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The Identification Characteristic' Physical Flashing of Long Flashover Arrester (LFA) with Different Breadth of Ring under 1.2/50 Micro Sec Positive Impulse Voltages

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Abstract: This study presents the investigation's characteristic' physical flashing of Long Flashover Arrester (LFA) by varying the breadth of ring components under the 1.2/50 micro sec positive impulse voltage. The breadth of the ring was various sizes at 0.25, 0.5, 0.75, 1.0, 1.25 and 1.5 cm. The gap space for specimen was determined 0.5 cm with a diameter of 2.2 cm. When applied the 1.2/50 micro sec positive impulse voltages to 9-150 kV. The results showed that at the level of 0-60 kV 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 >81 kV and the explicit difference of flashover lengths increased when increased the positive and negative impulse voltage to 130 kV.

Key words: Arching, breakdown voltage, lightning arrester, surge protection, explicit

INTRODUCTION

The casualty of overhead transmission lines due to of lightning strikes is the very important motive of shortages of electric supplies and economic losses. Now a days, there are many types of lightning protection equipment to use, nonetheless, the protection overhead transmission line by top metal-oxide arresters have main problem that can be destroyed by a direct lightning with high maintenance cost (Lines, 2004).

Long flashover arrester was designed for adjustment and modifies to reduce that problem. The (LFA) was a simple discharge circuit consisting of a surface in the flashover and the discharge (insulator and ring conductor). The main factor of protection overhead transmission line by using LFA was the value of Power Arc Follow (PAF). The PAF will be reduced faster with a reduction of the value of dielectric field stress (E, kV/m). 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. The value of dielectric field stress factors depend on the phase voltage (Uph, kV) and the length of flashover (L, m).

To protect against lightning voltage, the new LFA could improve by increasing the length of flashover (Podporkin and Sivaev,1998). 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 (Solaphom *et al*., 2015; Fouracre *et al*., 2006). There are two simple types of LFA, LFA-L (Loop type) consisting of insulator loop and ring conductor, ring gap space 2-4 cm^2. LFA-M (Modular) consisting of two cables like pieces; there is semi-conductive core in either cable piece. The cable pieces are connected with three flashover modules. It can protect overhead transmission line against direct lightning strokes and overvoltage (Filho *et al*., 2007).

This study presents the exploration characteristics of LFA by varying breadth of ring that consisting of ring's breadth that utilizing aluminum conductor size: 0.25, 0.5, 0.75, 1.0, 1.25 and 1.5 cm, especially the flashover length of the specimen that was tested under 1.2/50 micro sec positive impulse voltage level of 9-150 kV.

MATERIALS AND METHODS

Experiment setup

Specimen: The specimen for this research study was consisting of two parts. The insulator part was made by tube Polyvinyl Chloride (PVC) diameter 2.2 cm and

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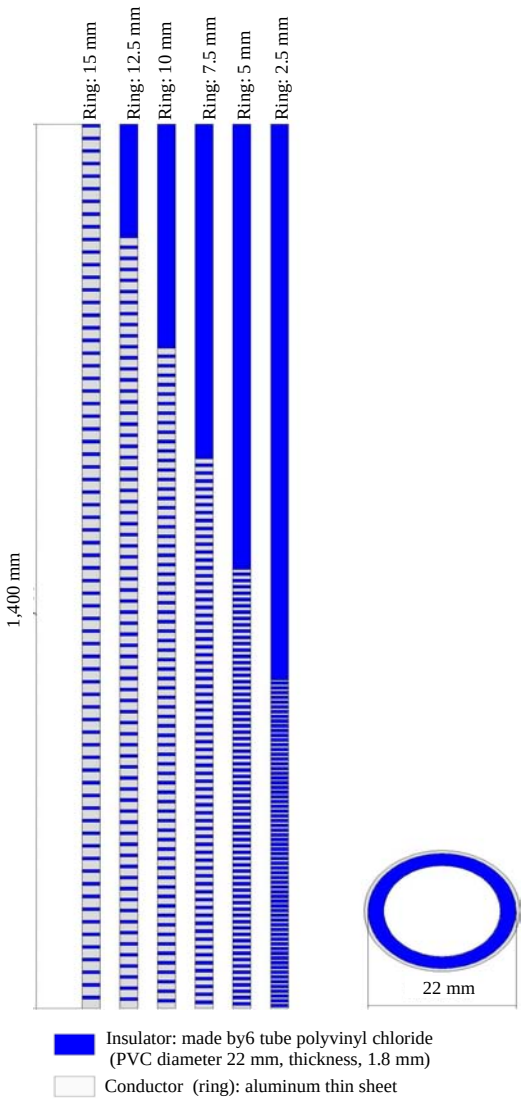

Fig. 1: Long flashover arrester with varying the length of ring's breadth

thickness 0.18 cm. The conductor part (ring) was made by the thin aluminum sheet. The ring's breadth of the specimen was designed and variable vary size of 0.25, 0.5, 0.75, 1.0, 1.25 and 1.5 cm. The specimens were experimented under the 1.2/50 micro sec positive impulse voltages level from 9-150 kV was applied. The LFA model was showed in Fig. 1.

