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Application of Anti-icing Coating on Transmission Line

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Abstract

For a long time, China mostly sets up transmission lines in the field of empty mines. Because they are often exposed to the air, they are very vulnerable to the influence of natural factors, which leads to the occurrence of transmission line icing and destroys the safety and stability of the whole power system. In recent years, China, like all countries in the world, is committed to the research on anti-icing, which is also an important premise to ensure the stable production of all walks of life. In view of this, this paper will carry out a deeper discussion on the anti-icing coatings applied on transmission lines, in order to provide reference for relevant people.

Keywords

Anti-icing coating; Transmission Line; Application.

1. Introduction

All kinds of equipment in the power system will suffer faults after the transmission line icing event, which will not only threaten the safe and stable operation of the power system, but also affect the power supply effect, and all walks of life can't produce stably. In the process of China's economic development, the problems caused by transmission line icing are very serious. Because there are more than 79% resources in the central and western regions with high altitude and ice and snow coverage, the central and western regions have gradually become the focus of economic construction. In the process of industrial development, power engineering construction is the most basic guarantee, which is also the main factor for the increasing number of high-voltage line construction in recent years. Therefore, it is urgent to solve the problem of transmission line icing.

2. Types of Transmission Line Icing

According to the meteorological conditions and physical process of icing formation, the icing of transmission lines can be divided into three types. The first type, snow cover caused by precipitation, that is, precipitation ice cover, mainly in the form of snow cover and rime formed by rain ice. The second type, icing caused by water droplets or liquid cloud particles colliding with ground objects and freezing under extremely low temperature. This type of icing is also called cloud icing. The third type, the water vapor in the atmosphere directly condenses into ice, or an ice frost formed by falling on the ground through condensation, which is called condensation icing, and its other name is crystal rime. Among these three types of icing, cloud icing is the most likely to occur, resulting in the most frequent transmission line faults.

3. Factors Affecting Transmission Line Icing Growth

3.1 Meteorological Factors

According to relevant research, there are three conditions for transmission line icing. Firstly, there should be a sufficient amount of supercooled water droplets in the atmosphere. Secondly, cooling water droplets can cover the transmission line. Finally, supercooled water droplets should be frozen

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immediately or before leaving the conductor surface. These three conditions, including meteorology, mechanics and thermodynamics, are closely related to the formation of icing.

3.2 Effect of Altitude

Each area will have a beginning and end point of icing, that is, its condensation height. For areas with the same conditions, generally, the higher the altitude, the higher the ice coverage rate, and most of them are Pinus foganum. There will also be a small amount of ice at lower altitudes, but its ice layer is thin, most of which are mixed freezing or rime. In China, the condensation height of icing has its own distribution law, low in the East, high in the West, low in the South and high in the North. If it is above the condensation height, the ice growth rate will gradually increase with the continuous rise of the elevation.

3.3 Influence of Terrain and Geographical Conditions

The slope direction, platform, air outlet, water ridge and other factors also play a decisive role in the weight of icing. In mountainous areas, terrain is a main factor affecting conductor icing. According to relevant data, in winter, the icing on the windward slope is more serious than that on the leeward slope, and the icing on the line at the seal and watershed is more serious than that in other areas.

3.4 Seasonal Influence

Icing does not occur in every season. It is mainly concentrated from November of the previous year to March of the next year, especially in the late spring cold and early winter. In December and January, the average temperature in the heavily icing area is low, but its humidity is low, so it is also a relatively light icing month. However, in November, February and March, although the average temperature is relatively high, the humidity is heavy, and the ice growth is more serious.

3.5 Influence of Wind Speed

Wind speed is an important factor affecting the formation of icing. At the same time, it also has a direct impact on the density, type and growth rate of icing. The wind speed will make the water drop move towards the conductor. When the conductor is infinite, the motion speed of the small water drop is the same as the wind speed. The greater the wind speed, the greater the inertia of small water droplets. When the water drop moves near the conductor, the smaller the component of the viscous force of the air flow in the direction perpendicular to the incoming velocity relative to the inertia, so the greater the collision rate of the water drop. When the wind speed increases, the collision rate of water droplets on the conductor also increases, which accelerates the speed of icing.

