch as the ring's breadth was showed at the voltage level of 130kV or more.

5. Conclusions

The LFA model with various breadths of ring under 1.2/50 microsecond positive and negative impulse voltage at the level of 9-150 kV was cogitated in this experiment. The LFA should tested under the negative impulse voltage because the flashover length was shorter and to decrease arcing power was less than that of the under the positive impulse voltage.

To decrease arcing power before transplant to ground, We should increase the flashover length, the increasing flashover length's characteristics forasmuch as the ring's breadth practically can help to develop ability of long flashover arrester and can help to increase effectiveness of transferring power arc to grounding system.

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