About Characteristics Of Dust Stands Out In The Air At Production Of Concrete Products

Y V Startseva 1, A I Evtushenko 2, N M Sergina 3

1 Senior Lecturer, Architecture of buildings and structures, Institute of Architecture and Civil Engineering of Volgograd State Technical University (IACE of VSTU), Lenin avenue, 28, Volgograd 400005, Russia
2 Assistant professor, Construction of unique buildings and structures, Don State Technical University, Gagarin square 1, Rostov-on-Don 344000, Russia
3 Assistant professor, Life Safety in Construction and Urban Management, Institute of Architecture and Civil Engineering of Volgograd State Technical University (IACE of VSTU), Lenin avenue, 28, Volgograd 400005, Russia

E-mail: korabina-j-v@mail.ru

Abstract. The article is devoted to the issue of the dust content of the air in the working area of enterprises producing reinforced concrete products. This article considers the main characteristics of dust that is released during the production of reinforced concrete products. The results of analysis of particulate dust including finely dispersed PM10 and PM2.5, taken from the air in the working area of the technological areas of the concrete mixing section, are obtained, the functions of distributing the mass of dust particles along the diameters selected at different technological sites are obtained. According to the Lyashchenko and Reynolds criteria, theoretical values of the dust settling rate in a stationary medium are calculated. The experimental values of the sedimentation rate of the evolved dust are given. The obtained results of investigation of dust deposition rates allowed estimating the difference in values for theoretical and experimental investigation, and the obtained dust characteristics are the initial data for the organization of ventilation schemes at enterprises of this type.

1. Introduction

The research of dust characteristics: a particulate composition, its diameter distribution function and settling rate [1, 3, 18] allows to evaluate the patterns of dust propagation in the air of the working area during the process, throughout the volume of the building.

Dust sampling for the research of its characteristics was carried out at one of the Volgograd enterprises specializing in the manufacture and production of concrete, reinforced concrete structures and products for industrial, civil, agricultural and individual construction of Promstroykonstruktsiya. The dispersion analysis of the dust was carried out according to the procedure [4, 5, 6]. The purpose of this analysis is to determine the quality of the production and ambient air environment, and accordingly, the degree of harm to human health Integral functions of mass distribution of dust particles on the diameter obtained during the particulate analysis [7, 8], taken at the "Promstroykonstruktsiya" (Fig. 1) show that in the air of the working area of the workshop fine dust is with dust's particle content of PM10 from 59% to 99.5% and dust particles with the size PM2.5 - 1.1% - 7.5% [13, 14, 15].
Figures 1 gives examples of the distribution of the mass of dust particles on the diameters [2, 9, 10, 11] taken at different technological sites of the concrete mixing section, and also the functions describing the graphs obtained by the Levenberg-Markardt evaluation method at a reliability level of 95%.

![Graph showing distribution of mass of dust particles](image.png)

**Figure 1.** An integral distribution function of particle mass in the diameter for a) the dust selected on the technological platform №1 during the cement boot by pneumatic transport into the working bunker and simultaneous loading of crushed stone; b) the dust of cement selected on the technological platform №2; c) the dust of cement selected on the technological platform №2 in the breath area; 1 - range of values of the integrated function of the mass distribution of dust particles; 2 is the average integrated mass distribution function of dust particles.

The speed of sedimentation of particles of released dust was determined in two ways: using criteria Lyaschenko and Reynolds and the experimental method. Experimental studies of sedimentation rate of the particles of dust collected in the working area of concrete mixing compartment by sedimentometer in air were carried out in a pilot plant. During the experiment simulated the emission of dust by applying it to a sedimentation tube portions weighing from 0.1 to 0.5 g.

According to the results of the experimental study, integral functions of the distribution of the mass of dust particles along the diameters are obtained (Fig. 2) [12, 13]. Each of the curves is a portion of dust with a certain range of settling rate.

