tions leads to a considerable decrease (by up to 2-3 times) in the minimum irrigation densities.

It is important to note that the results which have been obtained were achieved with relatively small energy consumptions for exciting the fluctuations, namely, 3-8% of the energy required for establishing the film flow.

NOTATION

\( G_0 \), liquid flow rate, \( m^3/sec \); \( \Gamma_0 \), irrigation density, \( m^2/sec \); \( f_n \), frequency of imposed fluctuations, \( Hz \); \( \delta \), liquid film thickness, \( mm \); \( D \), dispersion of the wavy flow with superimposition of fluctuations, \( mm^2 \); \( D_0 \), dispersion of steady-state wavy flow, \( mm^2 \); \( \Gamma_1 \), irrigation density for the beginning of the appearance of dry patch, \( m^2/sec \); \( \Gamma_2 \), irrigation density at moment of disappearance of dry patch in film, \( m^2/sec \).

LITERATURE CITED


VISCOS ISOTHERMAL MOTION OF A BINARY GAS MIXTURE THROUGH AN ORIFICE

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Motion of gases through an orifice at low Knudsen number is studied.

Motion of gas mixtures through an orifice in a thin film occurs in many technological processes. From the scientific viewpoint this process is interesting because any effect of channel walls on the gas flow is absent. However, until now experimental and theoretical studies of flows through an orifice have been limited in number and have essentially considered only single-component gases.

The present study will investigate the kinetic coefficients of isothermal motion of a binary gas mixture through an orifice at Knudsen numbers much less than unity.

1. Kinetic Coefficients of Isothermal Motion of a Binary Gas Mixture in Long Channels and an Orifice. If at the ends of a channel we create a pressure difference \( \Delta p \) and (or) a concentration difference \( \Delta c \), then motion of the gas mixture within the channel commences.


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Thermodynamic treatment of this situation permits relating the means of the component velocities across the channel section \( u_1 \) and \( u_2 \) to the pressure and concentration differences which cause the former in terms of kinetic coefficients \( L_{ij} \) with the expressions [1]:

\[
\overline{u}_1 c_1 + \overline{u}_2 c_2 = -L_{13} \Delta p - L_{12} p \Delta c_1, \quad \overline{u}_1 - \overline{u}_2 = -L_{23} \Delta p - L_{22} p \Delta c_1.
\]  

(1)

Under concrete conditions the values of the kinetic coefficients are determined by the characteristics of the mixing gas molecules and their interaction with the channel walls, as well as the channel geometry, temperature, pressure, and mixture concentration.

For long channels the coefficients \( L_{ij} \) have been thoroughly studied, both theoretically [2] and experimentally [3]. However, for viscous motion of a gas mixture through an orifice the only kinetic coefficient completely known is \( L_{11} \), describing flow of a gas caused by a pressure difference. Using an analytical solution of the Navier-Stokes equation [4] demonstrated that the mean velocity of motion of a single-component gas in the orifice section at small Knudsen numbers and low pressure heads \( \Delta p \ll p \) is given by the expression

\[
-\overline{u}_1 = -\frac{R}{3\eta_{11}} \Delta p.
\]  

(2)

This result was confirmed experimentally in [5]. Since in a viscous flow regime the velocities of the mixture components are close to each other \( (u_1 \approx u_2 \approx \overline{u}) \), Eq. (2) is also valid for mixtures, if in place of the viscosity of the single-component gas \( \eta_1 \) we use the mixture viscosity \( \eta_{12} \). The goal of the present study is to investigate the kinetic coefficients \( L_{12}, L_{21}, \) and \( L_{22} \) for an orifice, for which there are at present no theoretical or experimental data available.

A round orifice can be considered the limiting case of a cylindrical channel with radius \( R \) and length \( l \) as \( l \to 0 \). In view of this it can be expected that the expressions for kinetic coefficients describing viscous \( (Kn \to 0) \) motion of gas mixtures through an orifice will basically coincide with analogous expressions for the coefficients for extended channels of the same radius. Therefore, to establish the form of \( L_{ij} \) at an orifice we will use expressions for the corresponding kinetic coefficients from [1] for the case \( \ell \gg R \gg \lambda \):

\[
L_{11} = \frac{R^2}{8\eta_{11} l}, \quad L_{12} = \frac{\alpha D_{12}}{l p}, \quad L_{21} = \frac{\alpha_p D_{12}}{l p}, \quad L_{22} = \frac{D_{12}}{c_1 c_2 l p}
\]  

(3)

and generalize these to the case of the orifice.

Using Eq. (2) and definition (1), we obtain the kinetic coefficient \( L_{11} \) for the orifice:

\[
L_{11} = \frac{R}{3\eta_{11}}
\]  

(4)

Comparing the expressions for \( L_{11} \) for a long channel, Eq. (3), and an orifice, Eq. (4), we note that they may be written in one and the same form by distinguishing an "effective length" for the orifice in Eq. (3):

\[
L_p = \frac{3\pi}{8} R, \quad L_{11} = \frac{R^2}{8\pi \eta_{11} L_p}
\]  

(5)

It should be obvious that such introduction of \( L_p \) is possible only in a viscous flow regime. For arbitrary numbers \( Kn \) the differences in the expressions for \( L_{11} \) and \( L_{11} \) will be related to a number of additional parameters which appear upon transition from an orifice to a channel of finite length (the accommodation coefficients, Knudsen number over channel length).

The introduction of an effective length \( L_p \) has been used previously in considering flow [6] and diffusion [7] in channels with a finite ratio of channel length to radius. The physical meaning of \( L_p \) is that outside the channel near both its ends there exist regions of gas perturbed by the flow which produce an additional contribution to channel resistance. This change in channel resistance is equivalent to an increase in its length by an amount \( \Delta l \), which is termed the end correction. Having replaced the real channel length