# POLYTROPIC INFILTRATION OF AN INCOMPRESSIBLE LIQUID IN PORE COOLING

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The temperature is a function of the pressure alone, and the integral of the energy equation takes the following form of two-dimensional steady-state heat transfer on pore cooling when the infiltration is subject to D'Arcy's law and the boundaries of the infiltration region are isothermal and simultaneously isobaric:

$$\frac{\mu(T)}{\alpha\rho}\frac{dT}{dP} = -\frac{C_p}{\lambda}T + c, \tag{1}$$

where $\mu$, $\rho$, $c_p$ are respectively the dynamic viscosity and density, and specific heat of the coolant, T is temperature, P is pressure, $\alpha$ is the permeability of the porous medium, $\lambda$ is the effective thermal conductivity, and c is a constant of integration. As one has to determine c from the boundary conditions in order to solve (1) via a transcendental relationship, it is of interest to examine the region of possible values for c, which considerably facilitates finding the exact values.

We consider the infiltration of an incompressible liquid whose viscosity variation is

$$\mu(T) = \mu_0\left(\frac{T_0}{T}\right)^m. \tag{2}$$

We substitute (2) into (1) and perform some simple steps to get the polytrope for the infiltration:

$$\Pi = \int^{z}\frac{dz}{z^m(1-z)}. \tag{3}$$

Here

$$z = \frac{T}{c}; \quad \Pi = Pkc^m; \quad k = \frac{\alpha\rho C_p}{\mu_0\lambda T_0^m}; \quad m \geqslant 0.$$

The following results are obtained from this polytrope:

1. The calculated pressure difference between the input and output for fixed temperatures at those points is monotonically dependent on c for any m.

2. The branches of the infiltration polytrope defined for $0 < z \leq 1$ correspond to pore heating; pore cooling corresponds to the other two branches $-\infty < z < 0$ and $1 < z < \infty$.

3. In pore cooling one can distinguish zones of nominally weak and strong infiltration and obtain a criterion that enables one to use the given pressure difference between input and output to determine the infiltration zone and also the limits to z and hence c.

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## THERMAL CONDUCTIVITY OF A LAYER WITH BOUNDARY CONDITIONS OF THE FIRST KIND

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An analytical solution is presented for the nonstationary three-dimensional heat-conduction equation, when on the boundaries of the layer, the temperatures, which are arbitrary functions of the coordinates and time, are given.

The solution is represented in the form of a sum, each of the subsequent terms of which is a higher derivative of arbitrary functions, multiplied by the power of the instantaneous thickness of the layer.

We consider two examples for the case in which the temperatures at the boundaries of the layer differ by a constant value. At first, the temperature of the surface of a strip is varied along the length according to the cubic—parabolic law. In the second example, the surfaces of the layer are subjected to a burst according to a quadratic—parabolic law for the time. Here the solution is reduced to the zeroth initial condition, and curves are given for the variation of temperature for different periods of the burst.

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## ISOTHERMAL TRANSPORT OF STEAM IN CAPILLARY-POROUS COLLOIDAL OBJECTS

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The laws of transport of water vapor through crushed and dried soil are investigated for different gradients of the partial pressure; so far these laws have been studied inadequately. Experiments showed that in the initial period a sorption of the steam by the material occurs simultaneously with its transfer in the direction of smaller partial pressure.

The results of the experiments are used for computing the dependence of the flux density of steam inside the material on the gradient of the partial pressure and on the gradient of the moisture content of the material, the distribution of the equilibrium humidity along the axis of the samples (in the direction of flow of the steam), and the dependence of the coefficient of mass transfer (steam conductivity) of the material on its humidity.

Furthermore, the dependence of the coefficient of molecular flow of steam in the microcapillaries on the humidity of the material is computed, from which the forms of coupling of moisture in the material can be inferred.

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## NOTE ON OBTAINING OPTIMAL VULCANIZATION CONDITIONS

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In [1] the problem of finding the optimal thermal regime for the vulcanization of rubber articles simulated by an infinite sheet was reduced to the solution of the boundary value problem for the Euler equation.

The latter is easily extended to the case of other homogeneous bodies of classical shape — an infinite cylinder and a sphere.

An analytic investigation of the parameters of the solution and certain associated functions with allowance for the specified range of variation of the physical quantities yields the following conclusions.

The region of variation of the parameter $\lambda$, determined by the isoperimetric condition of the starting variational problem, is bounded above ($\lambda < 0$). The rate of variation of the optimal control at the initial moment of time is greater than unity, the surface temperature of the sheet $\psi(0)$ increasing abruptly to a certain value; its rate of variation $\psi'(0) > 0$ and close to its maximum value.

If the function $\psi(Fo^*) \simeq 1$, then it can only decrease for all $Fo \geq Fo^*$, and the optimal values of $\psi(Fo)$ correspond to the boundary of the permissible region of extremals, from the point where the boundary joins the extremal to the end of the interval on which the minimized functional is given.

These estimates make it possible to construct an algorithm for solving the boundary value problem on a computer and to find the first approximations for the iterative process of solving the corresponding Cauchy problems by the configuration method [2].

## NOTATION

$\psi(Fo) = T(Fo)/T_0$ is the relative temperature at the edge of the sheet at time Fo;
$T$ is the temperature in °K;
$T_0$ is the initial temperature of the sheet.

## LITERATURE CITED


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