TETRACOM: Technology Transfer in Computing Systems

FP7 Coordination and Support Action to fund 50 technology transfer projects (TTP) in computing systems. This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 609491.

Dynamic Thermal Rating of overhead power lines in icing conditions (DTRi)

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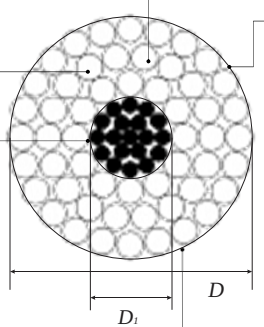
TTP Problem

"Guidelines for Meteorological Icing Models, Statistical Methods and Topographical Effects" 2006, Farzaneh, M. (2008), Atmospheric icing of power networks, Springer, Dordrecht ; London. Makkonen, L., Modeling power line icing in freezing precipitation, *Atmospheric Research*, 46 (1998) 131–142 .

TTP Solution

Heat transfer within the conductor

$$\nabla\lambda\nabla T + q_i = \rho c_p \frac{\partial T}{\partial t}.$$



Symmetry

$$\left.\frac{\partial T}{\partial r}\right|_{r=0} = 0$$

Heat source

Joule heating $Q_J = I^2 R(T)\left[\frac{\mathrm{W}}{\mathrm{m}}\right]$

Heat exchange with surrounding

convection $Q_C = -\pi D h(T_s - T_a)\left[\frac{\mathrm{W}}{\mathrm{m}}\right]$

Radiation $Q_R = -\pi D \sigma_B \hat{\varepsilon}_s (T_s^4 - T_a^4)\left[\frac{\mathrm{W}}{\mathrm{m}}\right]$

Solar heating $Q_S = \alpha_s I_T D\left[\frac{\mathrm{W}}{\mathrm{m}}\right]$

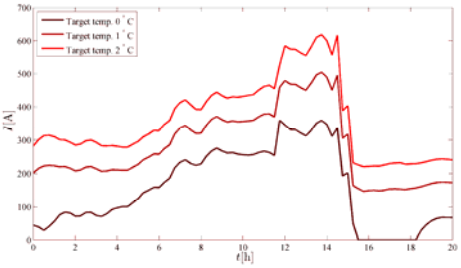
impinging $Q_{IM} = CED c_w \frac{d\rho_I}{dt}(T_S - T_I)\left[\frac{\mathrm{W}}{\mathrm{m}}\right]$

evaporation $Q_E = -h\frac{\partial L_e A_w}{c_p}\left(\frac{e_s - e_a}{p}\right)\left[\frac{\mathrm{W}}{\mathrm{m}}\right]$

criterion

$T_S > 0 + \varepsilon$

The basic idea is to determine a minimal electric current, needed to prevent icing by means of heat losses due to the line resistance. The core of solution is a physical model for the simulation of heat transfer within the transmission power line under realistic weather conditions related to the icing, i.e., ambient temperatures between -5 °C and 5 °C with super cooled rain present. The model has been named Dynamic Thermal Rating - icing (DTRi). The DTRi comprises the Joule heating, convection, solar heating, evaporation, radiation and impinging super cooled precipitation. Basically, the DTRi solves the heat transport equation (second order partial differential equation) with non-linear boundary conditions describing different heat terms due to the weather conditions.



TTP Impact

Significant reduction, in order of millions of €, of infrastructural reconstructions after catastrophic events due to extensive icing on overhead power lines. Such event last occurred in the beginning of February 2014, when a considerable number of transmission lines collapsed under the weight of accumulated ice glaze. The damage of this single event was estimated at 8.5 million €.

TTP Facts

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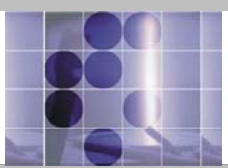
TETRACOM contribution: 30 479 50 €
Duration: 1/1/2016-30/6/2016



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