Study on Describing Icing Degree of Porcelain and Glass Insulators Based on Icing Thickness of Equivalent Diameter

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Content

- Introduction
- Characterization Method of Insulator Icing Degree
- Test Result and Analysis
- Conclusions

I Introduction

Background

- Power grid accident caused by flashover of iced insulator may **destroy** the network structure and **threaten** the safety operation of power system.
- With the development of **UHV** engineering projects in China, **higher requirements** are demanded for the reliability service of power system.
- **The icing degree** may influence the flashover performance of insulator.

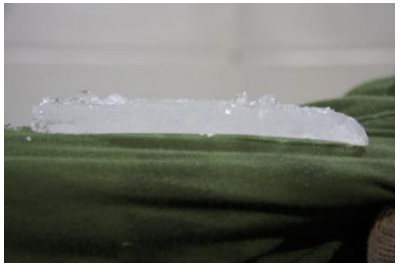
Table1 Icing Flashover outage of China in 2008

Voltage	Hunan	Jiangxi	Zhajiang	Henan	Chongqing	Total
500kV	126	62	50	8	14	260
220kV	683	172	25	6	9	895

I Introduction

Different characterization methods of icing degree

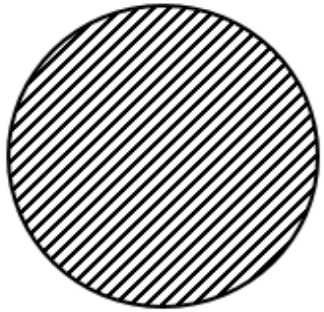
- icicle bridging degree.
- ice quantities of insulators
- ice thickness on the surface of insulator
- the length and diameter of icicle
- ice thickness of rolling conductor monitoring



II Characterization Method of Insulator Icing Degree

- **Equivalent Diameter of Insulators**

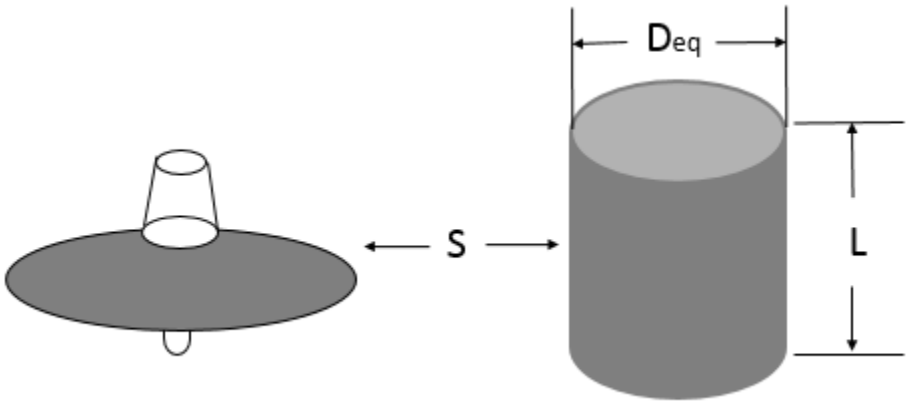
(a) Cross section of irregular sample



(b) Cross section of equivalent diameter cylinder

$$\Longrightarrow \quad D=2\sqrt{\frac{S}{\pi}}$$

II Characterization Method of Insulator Icing Degree



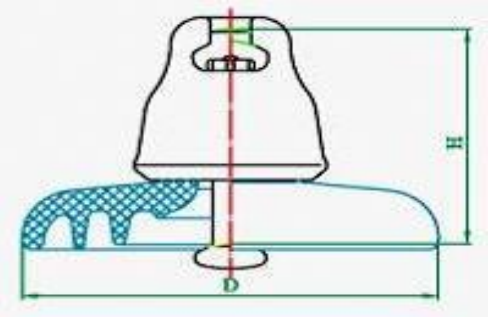
Based on idea above, the insulator can be equivalent to a cylinder whose surface area is identical with that of the insulator and the height is the creepage distance.

$$D_{eq} = \frac{S}{\pi \times L}$$

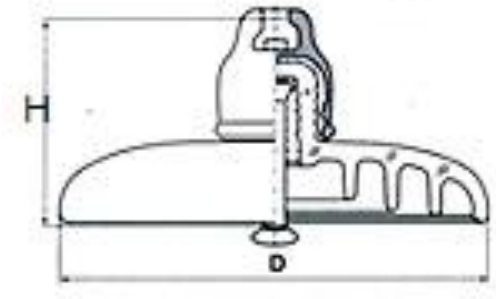
II Characterization Method of Insulator Icing Degree

