section, in m; δ, dynamic boundary-layer thickness in m; Δ, thermal boundary-layer thickness in m; x, distance measured from diffuser inlet section along longitudinal axis, in m; $\bar{x} = (x/d_0)$, dimensionless longitudinal coordinate; T, absolute temperature in °K. Indices: 0, diffuser inlet; 1, upper boundary of boundary layer; w, inner surface of duct; x, value of coordinate x; 2, static pressure to coordinate x downstream from inlet at the wall.

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CALCULATING TURBULENT NONISOTHERMAL JETS

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Experimental and calculated data concerned with the propagation of turbulent nonisothermal jets are compared.

Semiempirical methods of calculating nonisothermal turbulent jets, as a rule, well depict the qualitative flow pattern for T_0 = var and the influence of the overheating parameter $\omega = T_0/T_\infty$ on the velocity, temperature, etc., distributions [1-5]. With an appropriate choice of the numerical values of the empirical constant (or relationships) we can achieve a satisfactory quantitative agreement between experimental and calculated data. In connection with this, when evaluating the area of application of various calculation methods and their effectiveness — the capability of being used for sufficiently accurate predictive calculation of the characteristics of nonisothermal jets — the question of "universality" of the experimental constants which complete any semiempirical calculation system is important. First and foremost the question is about determining the degree of influence of the overheating parameter on the empirical coefficients and about estimating the calculation error connected with the assumption about their independence of ω.

In Table 1 we have presented, for a number of calculation schemes, the numerical values of experimental constants that are necessary for calculating velocity and temperature fields. These data, obtained on the basis of processing results of measurement in turbulent jets of variable density, are taken from [1-5].

The results of a calculation carried out for the distribution of the characteristic quantities along the axis of the jet are shown in Fig. 1. In Fig. 1a-c, for three values of

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TABLE 1. Value of Experimental Constants Used in Semiempirical Calculation Methods

Calculation method	Experimental constants: dynamic problem	Experimental constants: thermal problem	Dependence of experimental constants on ω
[1]	$c_0=0{,}22$ ($c_i=0{,}27$— initial section)	0,5	$c_0=0{,}35(\omega+1{,}7)^{-0{,}8}$ ($c_i=0{,}27$)
[2]	$2a=0{,}12$ $\frac{x_0}{d}=-1{,}8$	0,75	$2a=0{,}12(1+0{,}017\omega)$ $\frac{x_0}{d}=5\omega^{-0{,}1}-6{,}8$
[2]	$c=0{,}04$	0,75	$c=0{,}04(1+0{,}33\lg\omega)$ [6]
[3]	$\varkappa=0{,}0097$	1	
[4]	$\alpha=0{,}155$ $\beta=-4{,}3$	0,5	
[5]	$k=0{,}025$ $b=0{,}175$	0,75	$k=0{,}02\omega^{-0{,}22}$ [7] $b=-0{,}175$

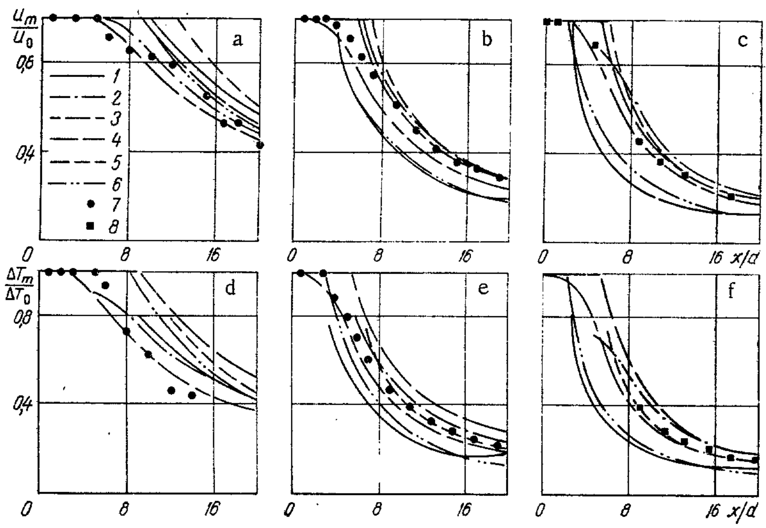

Fig. 1. Distribution of mean velocities and temperatures along the axis of the jet: a, d) $\omega = 0.33$; b, e) $\omega = 2$; c, f) $\omega = 4.3$; 1) calculation according to [1]; 2, 3) [2]; 4) [3]; 5) [4]; 6) [5]; 7) experimental data due to the present authors; 8) [9].

the parameter ω, we have presented the calculated curves $u_m/u_0 = f_1(x/d)$ and the experimental data on the velocity variation along the axis of nonisothermal jets ($\omega = 2$, $\omega = 4.3$) and jets of variable composition (inflow of Freon into air; $\omega = 0.33$). From the graph we see that the curves $u_m/u_0 = f_1(x/d)$ corresponding to different calculation schemes considerably differ from one another. With respect to their correspondence with experiment, the best agreement for the values of constants taken in the calculations (see Table 1) is provided by the method [3]. A comparison of the calculation according to [3] with data corresponding to larger values of ω shows that for $\omega > 4.3$ the calculated relations $u_m/u_0 = f_1(x/d)$ satisfactorily agree with experiment. Other calculation schemes for the values of experimental constants recommended in [1-5] are sufficiently effective only in a relatively narrow range of variation of the overheating parameter: for $\omega < 3$ [2] and for $\omega > 3$ [4].