For example, dust images are shown (Fig. 3, 4), the particle settling rate of which is above 0.6 m / s and less than 0.09 m / s. For such photographs, the multiplicity of the areas of dust particles was calculated and the fraction of dust that fall over each period of time settling time [14, 15, 16, 17].
Figure 2. Integral curves for the mass of dust particles released during the manufacture of reinforced concrete products, according to the diameters in the probability logarithmic grid: No. 0012 - for dust collection at a speed \( w_s > 0.6 \text{ m/s} \); No.0013 – 0,4\(\text{m/cm} < w_s < 0.6 \text{ m/c}); No.0014 – 0,3\(\text{m/cm} < w_s < 0.4 \text{ m/c}); No.0015 – 0,24\(\text{m/cm} < w_s < 0.3 \text{ m/c}); No.0016 – 0,2\(\text{m/cm} < w_s < 0.24 \text{ m/c}); No.0017 – 0,17\(\text{m/cm} < w_s < 0.2 \text{ m/c}); No.0018 – 0,15\(\text{m/cm} < w_s < 0.17 \text{ m/c}); No.0019 – 0,13\(\text{m/cm} < w_s < 0.15 \text{ m/c}); No.0020 – 0,12\(\text{m/cm} < w_s < 0.13 \text{ m/c}); No.0024 – 0,11\(\text{m/cm} < w_s < 0.12 \text{ m/c}); No.0025 – 0,10\(\text{m/cm} < w_s < 0.11 \text{ m/c}); No.0026 – 0,09\(\text{m/cm} < w_s < 0.10 \text{ m/c}); No.0027 – w_s < 0.09 \text{ m/c}

Figure 3. Image of dust particles released in the production of reinforced concrete products, settled in the sedimentation pipe with settling rate > 0.6 m/s.

Figure 4. Image of dust particles released in the production of reinforced concrete products, settled in the sedimentation pipe with settling rate < 0.09 m/s.

To calculate the speed of sedimentation of dust particles and the Reynolds Lyaschenko criteria with known particle diameter of usually use Archimedes formula [20]:

\[
Ar = (\rho_s - \rho) \rho g d^3 / \mu^2
\]  

\( \rho_s \) - density of particle material, kg / m\(^3\);
\( \rho \) - ambient density, kg/m\(^3\);
\( g \) - acceleration due to gravity, 9.81 m/s\(^2\);
\( d \) - particle diameter, m;
\( \mu \) - the dynamic viscosity of the medium, Pa s

Then, from the graph of the experimental dependences of the criteria and the criteria for the deposition of single particles in a stationary medium [16] define the criteria and of which we find the rate of deposition.; the rate of deposition

\[
Re = \frac{w_{\infty} d \rho}{\mu}
\]
then

\[
w_{\infty} = \frac{Re \mu}{d \rho}
\]

\[
Ly = w_{\infty} \left( \frac{3 \rho}{\mu \left( \rho_a - \rho \right)} \right) g
\]
then

\[
w_{\infty} = \left( \frac{Ly \left( \rho_a - \rho \right) g}{\rho^3} \right)
\]

According to known material density, density of medium and diameter of the dust particles Archimedes criterion was calculated for each of the materials (cement, gravel and sand) and the criteria Lyaschenko and Reynolds [20] were determined. after that the graphs of dust settling on the diameter of the particles of the material defined according to the criteria and Lyaschenko Reynolsda were plotted (Figure 4).

Based on experimental and theoretical calculations using formulas Lyashenko and Reynolds, knowing the integral mass distribution function of dust particle diameter construct experimental and theoretical distribution function of the mass of the dust particles on the settling rate (Fig. 6).

\[
D_{Ly} (w_{\infty}) = \int_{0}^{w_{\infty}} w_{\infty} (d_a) \cdot f (d_a) \cdot dD(d_a)
\]

\[
D_{Re} (w_{\infty}) = \int_{0}^{w_{\infty}} w_{\infty} (d_a) \cdot f (d_a) \cdot dD(d_a)
\]

Figure 5. Experimental and theoretical (1) the distribution function of the mass of the dust particles by sedimentation rate;1- theoretical calculations using formulas Reynolds; 2- theoretical calculations using formulas Lyashenko; 3 - experimental dates.
The difference between the theoretical and experimental values of the dust deposition rates (Fig. 5) obtained is due to external factors, namely, the portion of the released dust and the intensity of its knockout through the equipment leaks.

The data obtained during the study of dust characteristics are the basis for adjusting design decisions in the organization of both air exchange and local exhaust ventilation, as well as for addressing labor protection issues, in particular, ensuring the standardized air parameters in the workplace [19].

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