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STUDY OF TEMPERATURE WAVES IN CONTINUOUS MEDIA

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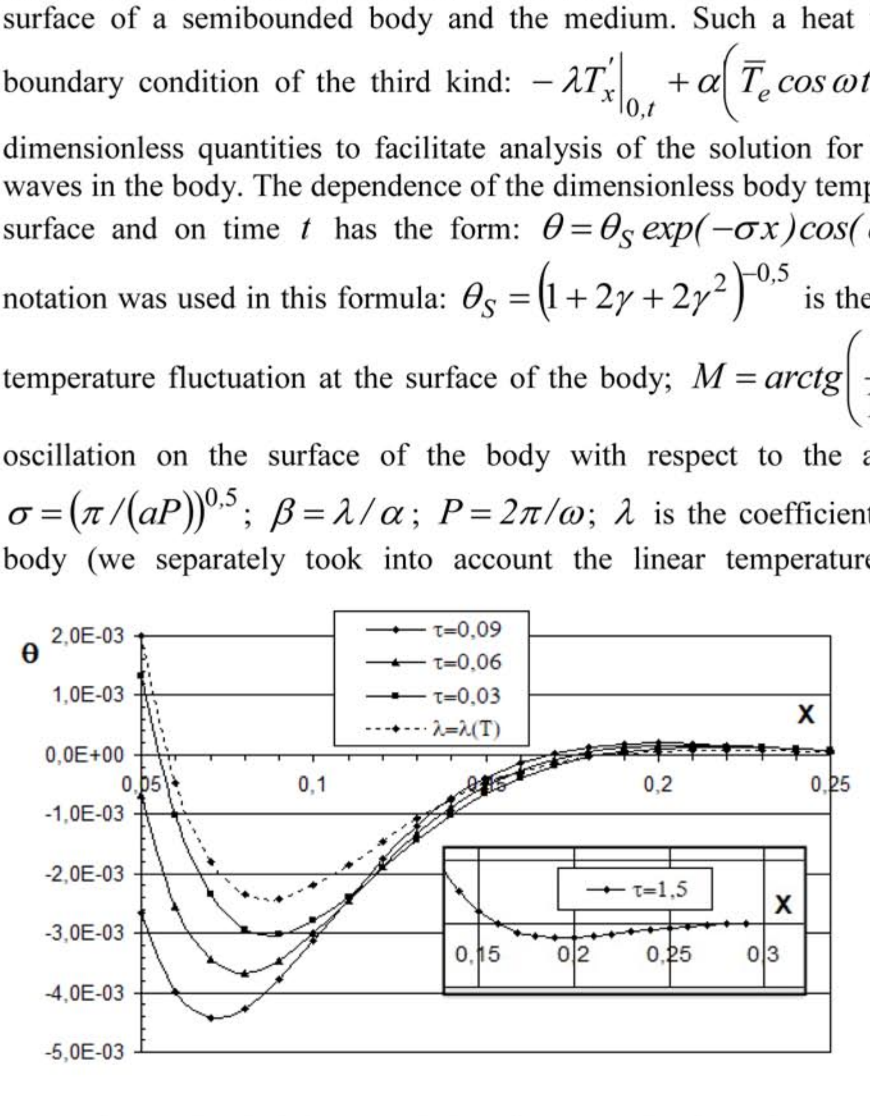
The work presents modelling and analysis of temperature waves in semibounded media. The case of a semibounded body temperature change under the influence of an external medium whose temperature T_e varies according to the harmonic law $T_e = T_{em} \cos \omega t$ is considered. We have considered the established temperature profiles of the body. In this state, the temperature at any point of the body performs a harmonic oscillation with gradually decreasing amplitude as it moves away from the surface of the body. Heat transfer according to Newton's law occurs between the surface of a semibounded body and the medium. Such a heat transfer can be described by a boundary condition of the third kind: $-\lambda T'_x\big|_{0,t} + \alpha\left(\overline{T}_e \cos \omega t - T_x\big|_{0,t}\right) = 0$. We introduced dimensionless quantities to facilitate analysis of the solution for the propagation of temperature waves in the body. The dependence of the dimensionless body temperature on the distance x to the surface and on time t has the form: $\theta = \theta_S \exp(-\sigma x)\cos(\omega t - \sigma x - M)$. The following notation was used in this formula: $\theta_S = \left(1 + 2\gamma + 2\gamma^2\right)^{-0,5}$ is the dimensionless amplitude of the temperature fluctuation at the surface of the body; $M = arctg\left(\dfrac{\gamma}{1+\gamma}\right)$ is the phase shift of the oscillation on the surface of the body with respect to the ambient temperature; $\gamma = \sigma\beta$; $\sigma = \left(\pi/(aP)\right)^{0,5}$; $\beta = \lambda/\alpha$; $P = 2\pi/\omega$; λ is the coefficient of thermal conductivity of the body (we separately took into account the linear temperature dependence in calculations); $\alpha = \alpha_1 + \alpha_2 \upsilon$ is the heat transfer coefficient for the medium velocity equal to υ; a is the thermal diffusivity of the body. The results of the calculations are shown in the figure for the dimensionless time $\tau = 0,03 \div 0,09$. The calculation taking into account the temperature dependence of the thermal conductivity is performed for time $\tau = 0,06$.



Thermophysical characteristics of ceramic bricks and carbon-carbon composite (inset in the figure) were used for calculations as properties of the simulated media. Analysis of the figures shows that in the second case the attenuation of the temperature wave occurs approximately 36% farther from the surface of the body. The small values of the medium temperature change frequency ω used in the calculation correspond to the case of effective heat transfer between the environment and the body. Large values of ω correspond to an increase in the propagation velocity $\upsilon_T \sim (a/P)^{0,5}$ of the temperature wave.