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AASRI Procedia 2 (2012) 309 – 317

AASRI Procedia

www.elsevier.com/locate/procedia

2012 AASRI Conference on Power and Energy Systems

Numerical Simulation Results and Laws of Transmission Lines Ice-melting

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Abstract

Based on the numerical simulation model of icing, the impact on icing of the current was further investigated. The critical current value with the meteorological conditions of foreign objects, as well as the physical parameters of the aerial cable itself change the law. The calculation results showed that the critical current value depends on the external weather conditions and the aerial cable itself, the physical parameters, and the critical current and the ambient temperature, wind speed, relatively good linear relationship.

*Keywords:*aerial cable; ice - melting；deicing;critical current；Numerical simulation

1. Foreword

The phenomenon that water accumulated on surface of the object becomes ice (frost) because of freezing is one nature phenomenon which is extensively distributed. Icing on the power transmission line is one phase transformation nature random process which is related with meteorology, thermodynamics, heat transfer, hydrodynamics etc and is controlled by local meteorology (micrometeorology), topography (Micro-topography) and surface condition of power transmission line etc. When serious ice disaster continuously comes, icing on the power transmission line isn't avoided. The researchers have developed several de-icing technology [1-], a part of technology gets into practice phase, there is still some difficulty when some technologies are applied in the grid system, such as electric pulse de-icing method, it is difficult to remove icing on line with sufficient length because applicable excitation source can't be found. Basic ideas on de-icing in the grid system consists of three categories [1-5]：

—— Electric energy is converted into thermal energy to deice；

 doi:10.1016/j.aasri.2012.09.051

—— Electric energy is converted into mechanical energy to destruct physical structure of icing on the power transmission line, so as to realize purpose of icing fall;

—— mechanical de-icing methods which directly destruct physical structure, such as install remote de-ice equipment.

De-icing technology that electric energy is converted into thermal energy shall calculate de-icing current and action time for the icing conductor, there is mature de-icing calculation mathematic model of icing conductor on this aspect [6-7]. Value simulation method of icing process and mechanism of the power transmission line starts from 1980s, foreign experts start to study various factors affecting icing of the power transmission line through establishing mathematic model for icing increment in power transmission line, such as wind speed, temperature, humidity, height and geometrical size of power transmission line etc, the established engineering model has strong theoretical meanings and engineering applicable value [8]. The author of this paper forwards one two dimensions value simulation method [10] for soft rime icing process on surface of the power transmission line based on Lagrangian method in document [9].This paper will fatherly observes influence of current on icing on basis of soft rime icing value method of the power transmission line. Give out change rules of critical current following change of external meteorological condition and change of physical parameters of the conductor. Which provides instruction for icing of the cable.

2. De-icing mechanism and mathematic model

2.1. Calculation of critical current

Each heat flux density in the surface heat balance equation can be calculated with the expression formula given in first chapter. After above influence factors are integrated, following formula is generally applied to calculate anti-icing critical current of the conductor:

$$I_c = \left(\frac{D}{\mu}\right)^{0.5} [(t_s - t) \bullet (\pi h + 4\pi\varepsilon\sigma t^3 + 2Ev_a LWCc_w) + 2Ev_a w_E L_e]^{0.5} \tag{1}$$

Where μ—— resistance of conductor in unit length (Ω/m); h in the formula is heat exchange coefficient between surface and air flow (generally called as heat transfer coefficient). ts is air flow temperature at location where is sufficiently far from surface of the power transmission line, i.e. edge of the boundary layer, it isn't affected by surface temperature of solid; t is surface temperature of the conductor. ε is total radiation coefficient of relative black body on surface of ice, it approximately equals to ; is Stefan-Boltzman constant, its value is 5.567×10-8(J/m2•K4•t). E is general collision rate, LWC humidity ratio of wet air ( ),cw is constant pressure specific heat of water , cw=4.18(kJ/kg•K); We is water evaporation capacity of the unit area in unit time, unit in (kg/m2•s). Le is evaporation potential heat. Chang of Le following temperature isn ‘t great, when surface temperature is about 0℃, Le=2500(kJ/kg), it is approximately considered as unchanged during calculation.

Seen from above formula, critical current value mainly depends on external meteorological condition and physical parameters of the conductor. Generally speaking, type of the conductor will not be changed when the line is routed, so critical current value will be determined when meteorological condition of the conductor is known during icing.