

Icing Features of Wire In Chongqing Region

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Abstract—In this paper, some factors that affect the type and the shape of ice in Chongqing power grid are discussed to improve the security and stability of it. With dramatic changes in global climate, more frequent local micro-climate phenomenon and repeated extreme weather caused serious icing phenomenon. And the ice-covering on wires had caused great losses to the national economy over the past decades. Therefore, it is important to study the characteristics of iced wire in Chongqing and the effective anti-icing measures. According to the data from Chongqing Weather Bureau, the ice are affected by climate, topography, altitude and many other factors. The icing phenomenon is mainly in mountains in northeast and southeast Chongqing regions. The main type of ice are glaze and hard rime. Topography and altitude have great influence on the ice.

1. INTRODUCTION

Icing is a beautiful natural phenomenon, but it is very harmful to the power system. The first ice-snow disaster of transmission line happened in China in 1954^[1]. A continuing snow and freezing weather happened in central China during the spring festival in 2005. It was so severe that the loss was very large^[2]. It is necessary to grasp the characteristics of grid under iced condition and to protect grid. And this is an important topic in China recently. In this paper, some factors that affect the type and the shape of ice in Chongqing power grid are discussed to improve the security and stability of it. And these factors are mainly weather and geographical environment.

2. RESULT AND DISCUSSION

The data from Chongqing Weather Bureau indicates that weather conditions, wind speed and direction, water droplets and other factors have significant impact on the iced transmission lines.

There are many hills in west Chongqing and many mountains in east and south Chongqing where the altitude is very high. Under the same geographical environment, the higher the altitude be, the more serious the icing be. It is very easy to form icing in these areas where the elevation in the range between 800m to 2600m. The ice at high altitude is mixed-phase ice. It is hard and it has strong adhesive power. The density is about 0.6-0.9g/cm³, as shown in Figure 2. The ice on the

transmission lines are glaze at low altitude. And they are transparent, smooth and hard. It usually has a high amount of density, about 0.8 ~ 0.9g/cm³, as shown in Figure 1. The icing phenomenon is usual in the northeastern part of Chongqing for its high altitude and the iced wire are scattered widely. The thickness of ice is thin even when the wires cross these peaks in hills, so it is not necessary to pay more attention to the influence on wire by the icing.



Figure 1. The glaze ice on the wire



Figure 2. The hard rime on the wire

3. CONCLUSION

According to the mechanism of icing, the formation of ice on lines is affected by temperature, humidity, wind speed and the size of dripping. Varied factors make the styles of icing different. The great difference in icing is caused by complex landform, changeable climate and big humidity in different regions.

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Abstract—With the dramatic changes in global climate, local micro-climate have become increasingly frequent. Recurrence of extreme weather in some areas has made a serious phenomenon of snow and ice cover. Chongqing is largest municipality in China. The security of grid operation in Chongqing is significant. There are many mountains in Chongqing and the temperature is low in winter. The rivers and the water vapor in air is abundant on the territory of Chongqing. The icing phenomenon often occur with wire in mountain, and cause many accidents. The snow disaster in 2008 seriously affected the security and stability of the grid. Therefore, it is important to study the characteristics of iced wire in Chongqing and the effective anti-icing measures. According to the data from Chongqing Weather Bureau, the ice are affected by climate, topography, altitude and many other factors. The icing phenomenon is mainly in mountains in northeast and southeast Chongqing regions. The main type of ice are glaze and hard rime. Topography and altitude have great influence on the ice.

Keywords—icing feature; mechanism; metrology; Chongqing region;

I. INTRODUCTION

Icing is a beautiful natural phenomenon, but it is very harmful to the power system. The first ice-snow disaster of transmission line happened in China in 1954^[1]. The ice-snow accidents on wires have caused great losses to the national economy over the past decades.

Especially, dramatic changes in global climate, more frequent local micro-climate phenomenon and repeated extreme weather caused serious icing phenomenon. A continuing snow and freezing weather happened in central China during the spring festival in 2005. It was so severe that the loss was very large^[2]. It caused the collapse of towers, flash over of insulators or gallop of conductors. The continuing rain and snow weather happened in the most parts of China in the early of 2008 is the most serious in its history, which made very serious effects on the safe performance of the power system and it even caused a large-scale outage. The security and reliability of grid's operation are affected seriously by ice-covering on overhead transmission lines^[3,13,14]. Consequently, it is necessary to grasp the characteristics of grid under iced

condition and to protect grid. And this is an important topic in China recently.

