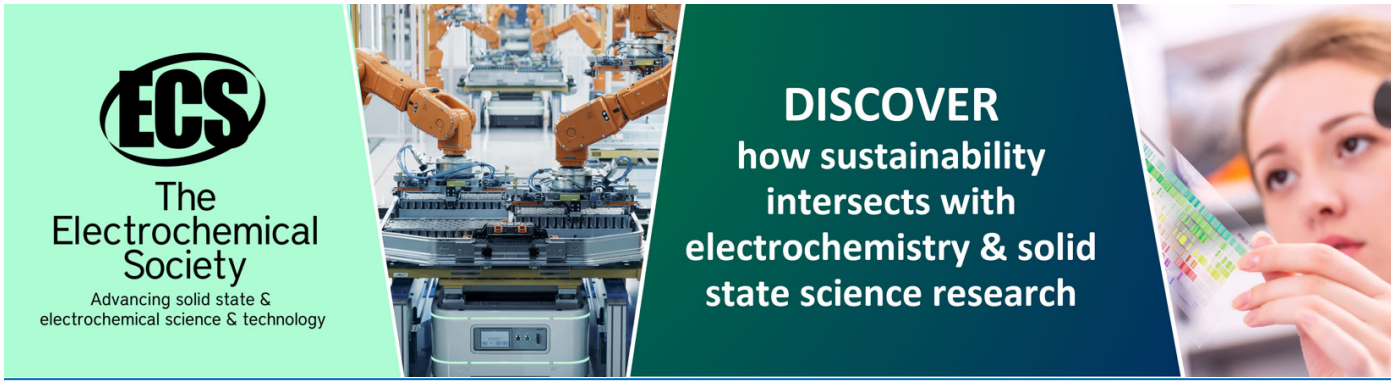
Analysis of Bird Damage Prevention Mechanism for Overhead Transmission Lines



Analysis of Bird Damage Prevention Mechanism for Overhead Transmission Lines

Mao Xiaopo*, Zhang Yaodong, Zhou Xueming, Feng Zhiqiang, Huang Zeqi, Ren Xiang, Shi Tianru, Fu Jianjin, Huang Junjie

Electric Power Research Institute, State Grid Hubei Electric Power Corporation, Wuhan, Hubei, 430077, China

*maoxp@hb.sgcc.com.cn

*Corresponding author's e-mail: mxp2004@163.com

Abstract. With the continuous development of the power system, 500kV transmission lines have become the backbone of power grid transmission lines. The construction of a large number of transmission lines is intertwined with the activities of birds. Line failures caused by birds have become the main cause of power system trip accidents. First, it seriously threatens the safe operation of the power system, and its degree of damage is second only to lightning strikes and external damage. Through related research and analysis, the bird damage of 500kV transmission line is mainly caused by three aspects: bird droppings, bird body and bird pecking. This paper analyzes the formation mechanism of bird damage on 500kV transmission lines, and provides some guidance for the corresponding prevention measures for the protection of transmission lines from bird damage.

1. Introduction

With the continuous construction and development of the power grid, large-capacity, long-distance UHV has become the development trend of transmission lines. With the continuous increase of voltage levels, the transmission distance of electrical energy has been improved. This can convert the rich primary energy in the west into electrical energy and transmit it to the central and eastern regions can greatly reduce the cost of power generation, and more importantly, significantly reduce environmental pollution. From the analysis of the current power grid situation, the 500kV transmission line has become the backbone of the power grid transmission line and is still being expanded.

Bird damage is caused by the tripping or failure of the transmission line caused by the bird's activities. Bird damage is the third-largest hazard of the transmission line after lightning strikes and external breakage. There are generally six types of bird damage to the transmission line: bird nest, bird Feces, bird body, bird peck, bird predation and birds are prey. At present, there are many studies on the prevention of bird pests on 110kV and 220kV transmission lines, and the application of prevention measures is more common, but less attention is paid to 500kV high-voltage transmission lines. As bird damages on 500kV transmission lines have occurred in recent years, people began to pay more attention to the failure mechanism of bird damages on high-voltage transmission lines. In general, the types of bird damage failures on high-voltage transmission lines include bird droppings, bird body and bird pecking. Analysis of the failure mechanism can be helpful for the research and implementation of prevention measures. Proportion of three bird damage types on 500kV transmission lines as shown in Fig.1.

