# DISTRIBUTION OF MAN-MADE IMPURITIES BY WIND FORCE

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One of the most pressing issues of concern to humanity and requires its decision - is pollution. Significant negative environmental effects caused by the release into the atmosphere of aerosols containing solid particles. To solve this problem, among other methods, to study the patterns of distribution of these emissions. The atmosphere is contaminated by anthropogenic emissions, is a heterogeneous multiphase medium.

Technological processes in which there are chemical reactions and thermal conversion, accompanied by a large number of emissions that are harmful to the environment. Much of harmful ingredients into the atmosphere. Under the action of wind, they can propagate in space and then fall to the ground, which can cause significant damage to the surrounding flora and fauna.

These phenomena are subject to the laws of hydrodynamics of multicomponent media. In addition, there are multi-component medium molecular kinetic and diffusion.

Under the influence of solar radiation and wind flow aerodynamic field moves, expands its volume and, therefore, falling can cover a large portion of the Earth.

Analysis of the hydrodynamics of these phenomena allows you to specify a way to reduce the degree of harm from man-made emissions.

**The purpose of research** - the definition of patterns of distribution of impurities in the atmosphere and an indication of the method of reducing the intensity of their distribution.

**Materials and methods of research.** Analysis of the impulse exchange between the components is carried out man-made environment hydrodynamics simulation process. This takes into account the probability of wind action.

**The results of research.** The intensity of the momentum exchange between the components expressed by the ratio:

$$P_{ji} = -P_{ji} = R_{ji} + J_{ji} v_{ji}; \left( j = 1,2,..., N; i \neq j \right) \qquad (1)$$

In this formula $R_{ji}$ - circumbinary (interphase), the force per unit volume of the mixture and the resulting friction forces, pressure, adhesion between components. As the phase transformation takes place at the interface between the phases (components), the value $v_{ji}$ should be regarded as the i-th speed phase at the interface with the j-th phase. In heterogeneous systems with viscous fluids at interphase boundaries are no jumps in speed and therefore $v_{ij} = v_{ji}$. In this case

$$R_{ji} = -R_{ij}. \qquad (2)$$

The intensity of the energy exchange between the phases is represented by the equation:

$$E_{ji} = W_{ji} + Q_{ji} + J_{ji} v_{ji} \left( u_{ji} + 1/2 v_{ji}^2 \right) \qquad (3)$$

Wherein $E_{ji} = -E_{ij}; \left( j = 1,2,..., N; i \neq j \right)$

In this equation, the first term expresses the flow of energy $W_{ji}$ in the i-th phase due to the work of interphase (interconnect) forces, namely friction, pressure, mutual coupling, etc .; the second term of the equation - the influx of energy due to heat transfer $Q_{ji}$ at the interface. The last term of the equation expresses the transfer of internal $u_{ji}$ and kinetic energy $1/2v_{ji}^2$ with mass transfer from one phase to another.

In equation (1) - (3) the notation: $P_y$ - the intensity of the momentum exchange between the j-th and i-th phase; $R_0$ - the total interfacial strength from the j-th phase of the i-th and per unit volume of the mixture, kg /m$^2$s$^2$; $v_{ji}$ - mass velocity, undergoes a phase transition, m / s; $E_y$ - The intensity of the energy exchange between i-th and j-th phases of the mixture per unit volume per unit time kg /m$^3$s; $W_y$ - work interfacial forces i-th phase at the interface with the j-th phase per unit volume of the mixture, kg / m$^3$s; $J_{ji}$ - the intensity of the phase transitions or phase transitions in mass transfer per unit volume of the mixture of the j-th phase in the i-th kg / m$^3$s; $\mu_y$ - internal energy.

Noteworthy is the question of the structure of the flow rate at Z> Z0. Numerous studies show that in the lower atmosphere mean velocity varies in height on a logarithmic dependence. Based on the research, the dependence:

$$\frac{d\bar{V}_B(z)}{dz} = \frac{V_*}{\wp} g\left(\frac{h_0}{z}\right), \qquad (4)$$

where $V_B$ - average speed, m / s; $V_* = \sqrt{\tau / \rho}$ ; $\tau$ - ыhear stress; $\rho$ - density, kg / m$^3$; $g$ - gravitational acceleration, m / s$^2$; $\wp = 0{,}38 - 0{,}4$ - Karman constant; $h_0$ - the height of the roughness of the soil, m.

According to the findings of the similarity theory, changes in wind speed with height in all cases must be determined by a universal function $f(\xi)$ of the dimensionless height $\xi = \frac{z}{L}$ where $L = -c_p \rho_0 T_0 u_*^3 / xgq$. For immediate verification of this result and the establishment of the exact form of the function $f(\xi)$ must have along with the values $\bar{u}(z)$ and also the values of the magnitude $u_* = \left(\frac{\tau}{\rho_0}\right)$ and *q*, allowing to calculate the scale of *L*. However, direct measurements of turbulent fluxes q and $\tau$ in the surface layer of the atmosphere have been started only recently and are still relatively few and quite inaccurate.

