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高电压技术

复合绝缘子表面水滴撞击特性的数值模拟与伞裙结构分析

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摘要： 现有复合绝缘子伞型结构易被冰凌桥接，且其冰闪特性并不优于瓷和玻璃绝缘子，为合理设计适用于覆冰地区的复合绝缘子伞型结构，该文根据流体力学的基本原理，建立了复合绝缘子外部三维流场数学模型和基于拉格朗日原理的水滴运动轨迹，分析了覆冰过程中复合绝缘子的水滴碰撞系数及其影响因素。结果表明：伞裙的水滴碰撞系数(E)随气流速度或水滴平均直径、下伞裙倾角和伞裙间距的增大而增大，随上伞裙倾角、伞裙直径及伞裙直径比的增大而减小，且伞径比的影响最明显，而伞裙间距的影响则可以忽略。根据计算结果并经试验验证，提出了优化应用于覆冰地区复合绝缘子伞裙结构的建议，即伞裙上倾角为15°、下倾角为0°，采用不等伞径的伞裙组合，相邻大伞之间可间插3个以上小伞，增大伞裙间的伞径比，相邻伞裙间距应大于30 mm。

关键词： 复合绝缘子 伞型结构 流场 水滴运动轨迹 水滴撞击特性

Numerical Simulation of Water Droplet Impingement on Composite Insulator Surface and Analysis of Shed Configuration

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Abstract: Existing composite insulators' sheds are easily bridged by icicles and their ice flashover performance is not obviously superior to that of glass and porcelain insulators. For the rational design and selection of composite insulators' shed applied in icing area, the 3-D fluid field mathematical model of composite insulators was established and the water droplet trajectories were calculated in Lagrange framework according to the basic principles of fluid dynamics. Then the water-droplet impingement characteristics were determined. It was found that the collision coefficient(E) increases with increasing of air flow velocity or mean diameter of water droplet and the bottom surface inclination or shed distance, but decreases with increasing of top surface inclination, diameter or diameter ratio of shed, in which the increasing of diameter ratio is the key factor. The influence of shed distance on droplet collision coefficient can be neglected. According to the results, integrated the electrical characteristics of composite insulators, suggestions of the optimized shed structures of composite insulators used in iced area were obtained: top surface inclination is 15° and bottom surface inclination is 0°; diameters of sheds are different, there should be more than three small sheds between adjacent large sheds; the diameter ratio of sheds should be increased; shed distance should be more than 30 mm.

Keywords: composite insulators shed structure fluid field water droplets trajectories water droplets impingement characteristics

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