As is evident from Fig. 4, the curves are strictly monotonic functions and hence (on further refinement of the curves) it is possible to calculate the change in filtration coefficients under the influence of water-soluble polymers, given only the specific surface of the soil particles. This means that it is possible, without lengthy and difficult experimental work, to make relatively rapid estimates of the likely change in the filtrational properties of soils when a particular organomineral fertilizer is used. Simply on the basis of the water-soluble polymers K-9, PAA, and K-4 investigated, the following conclusions can be drawn:

1) for clay soils with specific surface of the particles less than 200 m^2/g, the use of water-soluble polymers impairs their filtrational properties;

2) the use of these polymers in clays with a highly developed specific surface (up to 900 m^2/g) allows their filtrational coefficients to be increased by more than 300%.

It must be noted that all these results have been obtained from a comparison of the permeability of modified and unmodified soils for the filtration either of water or of aqueous solutions of mineral salts.

If the permeabilities of weakly filtering systems of the Na form of clay soils, i.e., pure alkaline soils, for water are compared with the permeabilities of these systems for aqueous solutions of potassium nitrate, then [1] the transfer coefficients in the latter case are found to be greater by a factor of 10-30. For land in this state (as confirmed by technicoeconomic calculations using valuable agricultural crops) the use of organomineral complexes is an effective measure.

NOTATION

K, permeability of disperse systems in liquid filtration; ε, porosity; C, concentration of polymer additive in system; S_1, specific surface of unit volume of solid phase; S, specific surface of unit mass of solid phase.

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THERMOPHYSICAL CHARACTERISTICS OF LIGHTWEIGHT AGGREGATE CONCRETE IN THE COURSE OF HARDENING DURING HEAT TREATMENT IN CHAMBERS HAVING THERMALLY INSULATING SURFACES

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The dynamic characteristics of the changes taking place in the internal transfer coefficients and criteria of lightweight aggregate concrete during heat treatment in a "dry" ambient are presented.

In order to predict and calculate the modes of heat treatment to be applied to concrete and reinforced concrete objects it is essential to be aware of the mechanisms underlying heat and mass transfer in these materials, as well as the values assumed by thermophysical parameters

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TABLE 1. Lightweight Aggregate Concrete Compositions Employed

No. of composition	Type of concrete	Bulk mass of concrete, kg/m³	Expenditure of materials on 1 m³ of concrete mix., kg						Water/cement
			cement	sand	gravel aggregate fraction, mm			Water	
					5—10	10—20	20—40		
1	10	600	160	—	160	260	—	104	0,65
2	15	800	190	210	150	215	—	124	0,65
3	50	900	225	230	160	250	—	125	0,55
4	10	800	140	—	—	—	640	110	0,79
5	50	900	220	150	—	430	—	140	0,66

TABLE 2. Experimental Values of the Temperatures and Moisture Contents of Lightweight Aggregate Concrete of Composition No. 1

Time, h	Temperatures, °C			Mass moisture content, %		
	t_1	t_2	t_3	u_1	u_2	u_3
0	16,7	16,7	16,7	15,2	15,2	15,2
0,5	26,0	20,8	22,5	14,82	15,06	14,94
1,0	37,5	30,8	34,0	14,28	14,78	14,50
1,5	48,0	42,0	45,2	13,64	14,16	13,82
2,0	58,0	53,2	56,5	12,62	13,25	12,95
2,5	65,5	63,5	66,0	10,60	11,70	11,00
3,0	70,5	70,0	73,5	8,40	9,62	8,85
3,5	72,7	72,5	76,0	6,76	8,08	7,20
4,0	71,5	72,0	75,0	5,55	6,75	6,00
4,5	69,5	70,0	72,5	4,48	5,76	4,96
5,0	66,0	67,2	69,0	3,63	4,95	4,15

and physicomechanical characteristics of the materials in the course of hardening by various forms of heat treatment.

In this paper we shall present some results of an investigation into the transfer parameters of lightweight aggregate concrete in the course of hardening by heat treatment in chambers with thermally insulating surfaces [1].

