

Principal Research Results

Reduction in Level of Audible Noise from HVAC Transmission Lines Using Superhydrophilic Spiral Wires

Background

Corona discharge may cause audible noise, and is particularly generated from wet conductors of high-voltage AC overhead transmission lines. Audible noise has two major components, namely, “random noise” and “hum noise”. Hum noise is a pure tone with a frequency that is twice the power line frequency. It is discomforting to a person because its tone quality does not exist in nature. Spiral wires are twisted around overhead transmission lines to reduce conductor aeolian noise under strong-wind conditions. However, spiral wires may increase the level of audible noise because of corona discharge from water dropping on spiral wires during rain.

Objectives

The purpose of this study is to clarify the relationship between the wetting property of a conductor surface and the level of audible noise for the development of a new spiral wire (hereafter referred to as low-noise spiral wire) that reduces both “aeolian noise” and “audible noise”, and to clarify the level of audible noise from low-noise spiral wires by full-scale high-voltage AC overhead transmission line corona examination.

Principal Results

1. Relationship between wetting property of conductor surface and level of audible noise

We fabricated several kinds of test conductor with different wetting properties. We clarified the relationship between wetting property and the level of audible noise by foundation experiment (refer to Fig.1). Although the superhydrophobic conductor had the lowest level of audible noise, when surface hydrophobicity deteriorated, the level of audible noise increased rapidly. In contrast, hydrophilic conductors had low and constant levels of audible noise.

2. Evaluation of level of audible noise from low-noise spiral wires

It was clarified that low-noise spiral wires with a superhydrophilic surface produced by the thermal spraying of TiO₂ are better for reducing audible noise by full-scale corona examination (Fig.2).

- (1) The number of corona-discharge-generating points on low-noise spiral wires was smaller than that on conventional spiral wires. This is because low-noise spiral wires discharged water drops quickly.
- (2) The audible noise reduction effect of low-noise spiral wires was excellent, particularly for hum noise; it was more pronounced than that of conventional spiral wires and the conductor that had no twisted spiral wire (Fig.3).

Future Developments

Low-noise spiral wires that hardly deteriorate with time will be developed for utilization.

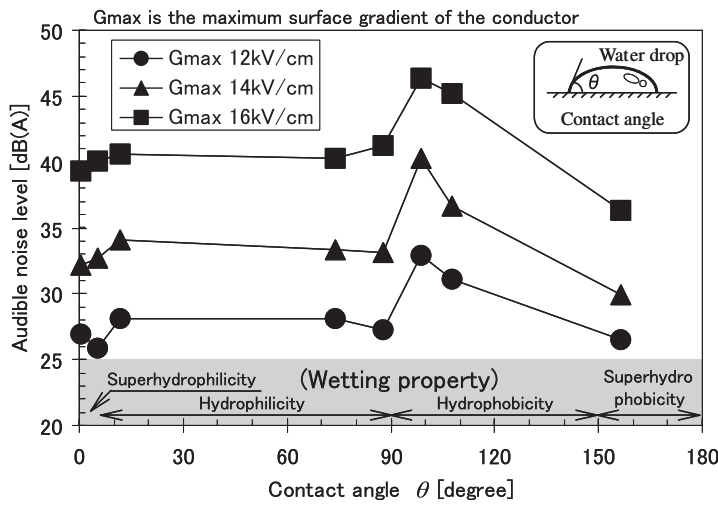
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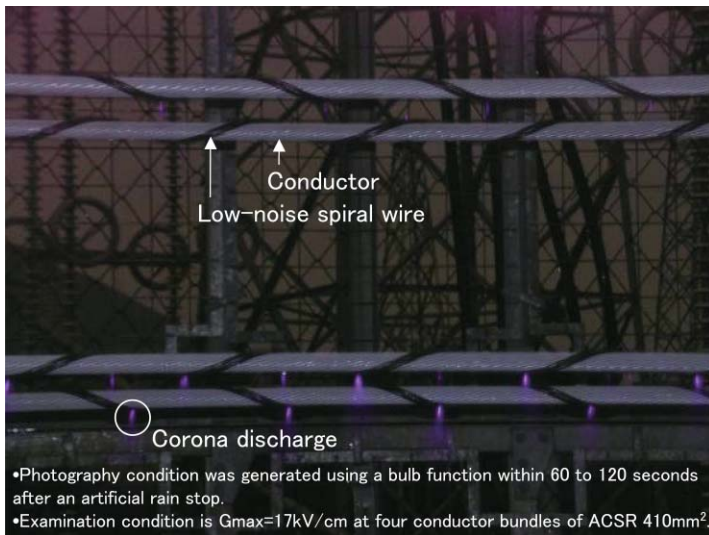
References

- K. Miyajima, et al., 2004, “A Study on Development of Corona-free Conductor for AC Overhead Transmission Lines making use of Surface Processing”, CRIEPI Report T03021 (in Japanese)
- K. Miyajima, et al., 2006, “Evaluation of Audible Noise from Conductor Bundles with Low-Noise Spiral-Wires -An Audible Noise Reduction Method of Spiral-Wires making use of Thermal Spraying of TiO₂.”, CRIEPI Report H05004 (in Japanese)

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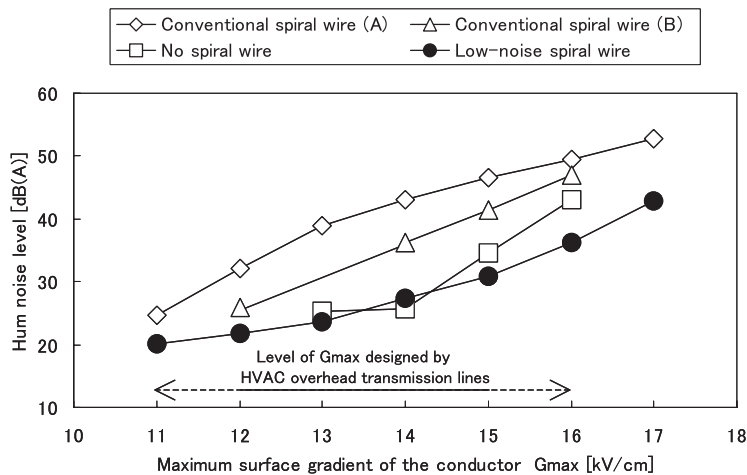


The audible noise levels are low when the contact angles are less than 5 degrees (superhydrophilicity) and greater than 150 degrees (superhydrophobicity). When the wetting property changes from being superhydrophobic to being hydrophobic, audible noise level increases by about 10 dB at $G_{max}=16\text{kV/cm}$. However, when the wetting property changes from being superhydrophilic to being hydrophilic, audible noise level increases by only 3 dB.



The corona discharge from the two conductors located below is stronger than that from the two conductors located above. This is because the electric field of water drops on the conductors located below is higher than that of water drops on the conductors located above.

Fig.2 Corona discharge under wet-conductor condition



The hum noise level of low-noise spiral wire is smaller over 10 dB than that of the two types of conventional spiral wire. (When four conductor bundles of ACSR 410mm² is used as 500kV HVAC overhead transmission lines, the typical G_{max} level is about 15 kV/cm.)

Fig.3 G_{max} characteristics of hum noise level under wet-conductor condition