Certain data on the distribution of the temperature along the axis of a jet of variable density are presented in Fig. 1d, e, and f. Here also the calculated relations $\Delta T_m/\Delta T_0 = f_2(x/d)$ (according to [1-5]) are marked. From the graph we see that for all values of ω a noticeable separation of the curves $\Delta T_m/\Delta T_0 = f_2(x/d)$ is observed. At the same time, none of the calculation schemes ensures sufficiently good agreement with the experimental data over the entire range of variation of the parameter ω.

TABLE 2. Numerical Values of Empirical Constants

Characteristic quantity	A	B	C	F	γ	λ	ν	ε
$\frac{u_m}{u_0}$	3,2	3,2	—1,5	1,1	—1,5	—1	—1,5	1
$\frac{\Delta T_m}{\Delta T_0}$	2,4	1	—1,5	1,1	—1,5	—1	—1,5	1
$\frac{(\rho u^2)_m}{(\rho u^2)_0}$	68	7	—5	0,02	—0,1	—2	1	—2
$\frac{(\rho u c_p \Delta T)_m}{(\rho u c_p \Delta T)_0}$	44	—7,5	8,5	0,01	—0,1	—2	1	—2

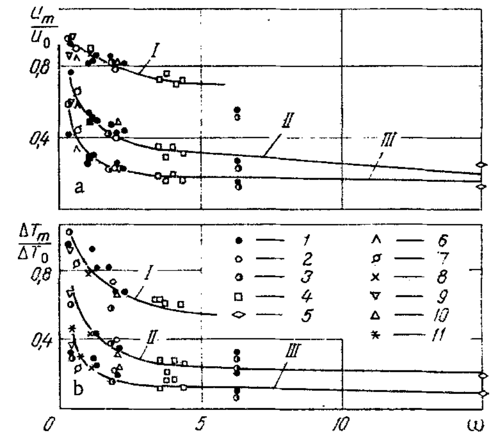

Fig. 2. Relations $(u_m/u_0)(\omega)$ (a) and $(\Delta T_m/\Delta T_0)(\omega)$ (b): I) x = 6d; II) 12d; III) 20d; 1) experimental data due to the present authors; 2) [1]; 3) [8]; 4) [9]; 5) [10]; 6) [11]; 7) [12]; 8) [13]; 9) [14]; 10) [15]; 11) [16]. Solid lines) calculation according to the expression (1).

It should be noted (and this is important) that variation of the numerical values of the empirical constants improves the agreement between calculation and experiment only for a specified value of the parameter ω. At the same time, the calculation error for other ω noticeably increases. Taking into account the dependence of the experimental constants on ω leads to a substantially better agreement between experimental and calculated data. The corresponding relations, obtained by comparing the calculated and experimental data on the velocity variation along the axis of the jet of variable density, are presented in Table 1. These results can be used to carry out calculations with increased accuracy.

Side by side with them, for practical purposes we can recommend the following empirical relation which describes the distribution of the characteristic quantities within the basic portion of turbulent nonisothermal jets:

$$P\left(\frac{x}{d}\right) = A\left(\frac{x}{d} + B\omega^{\gamma} + C\right)^{\lambda} (1 + F\omega^{\nu})^{\varepsilon}, \tag{1}$$

where u_m/u_0, $\Delta T_m/\Delta T_0$, $(\rho u^2)_m/(\rho u^2)_0$, $(\rho u c_p \Delta T)_m/(\rho u c_p \Delta T)_0$, A, B, C, F, γ, λ, ν, ε are constants whose numerical values are presented in Table 2.

The agreement between experiment and calculation according to the expression (1) is judged from Fig. 2 on which for specified values of ω we have shown the relations $(u_m/u_0)(\omega)$ and $(\Delta T_m/\Delta T_0)(\omega)$. From the graph we see that within a broad range of variation of ω ($0.33 \leqslant \omega \leqslant 15$ – inflow of Freon into air – inflow of plasma jets) the relation presented satisfactorily describes the experimental data.

NOTATION

T, temperature, °K; u, velocity; ρ, density; c_p, specific heat at constant pressure; $\Delta T = T - T_\infty$; ω, overheating parameter; x, coordinate directed along the axis of symmetry of the jet; d, diameter of nozzle. Indices: 0, initial parameters of the jet; m, parameters on the axis of symmetry of the jet; ∞, parameters of the medium.

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INFLUENCE OF FUNDAMENTAL FORCE FACTORS ON THE TRANSVERSE VELOCITY OF FINE PARTICLES MOVING IN A TURBULENT GAS STREAM

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On the basis of a numerical solution of the equations of fine particle motion in a turbulent vertical stream forces of a different nature, acting in the radial direction and governing the average transverse particle velocity, are analyzed.

The motion of axisymmetric streams of a gas suspension has been examined in many cases as one-dimensional [1, 2]. The magnitudes of the longitudinal velocity and the concentration have hence been considered averaged over the cross section, and the transverse particle velocity has been taken as zero. However, formation of a concentration profile, whose analysis is possible only in the presence of information about the transverse particle motion in the gas suspension stream, acquires special value for different heat- and mass-transfer processes, the deposition of particles on channel walls, etc. The appearance of a radial component of the average particle velocity is due to the presence of a number of force effects, to be considered later, which act in the transverse direction. The particle motion hence specifies the appearance of mass fluxes of a different nature: the average transverse motion is a source of convective mass transport and the pulsating motion is diffuse. The radial flux density of the particle mass is $j = \beta v_s - D_s(d\beta/dr)$. In a steady gas suspension

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