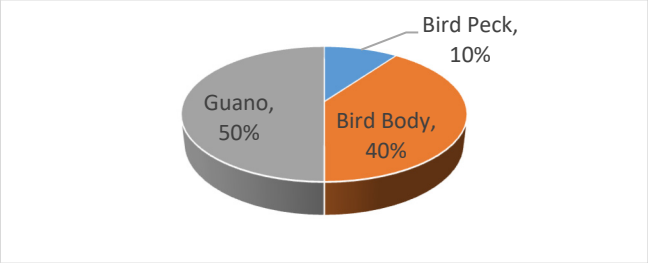


Fig.1 Proportion of three types of bird pests on 500kV transmission lines

2. Bird droppings experimental device

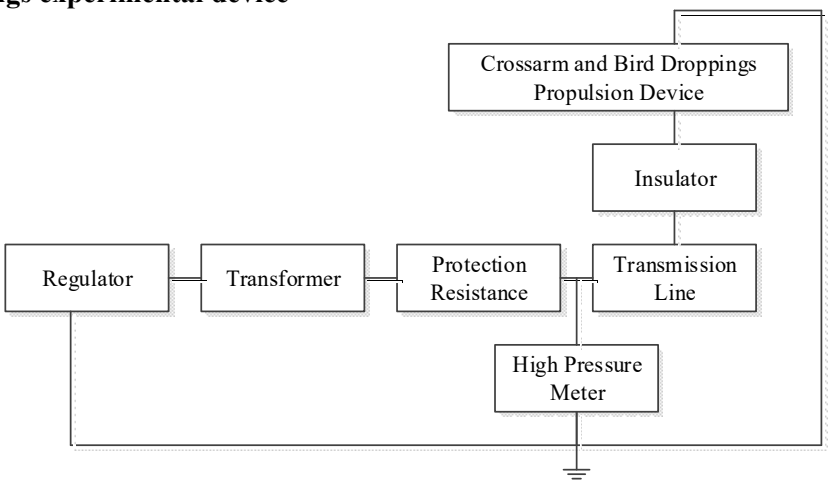
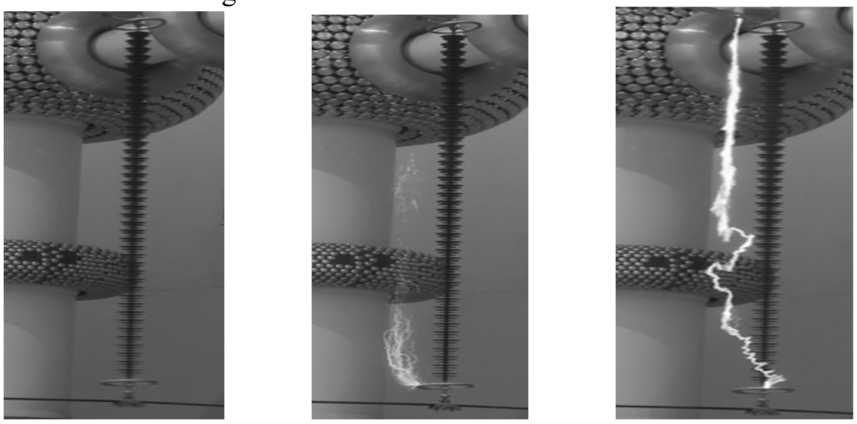


Fig.2 Block diagram of bird feces flashover simulation experiment

In the experiment, a transformer with a rated voltage of 800 kV is used, and for simulated bird droppings, a liquid with a conductivity of 8000 uS/cm is used. Fig.2 is an experimental block diagram. The experiment was to simulate the flashover of bird droppings, gradually increase the voltage of the wire, and set the initial voltage of the wire to 303.1kV ($\frac{500kV}{\sqrt{3}} \times (1+5\%) = 303.1kV$), in the process of increasing voltage, when the wire voltage increased to 330.1kV, local arc began to appear. When the voltage increased to 355.4kV, it was observed that the arc length reached about 70% of the entire insulator gap, when the voltage increased to 393.5kV, flashover is observed. Fig.3 shows the flashover of the conductor under three voltage conditions.



(a)303.1kV (b)355.4kV (c)393.5kV

Fig.3 The flashover process of bird droppings with different voltages applied to the conductor

Fig.3(b) shows the arc when the voltage is 355.4 kV. The brush arc in the figure shows that during the descent of bird droppings, the front end gradually diverges due to the high field strength, and a continuous channel cannot be formed. Fig.3(c) shows the arc when the voltage is 393.5 kV. It is observed that the upper end of the arc is straight and the lower end is curved. It can be judged that the upper end is the flashover of the bird droppings channel, and the lower end is due to the air flashover resulting in. The maximum operating phase voltage (303.1kV) was applied to the conductor, and the conductivity and form of bird droppings in the worst case were used, but no flashover occurred during the experiment, so it can be judged that for 500 kV transmission lines, clean The surface of the insulator is difficult to form a flashover in the gap of 500kV composite insulator just because of bird droppings. However, in recent years, due to serious air pollution, there has been a lot of contamination on the surface of the insulator, plus drought and rain in winter and spring. During bird breeding, a large amount of excretion is generated on the surface of the same insulator. Under the action of moisture, the insulator flashes phenomenon.