Possible and a different approach in the analysis of the spread of contaminants into the atmosphere by wind.

The authors are regarded as two-dimensional and three-dimensional distribution of an impurity. Takes into account the three-dimensional problem turbulent diffusion in the vertical direction and in a direction perpendicular to the wind velocity.

Distribution impurities under the influence of wind in its vertical diffusion is given by:

$$u(z)\partial_x n(x,z) = D_t(\partial_z n) \qquad (5)$$

where $n(x,z)$ - the number density of the impurity molecules.

Turbulent diffusion coefficient $D_t$ can be written in standard form as follows:

$$D = \delta(z),$$

where $\delta$ - the coefficient of roughness, is generally in the range of 0.01 - 0.4 m, depending on the properties of the underlying surface, which extends along the impurity.

In the surface layer of the impurities can be absorbed by soil. Cloud impurities mainly distributed in the atmosphere:

$$\frac{\partial n(x,0)}{\partial z} = 0, \tag{6}$$

We shall consider the simplest form of the initial conditions for the problem of propagation: the distance from the ground to a height of the number density of the impurity is constant:

$$n(0,z) = n_0, \tag{7}$$

its height on the rest of the number density of zero. It is obvious that the initial condition (3) agrees with the boundary condition (6).

Before performing the numerical simulation, a qualitative analysis of the problem using the Galerkin method. We seek a solution of (5) in the form:

$$n(x,z) = A(x)\exp\left(-2z^2/h^2\right). \tag{8}$$

Note that the expression (8) exactly satisfies the boundary conditions (5) and (6), which typically use significantly increases the accuracy of the Galerkin method. Substituting (8) into equation (4) and using the Galerkin method, we obtain for the unknown function $A(x)$ is already an ordinary differential equation:

$$k_0\frac{dA}{dx} = -Ak_1, \tag{9}$$

where

$$k_0 = \int_0^\infty u(z)\exp\left[-4z^2/h^2\right]dz,\quad k_1 = \frac{8}{h^4}\int_0^\infty D(z)z^2\exp\left[-4z^2/h^2\right]dz.$$

In the approximation of a constant rate of flow of surface intervals are easily calculated analytically, as a result of the solution of equation (9) has the form

$$A(x) = A_0\exp\left(-k_1x/k_0\right) = A_0\exp\left(-Dx/h^2u_0\right). \tag{10}$$

As follows from (11), the density of the impurity decreases exponentially with distance from the primary source. We introduce, using the expression (10) the characteristic length $l$ scattering clouds of impurity molecules due to turbulent diffusion

$$l = \frac{u_0 h^2}{D} = \frac{h^2}{\delta}. \qquad (11)$$

We note that the characteristic scattering length l does not depend on wind speed. In particular, if h = 1 m, $\delta$ = 0.1 m and have that $l$ = 10 m.

Increasing the value $\delta$ and hence the turbulent diffusion coefficient leads to a substantial reduction of the impurity density numerical altitudes up to 2 m. These altitudes practically disappears dependence coordinates, in other words, the number density profile vyholazhivaetsya impurity molecules. Thus, an increase in roughness coefficient leads to an increase of the diffusion flux in the vertical direction and decrease the density of the impurity molecules at elevations comparable with the average growth of human (~ 2 m) and a comparatively small distances from the spread of the cloud.

$$u(z)\partial_x n(x, y, z) = D_t (\partial_{zz} n + \partial_{yy} n). \qquad (12)$$

At the same time put additional boundary condition:

$$n(x, \pm\infty, z) = 0. \qquad (13)$$

Using the Galerkin method we seek an approximate solution of three-dimensional equation as follows ::

$$n(x, y, z) = n(x, z)\exp(-4y^2 / W^2), \qquad (14)$$

where $W$ - width spillage, which is a source of vapor, m.

Thus, using the expression (14) and the Galerkin method can be reduced three-dimensional problem of propagation of a two-dimensional to the drain. Actually introduced function $n(x, z)$ describes the density in the center of spreading clouds, and approximately exponential term describes the decrease in the number density due to diffusion in the direction perpendicular to the wind direction. It is clear that for a sufficiently large value of the strait at the cloud center will coincide with the solution of two-dimensional problems. Note that the expression (14) exactly satisfies the boundary condition (13).

This conclusion is confirmed by the analysis of experimental data. When this value is not dependent l wind speed. Its value is determined by the initial vertical size of the impurity clouds and inversely proportional to the roughness of the underlying surface.

## Conclusions

The increase in the coefficient of turbulent diffusion of impurities significantly enhances the dispersion of pollutants in the wind flow. Furthermore, boundaries of the identified impurities in the air. In view of the vertical diffusion of the impurity at a sufficiently large distance x curve 2 has such behavior as curve 1. In other words, the normalized number density of impurity molecules in the region bounded by the curve of the top 2, more than $10^{-2}$.