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SIMULATION OF HEAT TRANSFER IN A MULTI-WIRE CABLE BUNDLE IN ORDER TO DETERMINE ITS TEMPERATURE DISTRIBUTION

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The aim of this study is to model and simulate the heat transfer in a multi-wire cable bundle. This problem paid considerable attention during last years in the automobile industry. In order to reduce weight of cable harness, that leads to lower the fuel consumption, one should investigate the temperature distribution in the wire bundles. This task is difficult due to anisotropic non-homogeneous bundle media and requires the application of numerical methods.

The calculation of heat transfer in a multi-cable bundle belongs to the heat conduction problems for anisotropic multi-layered media [1]. In the previous study [2], the heat conductivity coefficient has been determined using *conservative averaging method for layered media* [3], where heat conductivity of single cables are transformed to a common mixed property or mixed heat conductivity coefficient. The algorithm of temperature determination using conservative averaging method is published in the publication [2].

Now, in this work, the aim is to determine the temperature distribution in the multi-wire bundle using numerical methods and received results to compare with the ones published in [2].

The proposed methodology to treat heat transfer in such a way allows to obtain efficient algorithm to compute temperature distribution in any cable bundle configuration.

In this study we consider one-dimensional heat conduction/convection and radiation problem for radial systems:

$$\frac{1}{r}\frac{\partial}{\partial r}\quad \lambda(r)\cdot r\frac{\partial T(r,t)}{\partial r}\quad + F(r,t) = c_p\gamma(r,T)\frac{\partial T(r,t)}{\partial t}. \tag{1}$$

For the equation (1) the initial-boundary conditions apply as following:

$$T(r,0) = T_e(r), \quad r \in [0, r_2] \tag{2}$$

$$(\partial T/\partial r)_{r=0} = 0, \quad t \ge 0 \tag{3}$$

$$-\lambda(\partial T/\partial r)_{r=r_2} = \alpha(d,T)(T - T_\varepsilon) + \varepsilon\sigma(T^4 - T_\varepsilon^4), \quad t \ge 0 \tag{4}$$

where: F - specific heat flux in W/m3; λ - heat conductivity of conductor or insulation in W/m.K; γ - specific heat capacity of conductor or insulation in J/kgK; c_p - density in kg/m3; T_ε - temperature of environment; α - convection heat transfer coefficient of wire insulation surface in W/m2K; d - diameter of conductor in m; ε - emissivity coefficient; σ - Stefan-Boltzmann constant.

REFERENCES

[1] Chien-Ching and Shin-Wen Chang. Analytical exact solutions of heat conduction problems for anisotropic multi-layered media. *Int. J. Heat Mass Transfer*, **47** , 2004, 1643 - 1655.

[2] H.D. Liess and A. Ilgevicius. Analytical versus numerical solutions of physical problems. The benefits of its combination. *Math. Model. Anal.*, **8** (4), 2003, 291 - 302.

[3] A. Buikis and N. Ulanova. Analytical-numerical method for temperature fields in multilayered system. In: *Advanced Computational Methods in Heat Transfer, VI*, Sauthappton, Boston: WITp, 2000, 445 - 453.