The effect of the initial humidity of a two-phase flow on the aerodynamic characteristics of a diffuser is considered. A series of calculations is carried out which permit the pressure distribution in the diffuser to be investigated in the case of change of the initial flow velocity, coefficient of slip of the phases, and the initial humidity of the flow. It is shown that, with increase of the initial humidity in the diffuser, there appears a sharply expressed region which has a negative pressure gradient, where the steam velocity can reach the critical value. The numerical solution is compared with the experimental results.

A system of basic differential equations, describing the flow of two-phase media, has been proposed repeatedly with various simplifications.

The averaged equations of motion for gas- and steam-liquid mixtures, taking phase transitions into account, were obtained by S. G. Teletov [1]. A more rigid derivation of the basic averaged equations for individual components was achieved by F. I. Frankl' [2]. The equations of motion of multicomponent media under conditions of the absence of phase transitions were analyzed in detail by Kh. A. Rakhmatulin [3]. A further series of papers, devoted to the equations of the dynamics of two-phase media can be cited [4-7].

The theoretical solution of the problem concerning the motion of two-phase media is linked with a certain idealization of the properties of the medium. Such schematization is promising, in which a discontinuous medium is considered as a virtual continuous medium, uniformly distributed in an isolated volume. The virtual medium, being equivalent to the original medium (in the sense of the proposed transformation), at the same time consists of a continuous liquid and a continuous steam phase, for which differential calculus can be used. The steam and liquid phases are considered as separate systems, between which exchange processes take place.

The system of equations describing the flow of a two-phase medium, has the form [6]

\[
\begin{align*}
\frac{dp}{dz} &= -\chi F, \\
\frac{d\rho_i C_i F}{dz} &= -\chi F, \\
\rho_i C_i \frac{dC_i}{dz} &= -(\beta_i - C_i) - R \\
\rho_i C_i \frac{dC_i}{dz} &= R - (C_i - C) - \frac{dP}{dz} \\
\rho_i C_1 (d/dz) i_{10} &= (i_{i0} - i_{i2}) + Q - N \\
\rho_i C_2 (d/dz) i_{20} &= (i_{i1} - i_{i2}) + N - Q \\
\frac{d\rho}{dz} &= \frac{p^2}{\rho_0 V_2 n RT_1} \left( 1 - \frac{T_1}{T_1} \right)
\end{align*}
\]

Here, the index 1 refers to the continuous phase; 2 refers to the discrete phase; and 3 refers to particles undergoing phase transformation; z is a coordinate along the axis of the channel; \( \rho \) is the density; \( \varphi \) is the volume concentration; \( F \) is the cross-sectional area of the channel; \( i_{i0} = i + C_i^2/2 \) is the stagnation enthalpy; \( i_{i2} \) is the thermodynamic potential of the particles undergoing phase transformation; \( C_i \) is their velocity; \( R \) is the force of the mechanical interaction between phases; \( Q \) is the rate of the mechanical interaction between phases; and \( T_1 \) is the temperature.
is the quantity of heat delivered to or received by the phase, in consequence of convective heat exchange; 
\( N \) is the intensity of the interaction forces of the phases in a gradient flow; \( \kappa \) is the phase transformation 
rate (bearing in mind the specific values of the quantities \( R, Q, N \) and \( \kappa, \) i.e., taken per unit volume of the 
phases).

It is assumed that

\[
\begin{align*}
\dot{t}_1 &= \frac{k}{k-1} \frac{p}{\rho_1} + \text{const}, \quad \dot{t}_2 = c_p T_2 + \text{const} \\
p &= \rho_1 \vec{R}_1 T_1, \quad \psi_1 + \psi_2 = 1, \quad \beta = 1
\end{align*}
\]

where \( c_p \) is the specific heat of a discrete phase and \( \vec{R}_1 \) is the gas constant.

\[
R = \frac{3}{4} q_2 c_p \frac{(C_1 - C_3) |C_1 - C_3|}{2}
\]

\[
N = R C_2 + p \frac{d(q_2 C_2)}{dz}, \quad \kappa = \frac{3 q_2 q_2 C_2}{r} \frac{dr}{dz}
\]

\[
Q = \frac{3}{2} q_2 \frac{\alpha N u}{r^2} (T_T - T_t)
\]

\[
\text{Nu} = 2 + 0.03 Pr_t^{0.32} Re^{0.34} + 0.35 Pr_t^{0.36} Re^{0.54}
\]

\[
c_t = 24/Re + 2.5/Re
\]

For a numerical solution on a computer, Eq. (1.1) reduces to the form

\[
y_i = f_i(z, y_1, y_2, \ldots, y_e)
\]

Thus, the change of static pressure is described by the equation

\[
\frac{dp}{dz} = \left[ L_{ct} + \frac{1}{F} L_{pr} \frac{dp}{dz} + Q L_{q} + R L_{3} \right] \left[ q_i (1 - M_i) \right]^{-1}
\]

where

\[
L_{ct} = - \left[ M_{ct} k \left( \frac{C_2}{C_1} - 1 \right) + \left( \frac{C_3}{C_1} - 1 - \frac{k}{C_1} \right) \left( 1 - M_i \right) + \left( \frac{k}{k-1} \frac{p_1}{\rho_1} \right)^{-1} \left( \rho_1 - \rho \right) - 1 \right] C_1
\]

\[
L_{pr} = p M_{ct} \left( k q_1 + q_2 - q_1 \right)
\]

\[
k = -(2-C_2/C_1) \left( p q_1 \right)^{-1}
\]

\[
M_{ct} = C_1 / k R T_1
\]

Calculations were carried out for a plane diffuser with an inlet height of \( h = 20 \text{ mm} \), expansion angle \( \alpha = 6^\circ \), expansion ratio \( F_2/F_1 = 1.45 \) over a range of change of velocities \( C_1 = 100-400 \text{ m/sec} \); coefficient of 
slip \( \nu = 0.7-0.25 \), initial humidity \( y_0 = 0 \) to 0.5, at pressure \( p_{10} = 6 \text{ bar} \) and temperature \( T_{10} = T_{20} = T_S \). The 
volume concentration occurring in Eq. (1.2) was determined from the following expression:

\[
\varphi_{10} = \left( 1 - y_{10} \right) \frac{C_{10}}{C_{10}} \left[ 1 - y_{10} \right] \frac{C_{20}}{C_{10}} + y_{10} \frac{\rho_{10}}{\rho_{20}} \right]^{-1}
\]

The results of the numerical solution are shown in Fig. 1, curves 4-6.

Figure 1 shows the relative pressure distribution \( \varepsilon = p/p_1 \) in the diffuser for a change of initial hu-
midity of the flow and for a value of the vapor phase velocity of \( C_1 = 300 \text{ m/sec} \) and a coefficient of slip \( \nu = 0.5 \). With increase of the initial humidity, the pressure distribution in the diffuser varies: at a certain 
starting section of the diffuser, the pressure gradient becomes negative; in the diffuser, a sharply ex-
pressed region of nozzle flow appears.

With increase of the initial humidity up to 50\%, the region of nozzle flow spreads to approximately 
half of the diffuser, where the pressure attains a minimum value. The next process is characterized by a