Combined transfer processes in concretes subjected to heat treatment may be described to a fair approximation (without allowing for the effects of internal heat sources and moisture sinks on hydration) by Lykov's system of differential equations; expressed in dimensionless form for one-dimensional solids, these take the form [2]

$$\frac{\partial T(N, \mathrm{Fo})}{\partial \mathrm{Fo}} = \frac{\partial^2 T(N, \mathrm{Fo})}{\partial N^2} + \varepsilon \mathrm{Ko} \frac{\partial U(N, \mathrm{Fo})}{\partial \mathrm{Fo}}, \tag{1}$$

$$\frac{\partial U(N, \mathrm{Fo})}{\partial \mathrm{Fo}} = \mathrm{Ly}\left[\frac{\partial^2 U(N, \mathrm{Fo})}{\partial N^2} + \mathrm{Pn}\frac{\partial^2 T(N, \mathrm{Fo})}{\partial N^2}\right]. \tag{2}$$

The method proposed by Temkin [3] enables us to make a complex determination of all the coefficients in Eqs. (1) and (2). Using the local temperatures and humidities of three layers in the concrete sample measured in the course of heat treatment, we may determine the internal heat- and mass-transfer parameters from the following expressions:

$$a = b^2 \frac{\partial Z_a}{\partial \xi_a}, \tag{3}$$

$$\varepsilon \mathrm{Ko} = Z_c - \xi_a \frac{\partial Z_a}{\partial \xi_a}, \tag{4}$$

$$\mathrm{Pn} = -\frac{\partial Z_p}{\partial \xi_a}, \tag{5}$$

$$\mathrm{Ly}^{-1} = Z_p - \xi_a \frac{\partial Z_p}{\partial \xi_a}. \tag{6}$$

After measuring the temperatures and layer-by-layer moisture contents at the points 1, 2, and 3 of the object (Fig. 1), the arguments of the characteristic functions Z_a, ξ_a, and Z_p are calculated [4] from the equations

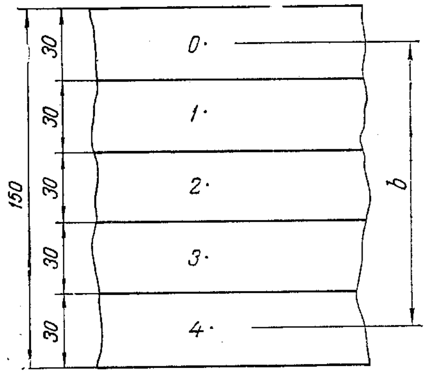

Fig. 1. Disposition of temperature- and humidity-measuring points in the concrete sample. For point 0) $x_0 = b/2$, $t = t_0$, $u = u_0$; 1) $x_1 = b/4$, $t = t_1$, $u = u_1$; 2) $x_2 = 0$, $t = t_2$, $u = u_2$; 3) $x_3 = -b/4$, $t = t_3$, $u = u_3$; 4) $x_4 = -b/2$, $t = t_4$, $u = u_4$.

$$Z_a = \frac{T'(N_3, \mathrm{Fo}) + T'(N_1, \mathrm{Fo})}{U'(N_3, \mathrm{Fo}) + U'(N_1, \mathrm{Fo})}, \tag{7}$$

$$\xi_a = 18\,\frac{T(N_3, \mathrm{Fo}) + T(N_1, \mathrm{Fo}) - 2T(N_2, \mathrm{Fo})}{U'(N_3, \mathrm{Fo}) + U'(N_1, \mathrm{Fo})}, \tag{8}$$

$$Z_p = 18\,\frac{a}{b^2}\cdot\frac{2U(N_2, \mathrm{Fo}) - U(N_3, \mathrm{Fo}) - U(N_1, \mathrm{Fo})}{U'(N_3, \mathrm{Fo}) + U'(N_1, \mathrm{Fo})}, \tag{9}$$

where the dimensionless T and U are referred to the maximum temperature and humidity differences:

$$T(N, \mathrm{Fo}) = \frac{t(x, \tau) - t_{\min}}{t_{\max} - t_{\min}}, \tag{10}$$

$$U(N, \mathrm{Fo}) = \frac{u(x, \tau) - u_{\min}}{u_{\max} - u_{\min}}. \tag{11}$$

The dimensionless coordinate N is referred to the distance between the sensors $b = x_0 - x_4$:

$$N = \frac{x - x_4}{x_0 - x_4}. \tag{12}$$

The same characteristic dimension is taken for the Fo number.