4. Application of Common Anti-icing Coatings

4.1 Application of Electrothermal Anti-icing Coating

The commonly used conductive fillers include carbon black, carbon fiber and zinc oxide. The above materials are mixed into the anti-icing coating and then coated on the transmission line insulator. The coating on the insulator surface will continue to heat due to the electrothermal effect, so that it will not cause icing disease due to low temperature in rainy weather in winter. On the other hand, only in winter, due to the relatively low temperature, if there is rainy weather, the transmission line is prone to icing. At this time, the application of electrothermal anti-icing coating can effectively protect the safety of transmission line. Once the winter is over, the rain weather in other seasons will not cause the transmission line to freeze. At this time, the electric anti icing coating will continue to heat. In the long run, the aging speed of the transmission line will be greatly accelerated.

4.2 Application of Anti-icing Coating for Melting Ice

Organic metal compounds and other electrolyte components are added to the ice melting and anti-icing coating. These electrolyte components will decompose and dissolve into the water after touching the water, so that the freezing point of the water will be properly reduced, and then there will be no freezing phenomenon. In addition, the surface of the transmission line should have a certain hydrophobicity, so that water without ice can easily fall from the transmission line. In the practical

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application of ice melting and anti-icing materials, there are great limitations. On the one hand, the migration speed of electrolyte components in water and the specific reduction effect on water coagulation point should be considered. On the other hand, the physical properties and thermal stability of anti-icing coatings coated on transmission lines should be evaluated, and the corrosion of anti-icing coatings on transmission lines should be reduced. In addition, the anti-icing coating can't play an effective anti-icing role in the low temperature environment beyond a certain temperature range. In general, it is very difficult to overcome the above difficulties in the application of ice melting and anti-icing coatings on transmission lines, which greatly limits the application and promotion of ice melting and anti-icing coatings.

4.3 Application of Photothermal Anti-icing Coating

Compared with the above two anti-icing coatings, photothermal anti icing coatings have less application in transmission lines due to their short development time. In terms of application principle, photothermal anti icing coating also has more significant anti icing effect by adding components with special properties to the anti-icing coating. Compared with other anti-icing coatings, photothermal anti-icing coatings have higher environmental protection and energy saving, because they play a role through the components that can absorb solar energy added to the anti-icing coatings, and convert solar energy into thermal energy for heating, so that the transmission line will not freeze. At present, there is a selective solar energy absorption coating, which has obvious advantages in adhesion and aging resistance compared with other photothermal icing coatings. Compared with electrothermal anti icing coatings, photothermal anti-icing coatings also have similar disadvantages, that is, continuous heating in non-icing weather leads to accelerated aging of transmission lines.

4.4 Superhydrophobic Anti-icing Coating

At present, a new anti-icing coating has been developed. This coating is developed according to the performance necessary for anti-icing. It has strong hydrophobicity and has a long validity period. At the same time, under the catalysis of sunlight, the super hydrophobic anti icing coating has a certain self-cleaning ability. On the other hand, when superhydrophobic anti icing materials are applied to actual transmission lines, it is necessary to overcome the adverse effects of electromagnetic field, dirty substances and weather environment on the performance of anti-icing materials. The biggest defect of superhydrophobic anti-icing coating is that it can only play an anti-icing role in a short low-temperature environment, that is, it can only play a mitigating role in anti-icing. If the low-temperature environment is maintained for a long time, icing will still occur on the transmission line. Moreover, there are a certain number of voids in the formed ice structure. When melting the ice, it is easy to discharge, and even burn out the coating layer in serious cases. It can be seen that the large-scale application of superhydrophobic anti icing coating still has limitations, and the practical application is difficult.

5. Conclusion

In a word, power construction personnel must pay attention to the development of icing work. According to the practical data, the anti-icing coating has obvious advantages in solving the icing problem of transmission circuit compared with other anti-icing technologies. The anti-icing coating not only has little technical application, but also has low cost in practical operation and research and development, and can well adapt to the harsh environment, and has a broad development prospect.

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