There are many hills and mountains in Chongqing, a city in the southwestern part of China. The topography of southeast Chongqing is higher than its west part, and

Yangtze River traverses it from east to west. Many branches of the river makes the city very humid.

The special terrain and climatic environment make the icing distribution of Chongqing power grid uneven. The security and stability of Chongqing power grid is impaired deeply by the complex climatic and geographic conditions. Therefore, studying on the ice-covering and finding effect anti-icing and anti-ice measures are becoming more and more important^[13].

In this paper, an summary that based on the data from Chongqing Weather Bureau and the investigation from icing transmission line describes the characteristics of transmission line under iced condition in Chongqing. The iced wires in Chongqing are mainly affected by the topography and these iced lines are usually in high altitude areas. The type of these icing is mixed-phase ice and the shape is crescent. In order to get the thickness of the ice on transmission lines, the length and width of it should be conversed

The study on the characteristics of the iced transmission lines in Chongqing provides effect anti-icing ways which can decrease the frequency of accidents occurrence.

II. MECHANISM OF ICE-COVERING

There are many mountains in Chongqing. Cold air mass attacks the city in every winter and early spring, which makes the formation of stationary front. The temperature inversion is affected by the stationary front. The temperature near the ground below 0 °C. When the air rises, it will increase to 0 °C and above by the influence of warm air mass. The temperature will decrease to 0 °C when the height up to reach the condensation level. Thus, Ice or snow is shaped.

The temperature of cooled water droplets will rise and Ice or snow will melt partly or entirely when they pass warm air mass. When they pass the atmosphere where the temperature below 0 °C, the big cooled water droplets would integrate with dust in the air. And the combination will be lowered to the ground, but these small cooled water droplets will down to ground. The sleet is caused by these small cooled water droplets. It is very difficult to change the structure of the small cooled water droplet for its small diameter and big surface tension. These unstable small cooled water droplets are very easy to change into ice when they touch cold objects such as line on the ground. At the same time, their shape will change by wind. The curvature and the surface tension of them will decrease while the surface of lines have no changes. As lines play the role of condensation nuclei, these small cooled water droplets condense into glaze or rime^[4,6,8].

It is obvious that weather conditions, wind speed and direction, water droplets and other factors have significant impact on the iced transmission lines. The type, shape, density and thickness of transmission lines are different because the icing have different forms in different conditions^[5,7].

III. THE ICING FEATURES OF WIRE IN CHONGQING

There are many hills in west Chongqing and many mountains in east and south Chongqing where the altitude is very high. The temperature in these mountains below 0 °C in winter. The complex terrain, sufficient moisture and small wind velocity make it easy to form icing. So the characteristics of the iced lines is clear in Chongqing^[9].

The data from Chongqing Weather Bureau and information from on-site show that there were 4 important features of the iced transmission line in Chongqing.

(1) The types of the iced transmission lines in Chongqing are mainly glaze and rime. The ice on the transmission lines are glaze at low altitude. And they are transparent, smooth and hard. It usually has a high amount of density, about 0.8 ~ 0.9g/cm³, as shown in Figure 1. The ice at high altitude is mixed-phase ice which is composed by transparent ice layer and opaque ice layer. It is hard and it has strong adhesive power. The density is about 0.6~0.9g/cm³, as shown in Figure 2.

(2) The iced transmission lines are on the mountains in northeast and south Chongqing. There is no ice-covering in these counties on the border of Sichuan such as Hechuan, Rongchang and Dazu, but the situation gets worse from the east to the south and to the north. The icing problems in these counties such as Chengkou, Wuxi, Wushan, Wulong and Pengshui are very serious. The elevation in these counties are very high, so it is very easy to form icing when transmission lines cross the mountains in these areas.

(3) Under the same geographical environment, the higher the altitude be, the more serious the icing be. It is very easy to form icing in these areas where the elevation in the range between 800m to 2600m. There is no icing in

these areas where the altitude does not exceed 800m. The thickness of ice is 5~10mm at 800-1100m altitude and 10~20mm at 1100-1500m altitude. The thickness of ice rises with increasing altitude when the elevation exceeds 1500m.



Figure 1. The glaze ice on the wire



Figure 2. The hard rime on the wire



Figure 3. The oval ice on the wire

(4) The shape of ice is oval when the thickness of iced transmission lines is small in natural environment. And these oval ice attached to the surface of lines, as shown in figure 3. The shape of ice will change into crescent when the thickness grows by wind. One side of it is very thin while the other is airfoil profile. The wind load is so heavy that the transmission lines are very easy to gallop^[10,11].