In our investigation we used lightweight aggregate concrete with a bulk mass of between 600 and 900 kg/m^3; the compositions are given in Table 1. This material was prepared from cements of the type most widely used in the Belorussian SSR: Volkovy Portland cement M-500 (compositions 1-3) and Krichev Portland cement M-400 (compositions 4 and 5). As concrete fillers we used lightweight aggregate sand and gravel from the Vitebsk Factory. The experiments were carried out in a laboratory electric-induction apparatus with thermally insulating surfaces and internal dimensions of 400 × 800 × 300 mm (h). Samples of dimensions 250 × 300 × 150 mm (h) were prepared in textolite molds with a metal base. In order to create one-dimensional temperature and humidity fields in the sample, the lateral surfaces of the mold were insulated with a layer of mineral wool.

In these experiments the samples were heat-treated on the 1 + 2.5 + 2.5 principle (preliminary holding period 1.0 h, temperature of the chamber medium raised from 55 to 130°C in 2.5 h, and holding with the heater winding disconnected for 2.5 h).

The local temperatures and humidities were measured at five points over the height of the sample (Fig. 1). The temperature of the lightweight aggregate concrete was continuously recorded by means of Chromel—Copel thermocouples, the readings of which were recorded on a 24-point automatic ÉPP-09M3 potentiometer with a measuring range of 0-150°C.

The layer-by-layer moisture content of the concrete was determined at intervals of 0.5 h. The absence of reliable methods of measuring the local moisture content by remote control necessitated the periodic sampling of five layers of sample 0.2h thick to establish their humidity. The "sectional column" method was used for this. The moisture content of the concrete in the selected samples was determined by the extraction method, with subsequent drying at 105°C.

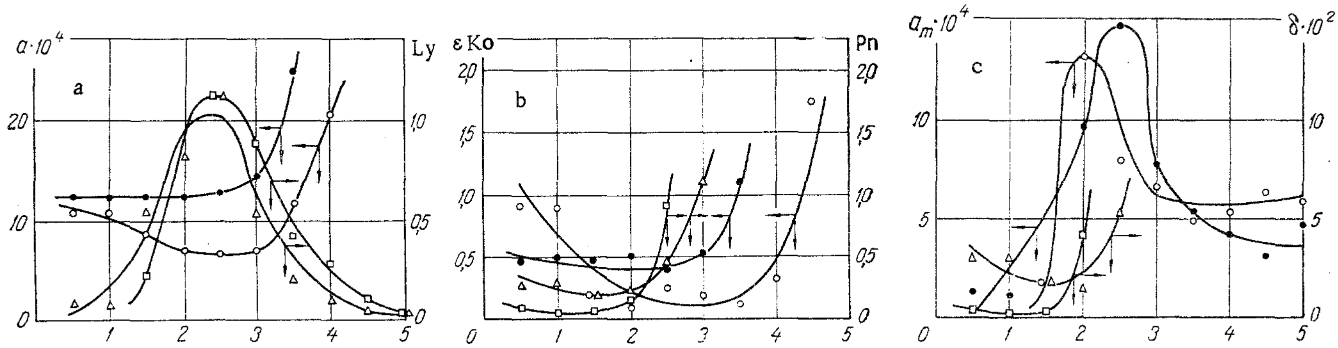

Fig. 2. Changes taking place in the thermal diffusivity and Lykov number (a), the Posnov number and the Kossovich epsilon complex (b), and the moisture-diffusion and thermal gradient coefficients (c) for concrete of composition No. 1 (dark circles) and No. 2 (light circles) during heat treatment.

The dimensionless time is referred to 5 h, so that the interval of 0.5 h between experimental points corresponds to a dimensionless interval of H = 0.1.

The derivatives of the dimensionless temperature and humidity were calculated in accordance with the rules of discrete differentiation [5]. The transfer parameters were calculated on a Minsk-22 computer. A program was composed in the AKI-T algorithmic language for this purpose.

The initial data for calculating composition No. 1 are shown in Table 2. The concrete temperature before loading into the chamber was 16.7°C; the highest value was 76.0°C. The scale temperature difference Δt = 59.3°C. The criteria εKo and Pn are referred to this quantity, and the dimensionless temperature is expressed in fractions of the latter.