Example of Insulators

Type	D/mm	L/mm	H/mm	S/cm^2	M/kg
XP-300	322	385	192	2455	13.5
LXY-300	320	485	195	3138	10.7



(a) XP-300



(b) LXY-300

Type	**D_{eq}/mm**
XP-300	**203.0**
LXY-300	**205.9**

II Characterization Method of Insulator Icing Degree

- **Ice Thickness of Equivalent Diameter of Insulators**

Keep icing weight of insulator and cylinder body as the same, the ice thickness of equivalent diameter of insulators can be expressed as

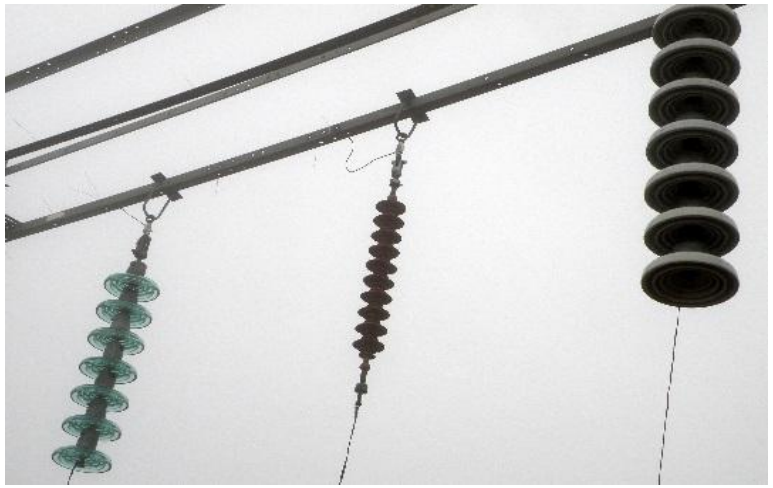
$$d = \frac{1}{2}\left(\sqrt{\frac{4V}{L\pi} + D_{eq}^2} - D_{eq}\right)$$

III Test Results and Analysis

- **Xuefeng Mountain Natural Icing Testbase**

III Test Results and Analysis

- **Arrangement of insulators**



Arrangement of insulators

III Test Results and Analysis

Environment Parameters Detection

- **Device Type：PortLog RS232**
- **Parameters：Temperature, Wind Speed, Wind Direction, Relative Humidity, Barometric Pressure, Dew Point**

