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DETERMINATION OF TEMPERATURE FIELD IN THERMALLY SENSITIVE LAYERED MEDIUM WITH INCLUSIONS

Purpose. Determination of the field of temperature which is caused by the presents of the heat flow thermally sensitive (thermo-physical parameters which depend on temperature) layered medium which contains through foreign inclusions.

Methodology. It is based on the use of generalized functions; this enables us to express the coefficient of heat conductivity for such a structure as something integral, provided the heat contact between conjugated surfaces of the layers and the inclusion is ideal. In this case, the boundary value problem is reduced to solving a single equation of heat conduction with discontinuous coefficients under the given boundary conditions at the boundary surfaces of the medium.

Findings. The heat flux is concentrated at one of the boundary surfaces of the medium, the other boundary surface is thermally insulated. There exists ideal heat contact at the surfaces of the conjugated layers. To determine temperature regimes in such a medium, a nonlinear equation of heat conduction with nonlinear boundary conditions is used. In order to solve the nonlinear boundary value problem of heat conduction, we introduce a linearizing function which enables us to obtain a partially linearized differential equation and linear boundary conditions to determine this function. After the piecewise-linear approximation of temperature with respect to spatial coordinates is carried out, a linear differential equation with discontinuous coefficients in the linearizing function is obtained. An analytical-numerical solution of the obtained linear boundary value problem is found with the use of Fourier integral transformation which determines the linearizing function and enables us to obtain calculation formulae for calculating temperature. For a two-layer medium with an inclusion, temperature distribution for a linear temperature dependence of the coefficient of heat conductivity of the material is found, and a comparative numerical analysis of the distribution of temperature is made with corresponding distribution for constant coefficients of heat conductivity of the materials of the layers (materials of the layers are Y12 and 08 steels). Calculation formulae for determining the distribution of temperature in a two-layer medium with a through inclusion are obtained in the work. Numerical calculations of the distribution in a layer and in a two-layer medium for constant and for linearly variable with respect to temperature coefficient of heat conductivity of materials of the layers are performed.

Originality. There has been carried out a partial linearization of nonlinear boundary value problem; due to this, we have obtained formulae for determination of the distribution of temperature in a thermo-sensitive piece-wise homogeneous medium.

Practical value. The practical value consists in the increase in accuracy calculation of temperature fields and in effectiveness of methods for investigation of thermo-sensitive piece-wise homogeneous media. The precision is achieved at the expanse of taking into account the piecewise homogeneous structure of the medium and that of the dependence of the coefficient of heat conductivity of the materials of the medium on temperature (nonlinear model).

Keywords: *heat conduction, isotropic, temperature field, inclusion foreign, thermally sensitive layered medium, heat flux, heat contact*

Introduction. Analysis of the recent research and publications. Construction of the mathematical models which describe heat processes mountain ranges, mine cavities, in building and operations of mining enterprises, and others, is an urgent problem. The processes of heat transfer in layered mountain ranges are described by two- and three-dimensional stationary equations of heat conduction with taking into account the nonlinear effects in the bulk of the Earth, these equations are also used as approximated mathematical model of systems which contain shaft mounting concrete casing, lintels, and other articles of mining enterprises.

It is considered that the average temperature of the Earth's crust is equal to 15 °C. Surface temperature variations can penetrate inside the earth, but to a limited depth. Daily variations vanish at a depth of 1–2 m, and annual (seasonal) variations at a depth of 10–40 m (with the exception of regions of eternal frost). The depth at which seasonal variations of temperature vanish is called the neutral level. Experimental investigations indicate that below the neutral level the temperature field of the Earth's crust practically does not vary with time, but just increase with the increase in the depth, this confirms the