The effect of the thermophysical and geometrical characteristics of the components of a composite on the dynamic behavior and asymptotic value of the coefficient of heat transfer between the layers is studied.

A multitemperature approach [1-3] based on averaging of the temperature fields of each component within an elementary microvolume is being employed increasingly in the calculation of the thermal state of heterogeneous media. In the case of layered and reinforced media this makes it possible to reduce the dimension of the initial heat equations, thus greatly facilitating the solution of the problem. The resulting system of differential equations (the order of the system is equal to the number of components) is closed by introducing a relation between the density of the thermal flux between the components and their average temperatures. In [1] such a relation was obtained from phenomenological linear relations between the thermodynamic forces and fluxes:

$$q_{ij} = \alpha(T_i - T_j).$$

It is understood that $\alpha$ is an effective characteristic of the thermophysical and geometric parameters of the structure of the composite. The explicit form for $\alpha$ for a layered composite was obtained in [2] and [3], respectively, as

$$\alpha_i = 2V^3 \frac{l_i \lambda_i \lambda_j}{l_i(l_i \lambda_i + \lambda_j \lambda_k)}, \quad \alpha_j = \frac{3\lambda_j \lambda_k}{l_k(l_j \lambda_j + l_k \lambda_k)}.$$  

The heat-transfer coefficient $\alpha$ is an integrated characteristic of the rate of heat transfer between the components. The integrated heat-transfer characteristics are generally not constants. It is known [4], e.g., that the effective thermal-conductivity coefficient, which is also an integrated characteristic, depends on time. By analogy we can assume that $\alpha$ will be a function of time in layered (reinforced) media.

We examine this by considering the model problem of propagation of heat in a two-layer composite with a regular structure (a representative cross section of the material is shown in Fig. 1) under boundary conditions of the second kind. On the assumption that the thermophysical characteristics of the components do not depend on the temperature, we can write the following for an isolated elementary cross section:
Fig. 1. Representative cross section of a two-layer composite with a regular structure: 1) first layer; 2) second layer; \( H \) is the thickness of the material.

We set \( \lambda_{21} > \lambda_{22} \), i.e., component (1) has better thermal conductivity. Applying the Laplace transformation with respect to time and the Fourier cosine transformation with respect to the temperatures of the components \( T_i(x, z, t) \) (3), we can reduce the equations to a system of ordinary differential equations of the second order in the transform of the temperatures \( \hat{T}_i(x, n, p) \), whose solution has the form

\[
\hat{T}_i = Q_L \left( \frac{1}{\lambda_{x1} \psi_i} - (-1)^i M_i(x, n, p) \right), \quad i = 1, 2,
\]

where

\[
\hat{T}_i(x, n, p) = \int_0^\infty \left\{ \int_0^H T(x, z, t) \exp(-pt) \, dt \right\} \cos(\psi_n z) \, dz;
\]

\[
Q_L = \int_0^\infty Q \exp(-pt) \, dt, \quad Q = q_0(t) + (-1)^i q_H(t);
\]

\[
\psi_i = \frac{p + a_{x1} \psi^2_n}{a_{x1}^2}; \quad \psi_n = \frac{n \pi}{H}; \quad K = (C_1 - C_2) p + (\lambda_{21} - \lambda_{22}) \psi^2_n;
\]

\[
M_i = \frac{\text{sh}(\sqrt{\psi_i} l_i) \text{ch}(\sqrt{\psi_i} [l_i - |x|]) \lambda_{x1} \sqrt{\psi_i} K}{H \rho_{x1} \lambda_{x2} \psi_i \psi_2}, \quad i, j = 1, 2, i \neq j;
\]