3. Bird body and bird pecking analysis

The bird body failure of the 500kV transmission line is mainly caused by the phase-to-phase short circuit when the bird leaps over the tower window. The transmission line failure caused by the bird body is mainly for larger birds. When flying, the wingspan is large and it is easy to cause short circuit between phases, as shown in Fig.4. In view of this situation, it is necessary to stick eye-catching notes or install light-emitting devices on birds that often fly over tower windows.

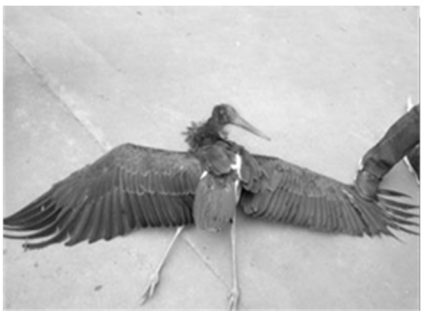


Fig.4 Bird-to-phase short circuit between transmission lines

The bird pecking failure occurred on the 500kV transmission line, which was mainly aimed at small birds. It was mainly pecking composite insulators. Because birds have no teeth, it is difficult to grind food. Small birds rely on pecking composite insulators to help food digestion, thereby destroying the insulator Performance, making it not work properly. In response to this situation, it is necessary to place some small stones or small fragments of composite insulator materials near the insulators that birds often peck.

4. Conclusion

For the 500kV transmission line, this paper analyzes the experimental results and the actual transmission line bird damage, and the conclusions are as follows:

1) For bird dung faults, due to the long length of 500kV line insulators, it is difficult to cause flashover phenomenon just because of bird dung, which is often accompanied by a lot of contamination on the surface of the insulator, plus moisture, causing transmission line failures. Therefore, it is necessary to install a bird-proof device on the insulator. At the same time, the transmission line in contact with the insulator is wrapped with an insulating sheath. The presence of the insulating sheath makes the potential of the equalizing ring lower than the minimum voltage that can cause bird droppings flashover. The discharge between bird droppings and the equalizing ring is avoided, and the probability of bird dropping flashover is reduced.

2) For bird body failures, it is necessary to stick eye-catching injections or install light-emitting

devices on the birds' frequent flying tower windows to attract bird attention and reduce the phase-to-phase short-circuit failure caused by bird bodies.

3) For bird pecking faults, some small stones or small fragments of composite insulator materials need to be placed near the insulators that birds often peck to reduce bird pecking on the composite insulators.

4) Without considering the actual operating conditions of the line, the situation of the flashover of bird droppings in the long gap of the I series 500kV composite insulator is simulated. It can be obtained through the experiment that the flashover phenomenon occurs only when the applied voltage on the conductor reaches 393.5kV.

References

[1] X. Ran, Q. Yang, W. Sima, T. Yuan, and S. Ou-Yang, "Research on AC discharge characteristics of analog tower-line air gaps under the influence of bird streamer," in Proc. Int. Conf. High Voltage Eng. Appl., 2012, pp. 392–395.

[2] P. Taklaja, R. Oidram, J. Niitsoo, and I. Palu, "Causes of indefinite faults in estonian 110 kV overhead power grid," Oil Shale, vol. 30, no.2S, pp. 225–243, 2013.

[3] Zhao Tiebin，Comber M G．Calculation of electric field and potential distribution along non-ceramic insulators considering the effects of conductors and transmission towers[J]．IEEE Transactions on Power Delivery，2000，15(1)：313-318．

[4] Electric Power Research Institute．Electric field modeling of NCI and grading ring design and application[R]．Palo Alto，California：Electric Power Research Institute，1999．

[5] Zhang Bo，He Jinliang，Cui Xiang，et al．Electric field calculation for HV insulators on the head of transmission tower by coupling CSM with BEM[J]．IEEE Transactions on Magnetics，2006，42(4)：543-546．

[6] K. Naidoo, N.M. Ijumba, A.C. Britten. Bird Streamer Initiated Breakdown Characteristics under HVDC Conditions[C]. 2006 International Conference on Power System Technology.

[7] Van Rooyen C, Vosloo H, Harness R. Eliminating bird streamers as a cause of faulting on transmission lines[C]. 2002 Rural Electric Power Conference. Papers Presented at the 46th Annual Conference.