Circuit diagram: The circuit diagram for this test experimenting is consisting of several mains equipment such as. The input voltage was controlled by using AC slide voltage regulator transformer 0-220 V after that the voltage was increased by stepping up transformer 220 V/15 kV and applied to the Cockcroft-Walton circuit

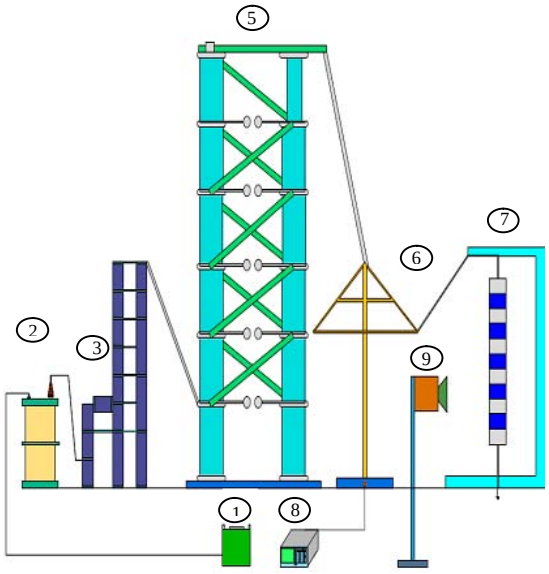

Fig. 2: Circuit diagram for testing long flashover arrester models: 1) AC slide voltage regulation transformer 0-220 V; 2) Step up transformer 220 V/15 kV; 3) Cockcroft-Walton circuit DC generator 0-100 kV positive/negative; 4) Positive impulse generator 0-375 kV; 5) Series resistor; 6) Impulse voltage divider (Foster) ratio 1:1000; 7) Long Flash over Arrester (LFA); 8) Oscilloscope (Tektronix 2212) and 9) High speed camera

DC generator 0-100 kV. The voltage from the Cockcroft-Walton circuit was applied to positive impulse generator 0-375 kV. To limit the current level for safety, we used series resistor for protecting. 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 is used for recording the flashover distance of the under specimen, the circuit diagram was showed in Fig. 2.

Process of experiment: The process of experiment starts after setup circuit is already. Either specimen was tested under 1.2/50 micro sec positive impulse voltage level of 9, 18, 27, 35, 42, 52, 60, 71, 81, 90, 99, 105, 112, 120, 130, 135, 145 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 108 cases were tested in this research study. Either case was retesting >5 times (Fig. 3-5).

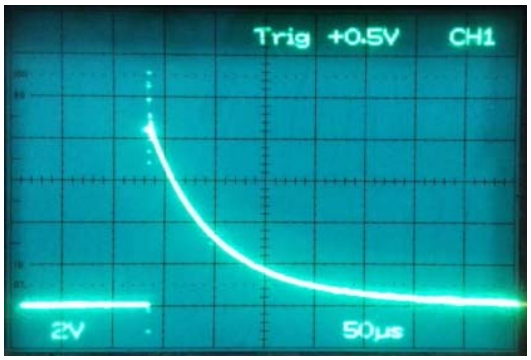

Fig. 3: Typical positive standard impulse voltage (1.2/50 micro sec) was used in this experiment

Fig. 4: Cockcroft-Walton circuit DC generator 0-100 kV

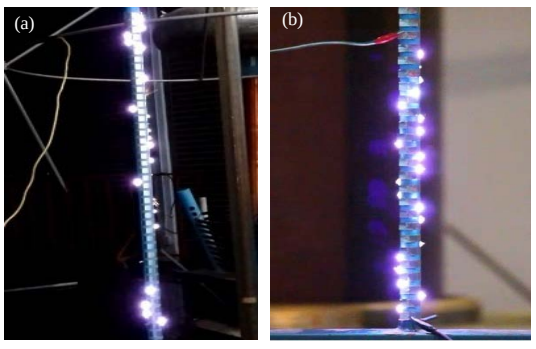

Fig. 5: a) LFA ring's breadth 1.5 cm and b) LFA gap space 1.0 cm under positive impulse voltages

RESULTS AND DISCUSSION

Testing results: When the breadth of the ring was varied by 0.25, 0.5, 0.75, 1.0, 1.25 and 1.5 cm under positive and negative 1.2/50 micro sec impulse voltage 9-150 kV, then we are able to distinguish the characteristic as was presented in Table 1 and Fig. 6. There were five cases for the results: From the observation we can separate the results in 3 cases according to characteristic of flashing. The breadth of ring size 0.25 and 0.5 cm: the flashover's length will gradually increase as the positive impulse voltage. The flashover's length approximately same length at the positive impulse voltages level of 0-81 kV. If we increase the positive impulse voltages level higher than 81 kV, the flashover length of LFA breadth of ring size 0.5 cm was longer than the breadth of ring size 0.25 cm average length of 1.67 cm and at the positive impulse voltages level higher more than 135 kV the breadth of ring size 0.5 have length of flashover longer than the breadth of ring size 0.25cm at 2 cm (4 gaps).