II Characterization Method of Insulator Icing Degree

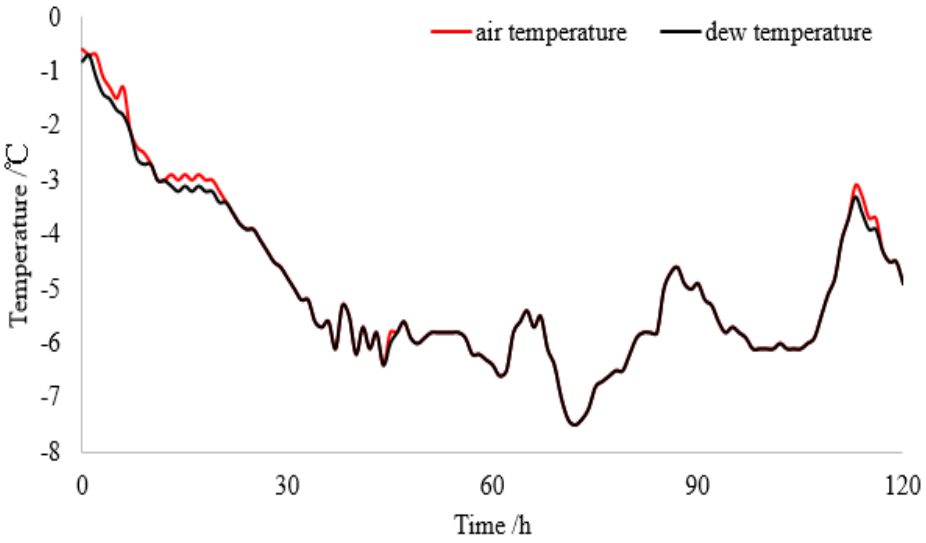
Icing Load Monitoring

- **Rate load: 100, 200, 300 kg Sensitivity: 1.353 mV/V**

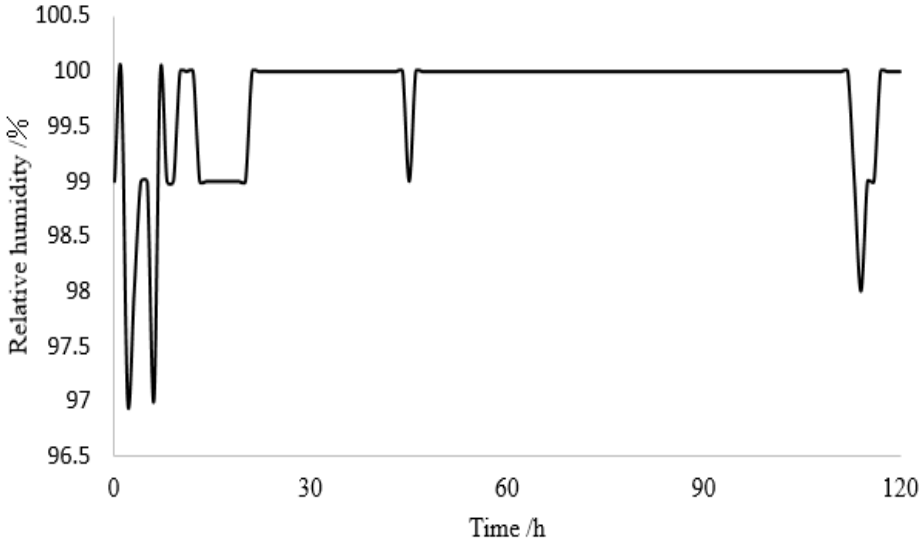
Taking weights of insulators into consideration, 300kg strain gauge load cell was selected to record the variation of ice mass of insulator string.

