By transforming the results obtained to the processes of structuring capillary-porous materials, it can be concluded that the magnitude of the internal pressure developing during the vaporization of moisture from these materials is dependent on the mobility of the disperse particles (i.e., on the degree of dispersion and, consequently, on the coefficient of shrinkage) and, to a lesser extent, on the intensity of moisture vaporization from the material.

NOTATION

\( L \), capillary (Laplace) pressure, \( N/m^2 \); \( \sigma \), surface tension, \( N/m \); \( a \), width of gap between plates, \( m \); \( b \), diameter of fluid drop held between plates, \( m \); \( \varepsilon \), modulus of elasticity of membrane material, \( N/m^2 \); \( \gamma \), Poisson coefficient of membrane material; \( t \), temperature in thermohygrostat chamber, \( ^\circ C \); \( \varphi \), relative moisture content of air, \( \% \); \( \delta \), membrane thickness, \( m \); \( W(\varphi) \), deflection of center of membrane, \( m \); \( c \), eccentricity of fluid drop relative to membrane, \( m \); \( d \), diameter of membrane, \( m \); \( j_\Sigma \), intensity of moisture vaporization from slit, \( kg/m^2 \cdot sec \); \( \Delta V \), increase in drop volume, \( m^3 \); \( S \), surface of vaporization of moisture from slit, \( m^2 \); \( \tau \), duration of process, \( sec \); \( j_\Sigma \), intensity of vaporization from free surface of water, \( kg/m^2 \cdot sec \); \( S_\Sigma \), vaporization surface, \( m^2 \).

LITERATURE CITED

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FORMATION ON SOLID SURFACES OF A GAS MONOLAYER PROVIDING PROTECTION AGAINST FRICTION IN RAREFIED MEDIA

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The dynamics of formation of a monomolecular gas layer on an exposed surface are analyzed on the basis of a solution of the kinetic adsorption equation, with allowance for adsorption, desorption, and the migration of molecules to the free parts of the surface under equilibrium external conditions.

It is known [2, 3] that gas films adsorbed on the surface of rubbing bodies have an important influence on the variation of the friction and wear characteristics. This effect is especially significant in connection with studies of friction processes in a high vacuum, where the use of liquid lubricants and greases is impossible owing to their evaporability. Adsorbed gas films protect the surfaces from "juvenile" contact, thus reducing...
TABLE 1. Depth of Potential Well in the Gas Molecule—Surface Interaction [10]

<table>
<thead>
<tr>
<th>Gas</th>
<th>H₂</th>
<th>He</th>
<th>CH₄</th>
<th>Ne</th>
<th>N₂</th>
<th>O₂</th>
<th>Ar</th>
<th>CO₂</th>
<th>Kr</th>
<th>Xe</th>
</tr>
</thead>
<tbody>
<tr>
<td>U•10⁻¹¹ J</td>
<td>11.0</td>
<td>1.0</td>
<td>20.3</td>
<td>3.06</td>
<td>11.7</td>
<td>15.3</td>
<td>16.7</td>
<td>41.1</td>
<td>29.3</td>
<td>47.9</td>
</tr>
</tbody>
</table>

the possibility of surface failure. The formation on the friction surface of a gas layer one molecule thick (monolayer) is sufficient to produce qualitative changes in the dry friction process. Hence the importance of studying the process of formation of a protective gas monolayer on friction surfaces in rarefied media and determining the duration of the process.

Let us consider the covering of an exposed surface by an initial layer (monolayer) of gas molecules. The deposition of the molecules on the surface and the rate of formation of the monolayer are determined by the flow regime and the internal state of the gas and by the surface—molecule interaction conditions [9]. On making contact with the surface the gas molecule enters the zone of forces of attraction. If the initial kinetic energy of the molecule is small, it is captured by the surface, and its energy is dissipated into the lattice as vibrational motion. If the initial energy is large, the molecule rebounds and leaves the surface.

If we take as the initial moment of time the deposition of molecules on an absolutely juvenile surface, then for determining the number of molecules adsorbed by the flat surface it is possible to propose [6] the equation

\[ \theta(r, t) = \int_0^t \{1 - \sigma (r, \tau) \} \left[1 - \xi_D (T_{w}, 0, \tau, r) \right] \int_{u_n < 0} |u_n| f(u_n, r) \xi_A (T_{w}, u, 0) du_n du d\tau \, d\tau. \]  

(1)

The quantity \( \sigma \) in (1) is defined as the surface area occupied by a single molecule, or \( \sigma = 1/\nu_0 \), where \( \nu_0 \) [2] is the maximum possible number of molecules in the monolayer per unit area. Thus, \( 1 - \sigma (r, \tau) \) is the probability of a gas molecule striking the free part of the surface.

If we neglect the dependence of the adsorption probability \( \xi_A \) on the velocity vector \( \vec{u} \) of the molecules impinging on the surface, which is valid for thermal molecule velocities, then the triple integral in (1) is the mathematical expectation of the number of molecules striking an element of the surface in unit time:

\[ \nu = \int_0^t \int_{u_n < 0} |u_n| f(u_n, r) du_n du d\tau. \]  

(2)

Since for Maxwellian molecules the distribution function does not depend on the coordinate [1], Eq. (2) simplifies to

\[ \nu = \frac{p}{k} \sqrt{\frac{R}{2\pi \mu T}} \frac{1}{M^2 \cdot \text{sec}}. \]  

(3)

With allowance for (3), the kinetic equation of the adsorption layer (1) reduces to

\[ \theta(t) = \nu \int_0^t \{1 - \sigma (\tau) \} \left[1 - \xi_D (T_{w}, 0, \tau) \right] \xi_A (T_{w}, 0) d\tau. \]  

(4)

As a result of energy transfer between the molecule and the lattice (at high surface temperatures) even an adsorbed molecule may acquire sufficient energy to leave the surface (so-called "spontaneous desorption"). To determine the desorption probability \( \xi_D \) we use the Frenkel' model [7]:

\[ \xi_D = 1 - \exp \{1 - \psi (l - \tau) \}. \]  

(5)

The spontaneous desorption coefficient [8]

\[ \psi = \tau_0^{-1} \exp \left( - \frac{Q}{kT_w} \right), \]  

(6)

where, for calculation purposes, the finding energy \( Q \) can be taken on the range \((1.5-3.0) \times 10^{-19} \, \text{J}\); \( \tau_0 \) is a quantity of the same order as the period of the normal vibrations of the adsorbed atoms \((10^{-15}-10^{-13} \, \text{sec})\).

Monolayer adsorption is a consequence of: direct impingement of a molecule on the clean part of the surface and impingement of a molecule as a result of ricochet collisions or as a result of migration to the exposed parts of the surface after adsorption in the second layer.