The breadth of ring size 0.75 cm: the flashover's length of this LFA size was homologous as LFA that the breadth of ring size of 0.25 and 0.5 cm for positive impulse voltages level <81 kV. At positive impulse voltages level of 81-130 kV, the flashover's length was longer than LFA breadth of ring size 0.25 and 0.5 cm average 1.2 cm and if the positive impulse voltages level higher than level of 130 kV, the flash's length was longer than LFA breadth of ring size 0.25 and 0.5 cm about 4.5 cm (9 gaps).

The breadth of ring size 1.0, 1.25 and 1.5 cm: the flashover's length of LFA in this case was similar as LFA breadth of ring size 0.25, 0.5 and 0.75 cm at the positive impulse voltage lower than level of 71 kV. At the positive

Table 1: The gap number of flashover

	Breadth of ring (mm)					
Impulse voltages	2.5	5.0	7.5	1.0	1.25	1.5
0	0	0	0	0	0	0
9	1	1	1	1	1	1
18	2	2	2	3	2	2
27	4	5	4	4	4	4
35	5	5	5	5	5	5
45	7	6	7	7	7	7
54	9	8	9	8	9	9
60	9	8	9	9	9	9
71	10	10	10	13	15	15
81	14	14	17	17	16	16
90	17	18	20	21	21	24
99	18	23	21	22	22	25
105	19	24	24	24	26	28
112	24	26	26	27	28	35
120	26	29	30	32	33	40
130	30	33	36	40	43	44
135	35	38	47	49	50	54
144	37	41	50	52	54	58
150	40	44	53	57	60	67

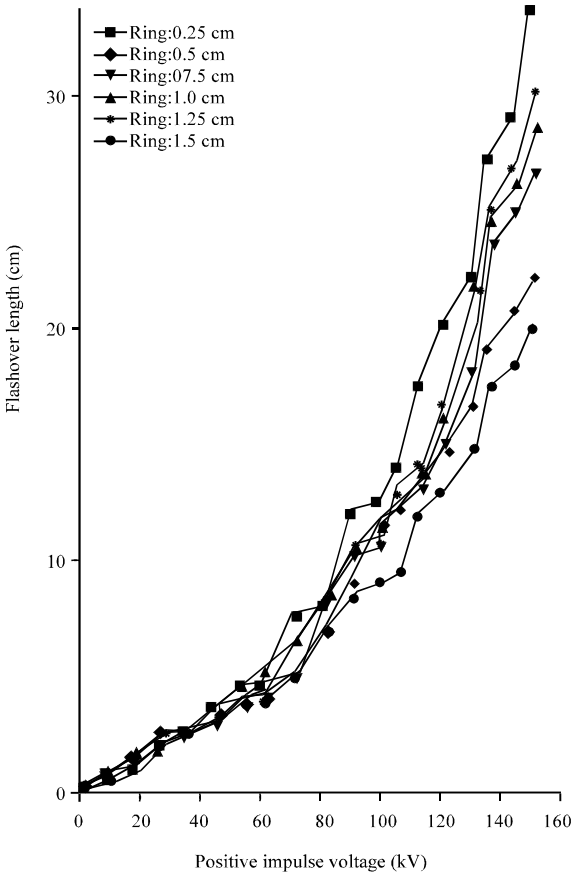

Fig. 6: The experimental results of LFA under 1.2/50 micro sec from 0-150 kV positive impulse voltage

impulse voltage level of 71-130 kV, the flashover's length was slightly different and in breadth of ring bigger size, the flashover's length was longer than the smaller one. If increase the positive impulse voltage level >130 kV, the flashover's length of this case was obviously longer than another cases especially in LFA breadth of ring size 1.5 cm was able flashover to 33.5 cm (67 gaps) at the positive voltage level of 150 kV.

CONCLUSION

The LFA model with various breadths of ring under 1.2/50 micro sec positive impulse voltage at the level of 9-150 kV was cogitated in this experiment. The affectation of ring's breadth to the flashover length can be summarized as showed below.

The LFA with different breadth of the ring have the exact same flashover length under 1.2/50 micro sec impulse level same level limit of 0-60kV; at the 1.2/50 micro sec positive impulse voltage level of 71kV or more, the flashover's length of LFA all of 3 case was slightly different length and the length of flashover increase according the positive impulse voltage level and the size of ring's breadth. 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's length forasmuch as the ring's breadth obviously at the voltage level of 135kV or more.

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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