III Test Results and Analysis

- **Environment Parameters During Icing Process**

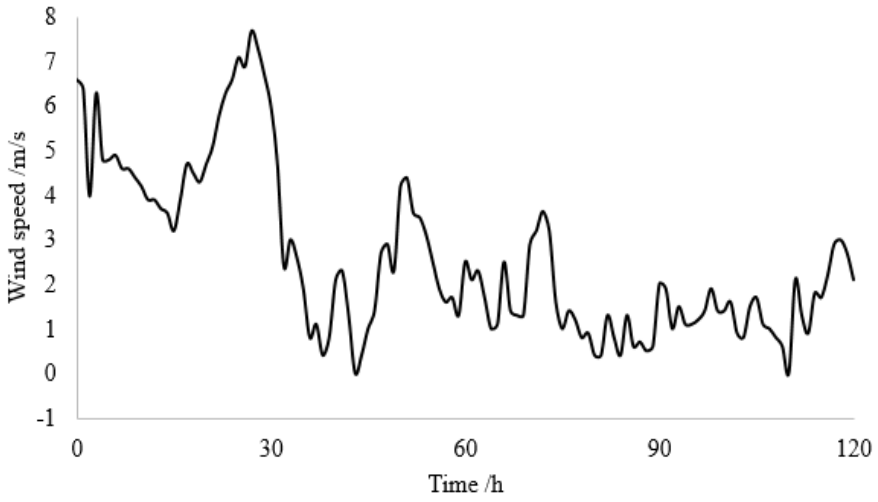


Temperature

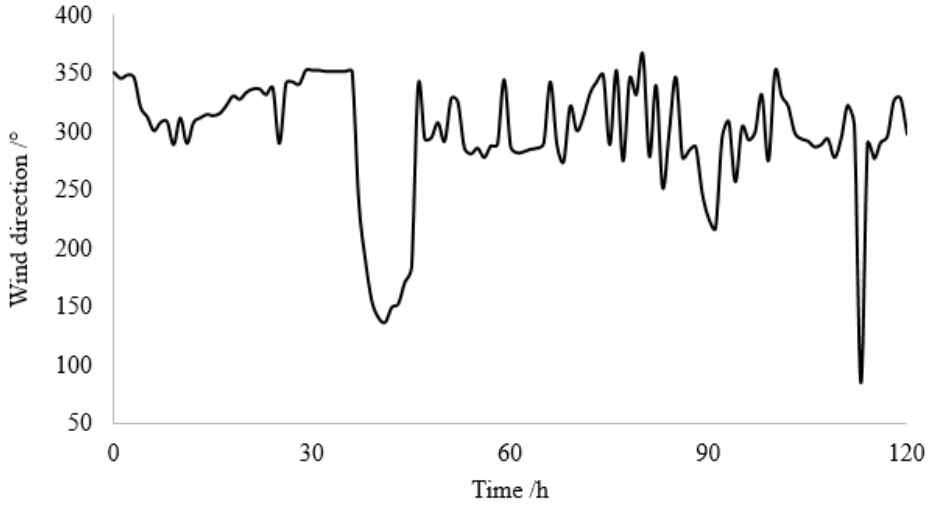


Relative humidity

III Test Results and Analysis



Wind Speed

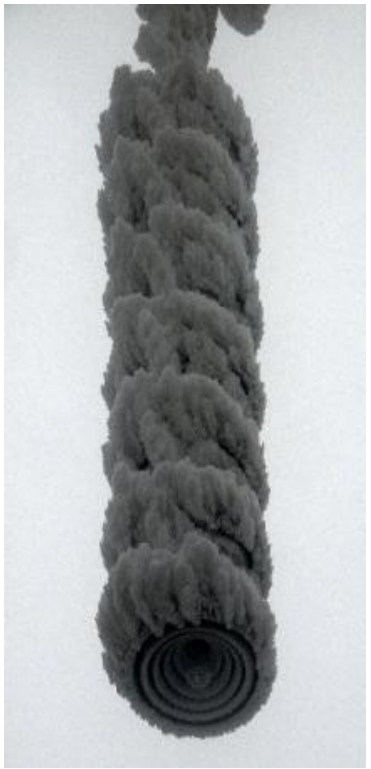


Wind Direction

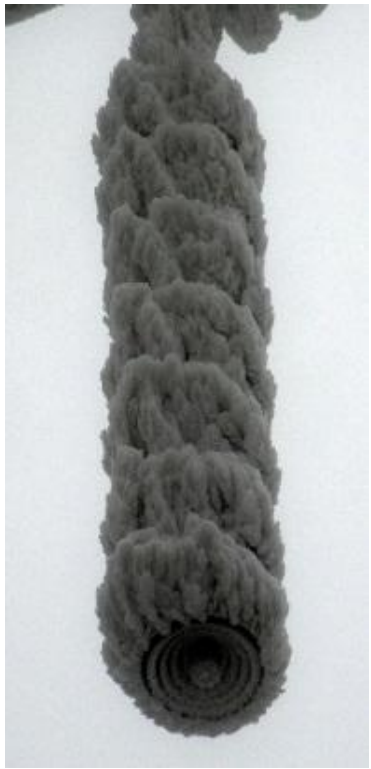
III Test Results and Analysis

- **Icing Accretion Results on Insulators**

(a) time:21h



(a) time:40h



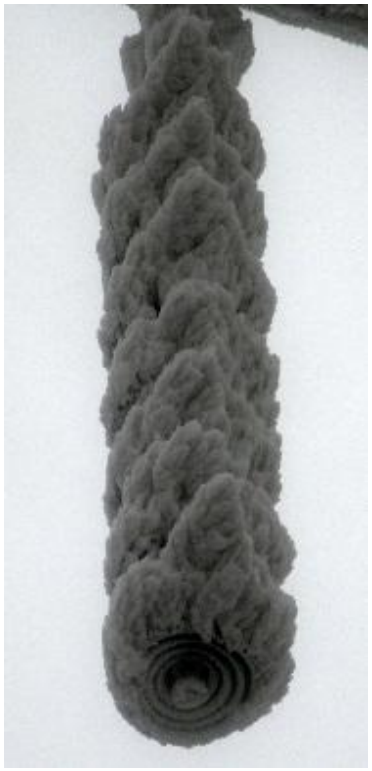
(a) time:88h

Ice shape of XP-300 porcelain insulators

III Test Results and Analysis

(a) time:21h

(a) time:40h

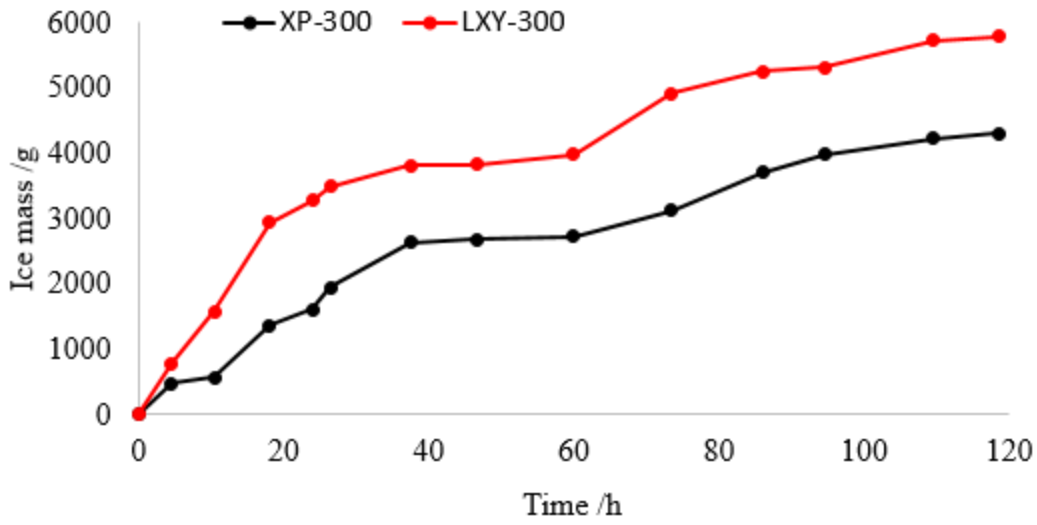


(a) time:88h

Ice shape of LXY-300 glass insulators

III Test Results and Analysis

- **Performance of Icing Accretion on Insulators**



III Test Results and Analysis

- **Icing Thickness of the Equivalent Diameter on Insulators**

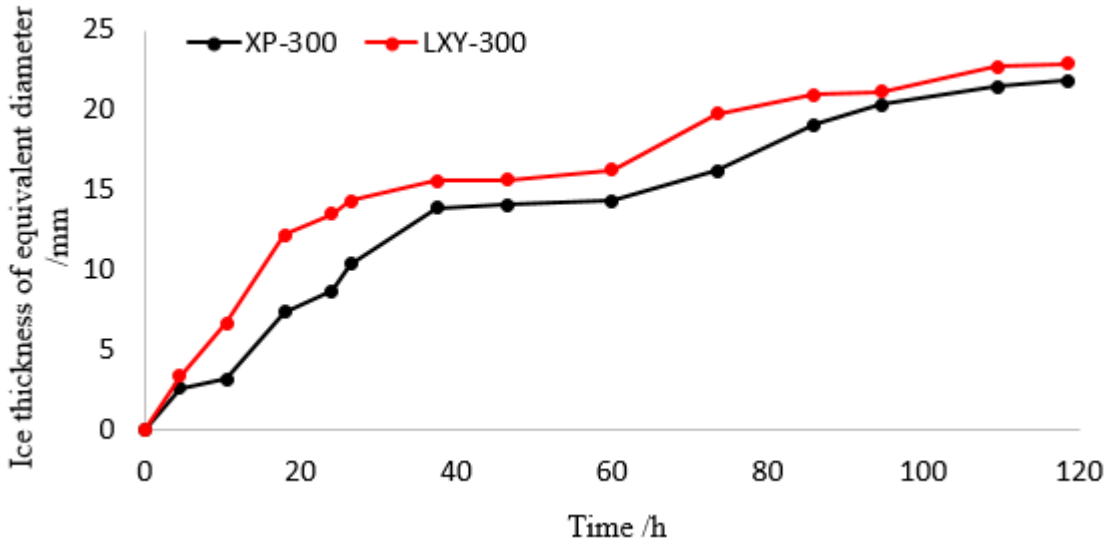
Ice Quantities $\Longrightarrow$ V

$$D_{eq} = \frac{S}{\pi \times L}$$

$$d = \frac{1}{2}\left(\sqrt{\frac{4V}{L\pi} + D_{eq}^2} - D_{eq}\right)$$

III Test Results and Analysis

- **Icing Thickness of the Equivalent Diameter on Insulators**



- ✓ **For XP-300 porcelain insulator and LXY-300 glass insulator, their equivalent diameter are pretty much the same and variation rule of icing thickness of equivalent diameter of insulator are similar.**

IV Conclusions

(1) Based on equation of the equivalent diameter of insulators deduced by equal-area method, the equivalent diameter of insulators is related to configuration parameters. The larger the sheds and areas of insulators are, the bigger the equivalent diameter of insulators is.

(2) There are obvious different icing shape between windward side and leeward side on the surface of icing insulators in natural icing environment. Meanwhile, the icing of insulator is related to icing time, meteorological parameters and its structure. The greater the wind speed and lower the temperature is, the faster the insulator icing accretion is.

(3)The icing thickness of the equivalent diameter of insulators is obtained from equal icing volume. More serious the icing on insulator surface is, the heavier the icing thickness of the equivalent diameter of insulator is.

Thank You For Your Attention!