IV. SPECIAL FACTORS THAT AFFECT ICING IN CHONGQING

A. Meteorology

The reason why the temperature in winter is not low in Chongqing is that the cold air masses from north could not move into the south by Qingling Mountains. The data from Chongqing Weather Bureau shows that the minimum temperature of downtown Chongqing is above 0°C in winter while the temperature is different in its east and south counties. The temperature of these areas are affected by altitude and the mean minimum temperature is 2~5°C, the icing phenomenon appears only in some peaks where the altitude is high. More than 90% of the regions have no icing phenomenon, but the mean minimum temperature is below 0°C in Chengkou, Wushan and Wuxi in winter. It is

very easy to form ice when cooled water droplets or drizzle drops touch lines. So the icing phenomenon is very usual in these areas especially in Chengkou^[15,16,17].

The Yangtze River crosses Chongqing from the east to the west. There are so many lakes and rivers in it that the city is very moist. The city is surrounded by many mountains. The annual air humidity in Chongqing is very high because moisture content in the air is difficult to lose. The relative humidity of the atmosphere is 70%~80% and it is usual to see fog and drizzle drop in these mountains. And sufficient water vapor content makes it easy to form ice. So icing phenomenon happens frequently in these places where wires near water or cross rivers^[1].

The difference of wind velocity between Chongqing and plain area is great. The wind velocity in plain is gently and it is below 2m/s in hills where the shape of ice is oval. The wind velocity in mountains is high, the higher the altitude is, the bigger the wind speed is, especially in these gorges and draught. The shape of ice is crescent in these places^[10,18].

B. Topography

The weight of iced line depends on the trend of the mountain range, slope direction and watershed, draught and water bodies and so on. But in Chongqing, the topography and the geographical conditions have significant influence on the iced transmission lines^[12,19].

It is very easy to form mist when the amount of cooled water droplets increased near peaks and cliffs, and this phenomenon is caused by wind which makes cooled water droplets move upward and expand. For example, the altitude outside the Golden Buddha mountains in Nanchuan district is low while it is high inside. The icing phenomenon occurs every year on a 10kV overhead line in the scenic spot and some towers collapsed frequently.

The air currents speed up fastly in gorges. The wind load and the content of ice increase as wires cross these places. For example, there is a 35kv overhead line from east to west and it traverses Luoping section in Wushan county in Three Gorges. The altitude is about 1500~1800m in these areas. And ice-covering accident occurs in this area every year. The reason why the icing cut off another 35kv line in Golden and Baiguo of Pengshui is that the lines are in draught every year.

The icing usually occurs in those lines where has lakes and rivers because it has enough water vapor content. For example, a line from Wulong to Baima in Wulong, which linked the two towns. Because the line near the water and it land on the windward slopes, the icing is very serious. Especially in 2008, over 10 towers fell down.

C. Altitude Equations

Not only temperature, pressure and wind speed are affected by altitude, but also the relative humidity of the atmosphere involved. The higher altitude the wire at, the lower temperature of the air is, the lower pressure and the greater wind speed are, the easier the formation of icing.

Altitude has significant influence on the Chongqing power grid. Some factors that affect the icing process change with the height. The higher altitude, the lower temperature. And the atmospheric liquid water content in air changes with height. The data from on-site shows that the relationship between the thickness of ice and altitude is an exponential function. And the thickness rises with increased altitude.

The icing phenomenon is usual in the northeastern part of Chongqing for its high altitude and the iced wire are scattered widely. Because the mountains in east Chongqing are high, the ice-covering phenomenon appeared in these high altitude mountains is common while there is no icing on other mountains with low altitude. There are many hills in the northwestern part of Chongqing, so it is not usual to see large-scale icing phenomenon. The thickness of ice is thin even when the wires cross these peaks in hills, so it is not necessary to pay more attention to the influence on wire by the icing.

V. CONCLUSION

According to the mechanism of icing, the formation of ice on lines is affected by temperature, humidity, wind speed and the size of dripping. Varied factors make the styles of icing different. The great difference in icing is caused by complex landform, changeable climate and big humidity in different regions.

(1) The data from on-site indicates that the ice on wires in Chongqing has their features in type, density, geographical distribution, the thickness of ice, appearance and so on.

(2) The special weather conditions, the different geographical characteristics of the terrain, the altitude and some cases that lines were destructed by icing in Chongqing are discussed to analyze the influence on iced wire.

(3) The traits of the line covered with ice is obvious in Chongqing. Those factors that affect the iced lines are different. The application of proper anti-icing measures should be based on the features of ice-covering in different regions. Only in this way, the accident that caused by ice on wire would be prevented effectively.

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