the surface (which agrees with [8]), and the supports of the hot-wire do not introduce significant disturbances in the flow even for the wire oriented along the flow. The hot-wire technique may be of independent interest as a means of the determination of accommodation coefficients of translational and internal energy of the flow.

In conclusion, the authors acknowledge A. K. Rebrov for useful discussions stimulating development of studies with hot-wire anemometry.

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INFLUENCE OF ACOUSTIC DISTURBANCES ON THE BLOWING OF SOLID PARTICLES

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The process of blowing of solid particles by an airstream is initiated and evolves within the limits of boundary-layer flow over a surface and depends on the nature of the flow in the layer. However, when the airstream moves over a natural surface, it encounters various obstacles and roughness elements, which disturb the flow pattern and generate acoustic oscillations, i.e., vortex sounds of various frequencies.

It has been shown [1-4] that the nature of the flow in a boundary layer depends essentially on the frequency of the acoustic oscillations existing in the flow.

When the boundary layer is irradiated by sound at a definite intensity and frequency, the laminar-to-turbulent transition is accelerated. A variation of the degree of flow turbulence is known to have a stronger influence on the blowing and entrainment of particles [5]. Consequently, the impingement of solid particles on a surface can affect the evolution of the erosion process.

The problem of the influence of acoustic disturbances on the blowing and entrainment of particles has been covered very meagerly in the literature. The present article reports

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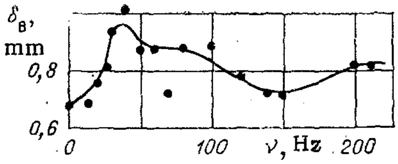

Fig. 1

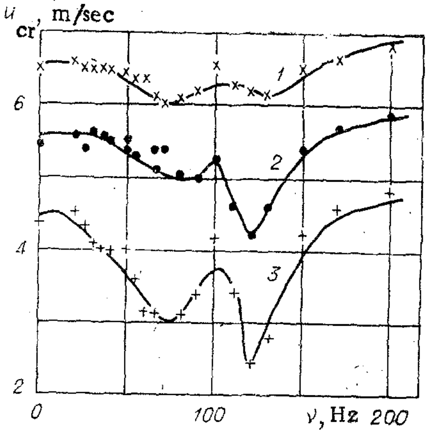

Fig. 2

an investigation of the mechanism of the blowing of solid particles, i.e., the inception of wind erosion of soils in the presence of acoustic oscillations. The experiments were carried out on the aerodynamic test facilities at the M. T. Urazbaev Institute of the Mechanics and Earthquake Resistance of Structures of the Academy of Sciences of the Uzbek SSR.

Inasmuch as the direction of sound radiation only slightly affects the nature of the flows in an airstream [3], the investigated (erodable) plate surface was irradiated perpendicularly in our experiments.

The investigations to determine the influence of acoustic disturbances of various frequencies on the boundary layer were carried out on a smooth plate without the blowing of solid particles at fixed values of the flow velocity and sound pressures. The boundary layer was created on a smooth steel plate of areal dimensions 150 × 450 mm, which was placed in the middle of the working section of a low-turbulence (ε = 2.0%) installation. The tests showed that acoustic disturbances of a definite frequency exert an appreciable influence on the nature of the flows in the viscous sublayer. For constant values of the freestream velocity, the thickness of the viscous sublayer in a given cross section of the experimental plate varies as a function of the acoustic frequencies, even though the sound pressures were held constant (>20 dB).

Figure 1 shows the variation of the thickness of the viscous sublayer as a function of the acoustic frequency at a distance x = 250 mm from the leading edge of a flat plate for a flow velocity of 8 m/sec and a signal output voltage H = 80 V.

The variation of the thickness of the viscous sublayer in irradiation of the boundary layer with sound of different frequencies is attributable to resonance effects that occur when the frequency of the external acoustic disturbances coincides with the frequencies of oscillations already present in the flow (e.g., oscillations of the Tollmien–Schlichting type) [1]. The frequency at which variations of the flows in the viscous sublayer are initiated depends on the history of the impingent flow and the nature of the exposed surface.

Experiments to determine the influence of acoustic disturbances on the intensity of blowing of solid particles were carried out in an open-throat wind tunnel of square cross section 100 × 100 mm operating on the forced-draft principle (flow turbulence ε = 22%). The freestream velocity was recorded outside the boundary layer. The velocity profiles in the boundary layer were determined by a pneumatic technique.

The solid-particle samples were granules of lugovosaz soil (a tillable grassland soil) (0.3 < d < 0.5 mm and d ≤ 2.0 mm), which were placed in carriages in special grooves flush with the flow surface of the plate.

The source of acoustic oscillations was a 15-KZ-1 sonic tower, which as placed at a distance of 150 mm from the exposed surface of the experimental plate. The sound signals were generated by a GZ-33 generator and were amplified by means of TU-100 and U-50 amplifiers. The experiments were carried out at output voltages H = 20, 40, 60, 80, and 100 V and at oscillation frequencies ν = 20, 30, 45, 50, 60, 80, 100, 120, 140, 180, and 200 Hz. The output voltage was held constant during the tests while the radiation frequency was varied, or the voltage was varied at constant frequencies.

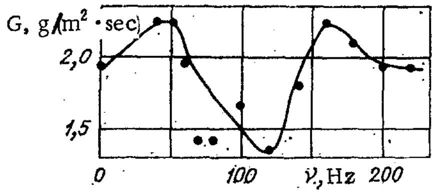

Fig. 3

Figure 2 shows the variation of the critical flow velocities [6] at which blowing and entrainment of the lugovosaz sandy-loam particles (d ≤ 2.0 mm) sets in, as a function of the frequency of the acoustic disturbances at H = 28 V: 1) u_{max}; 2) u_{tr}; 3) u_1.

Figure 3 shows the variation of the rate of entrainment of the solid soil particles as a function of the acoustic frequency at a flow velocity of 8 m/sec and H = 40 V.

An analysis of the experimental results shows that the thickness of the viscous sublayer, the critical flow velocities, and the erosion rates depend on the frequency of the external disturbances in a given cross section of the plate for constant values of the flow velocity and sound pressure (>20 dB); it is established in this connection that the erodability of the soils as a function of the disturbance frequency increases noticeably at several values of the latter. The erodability of soils therefore varies along the flow near sources of acoustic disturbances. It is important to note that the influence of acoustic disturbances on the development of the erosion process sets in when the sound pressure and the flow velocity reach certain threshold levels, which depend on the flow parameters. For a flow velocity of 8 m/sec (ε = 22%) erosion of the soils sets in at frequencies of 40-60, 120, 150-180, 230-250 Hz, etc.

The sensitivity of the wind-erosion process to acoustic oscillations of a definite frequency can evidently be attributed to resonance effects that occur in interaction between the external acoustic oscillations and waves existing in the flow. If the frequency of the disturbing acoustic oscillations corresponds to the frequency of maximum excitation of wind-stream oscillations, the particle-blowing process increases abruptly, i.e., the critical velocities are lowered. When the sound pressure level is increased at a fixed acoustic signal frequency, the critical velocities are lowered, and the rate of blowing and entrainment increases.

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