The results of our calculations of the internal transfer coefficients and criteria (numbers) for compositions 1 and 2 of the concrete are shown in Fig. 2.

Analysis of the resultant data enables us to refine the mechanism of heat and mass transfer in the concrete during its hardening, subject to the mode of heat treatment under consideration, and to trace the process of structure formation.

In the first period of heat treatment (from 0 to 1.5 h), intense heat transfer occurs in the concrete from the surfaces to the center of the object, while the diffusion of moisture is insignificant, since the inertial Lykov complex Ly is extremely small. From 1.5 to 2.5 h the Ly number and moisture-diffusion coefficient a_m increase sharply. This indicates a considerable intensification of moisture migration during this period, the chief exciting factor being the moisture-conductivity potential. A confirmation of this situation is the low value of the Posnov thermal gradient number Pn at this period of time. The reduction in thermal diffusivity over this period is evidently due to the increasing concentration of new formations in the liquid phase [6].

After 2.5 h the moisture-diffusion coefficient and the Lykov number start falling. This is due to the intensive formation of a capillary-porous structure, characterized by a substantial reduction in the mass-transfer potential. With the formation of the capillaries, the thermal diffusion transfer of matter intensifies, and this expressed itself as an increment in the Posnov number and the thermal gradient coefficient δ.

It should be noted that an analogous change in the coefficients a_m and δ has been observed for heavy concretes as well in the experiments of a number of research workers during the formation of the capillary-porous structure of the concrete [7, 8].

After the falling period, the thermal diffusivity stabilizes for a short period of time, but starting from 3.0-3.5 h it increases again; this is apparently associated with the crystallization strengthening of the capillary-porous structure of the material. A similar time dependence of this coefficient is found in the normal hardening of concretes [6] and also in the case of steam-heating [4, 8].

The Kossovich complex εKo gradually falls over 3.0-3.5 h, and only in the last 1.0-1.5 h does it start rising. The values (in contrast to steam-heating [4, 8]) are positive, since moisture is evaporating, which is associated with the additional absorption of heat by the concrete. The small value of εKo indicates that moisture transfer in the object is taking place chiefly in the liquid phase.

The resultant values of the internal heat- and mass-transfer coefficients may be used for calculating the temperature and humidity fields in objects made of lightweight aggregate concrete of the compositions under consideration during heat treatment in chambers with thermally insulating surfaces and also for selecting the optimum modes of treatment.

NOTATION

T, U, dimensionless temperature and moisture content; Fo, homochronicity number; N, dimensionless coordinate; εKo, Kossovich complex; Ly, inertial Lykov simplex; Pn, thermal gradient Posnov number; a, thermal diffusivity, m^2/h; b, distance between end points of measurement, m; Z_a, ξ_a, Z_p, arguments of the characteristic functions of irreversible thermodynamic processes; $t(x, \tau)$, $u(x, \tau)$, temperature and moisture content at the point with coordinate x at the instant of time τ; h, height of the sample, m; a_m, moisture-diffusion coefficient, m^2/h; δ, thermal gradient coefficient, 1/°C.

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COMPUTATION OF A LAMINAR NON-SELF-SIMILAR SEMIBOUNDED FLUID JET

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UDC 532.522.2

The numerical solution of dynamic and heat problems of a laminar plane incompressible fluid jet being propagated along a solid surface is performed within the framework of boundary-layer theory.

§1. Dynamic and thermal problems on the propagation of a laminar, plane, near-wall fluid jet have been solved earlier on the basis of an asymptotic boundary-layer scheme in a self-similar formulation [1]. A method and results of a computation of a semiinfinite incompressible fluid jet in the whole flow domain are elucidated below.

The initial system of equations of motion and heat propagation of a plane stationary incompressible fluid boundary layer is presented on the left in Table 1. The equations and initial and boundary conditions are written in dimensionless form, where the bar above the dimensionless quantities has been omitted for simplicity.

It is assumed that the jet issues from a slot with uniform velocity and temperature profiles in parallel to the surface of a solid wall. At a range of one integration spacing along the transverse coordinate, the magnitude of the velocity at the wall and at the outer edge of the slot drops to zero at the exit and the temperature becomes equal to the value of the

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