METHOD FOR DETERMINING SEDIMENTATION VELOCITY OF POLLEN

V.L. ISTOMIN
Institute of Hydrodynamics SB RAS, Novosibirsk, Russia
K.P. KOUTSENOGII, V.V.GOLOVKO
Institute of Chemical Kinetics and Combustion SB RAS, Novosibirsk, Russia
e-mail: koutsen@ns.kinetics.nsc.ru

В настоящей работе приводится методика и описывается установка для экспериментального определения скорости седиментации индивидуальных пыльцевых зерен березы и агломератов, состоящих из нескольких частиц.

Установка состоит из импульсного газодинамического генератора для распыления порошка пыльцы, образующего пыльцевое аэрозольное облако, и седиментатора.

Приводятся экспериментальные данные по определению скорости седиментации пыльцы березы и агломератов, содержащих до семи частиц.

Pollination is a characteristic phenomenon in the world of plants which allows both the exchange of genetic information and its integration in a seminal posterity thus providing a more complete use of habitat by plants. There are two types of pollination: self-pollination and cross pollination. The cross-pollination occurs in the case where pollen in transported between the flowers of different specimens. The cross pollination is realized by insencts (entomophilia), birds (ornitophilia), bats (chirontophilia) or the agents of dead nature: wind (anemophilia) and water (hydrophilia) [17]. In middle and, particularly, high latitudes, with a deficit of insects-pollinators, the wind is rather important and reliable agent of pollination. Therefore, anemophilia is most widely spread in the zone of boreal forests. The remoteness of the spreading of anemophilous plant pollen and the effectiveness of sedimentation on pollinated plants depend on the aerodynamic characteristics of pollen grains [2-4, 10-15]. At the same time, owing to the complex and specific form of spores and pollen grains, a theoretical determination of sedimentation velocity which is one of the main aerodynamic characteristics of pollen as a separate particle and especially, its agglomerates, is as yet impossible. At present, the results are known of the determination of the sedimentation velocity of small particles of simple geometrical forms: spheres, ellipsoids, cylinders, rectangular parallelepiped, plates [5]. The sedimentation velocity of spores and pollen is, as a rule, determined experimentally. It is measured by different sedimentators, e.g. [8, 9]. This paper describes the measurement results for the sedimentation velocity of birch pollen grains and aglomerates containing up to seven particles.

Description of the set-up

The set-up is schematically shown in Fugure 1. It consists of two basic blocks: 1 - measuring hopper, and II - sedimentator itself. The dosing system is the system of pulse pollination and consists of receiver 1, electrocontact manometer 2 and electrovalve 3 that allow one to create a gas pulse of required parameters. Measuring hopper 4 included in this system is used to load a given portion of studied fine-disperse substance. This part of the set-up is similar to that described in [7]. The sedimentator itself is cylinder 5 divided by slide 6 into two parts. The upper part receives the pollinated substance coming from measuring system 1 through nozzle 7. This part ends, on the other side, with filter-holder 8 with filters of type AFA-KhA-18 placed on a metallic net [1,16] for air escape. In addition, this part contains auxiliary slide 9. The lower part of sedimentator cylinder ends with device 10 containing micsoscope slide for collecting pollinated fine-disperse substance. This device is the immovable slit diaphragm 11 with window 12 in the form of a sector. Below is changeable window 13 placed on rotating bed 14 which is fixed with stopper 15 relative to ratchet 16. The bed with the slide can rotate with variable rate and has from one to 11 fixed positions. The glass is turned through a given angle by ratchet 16. In experiments we used a vertical cylindrical channel with a 70 mm i.d. The distance of the lower part from damper 6 to microscope slide 3 was 900 mm. The receiver vollume was 300 cm3, and the initial pressure was 1,6 MPa.

Experimental

A portion of birch pollen of several tens of milligrams was pollinated in the upper part of the set-up with closed damper 6. A slit diaphragm was placed in the receiving part of the sedimentator with a length of vertical channel of 900 mm. In experiments, the slit diaphragm was replaced by hand each 20 sec beginning with the first one up to the eleventh

diaphragm. The latter was exposed for 1 min. The previous ones were exposed for 20 sec. Slide 6 was opened 20 sec after pollination. Sector 1 served as a background controlling the clouding of the glass plate. According to experimental data, in the first sector there are single dust particles (no more than five) and no more than two doublets and triplets (no more than one). No larger agglomerates were recorded. This clouding could result either from dynamic dislodging of pollen from the surface of sedimentation channel or penetration of small particles through slits in damper 6. The method of double dampling can be used to prevent penetration of particles and pollen grains. Figure 1 shows both dampers: damper 6 and the second auxiliary damper 9. The technique was tested using lycopodium spores for which there is sufficient body of information. It showed fair agreement with the published values of sedimentation rate [6]. We have carried out ten experiments which were the basis for determination of values of interest to us. In each experiment, the glass with deposited pollen particles was placed under a microscope MBI-11 after selecting samples with deposit. Thereafter, with a 77x magnification, about 30 visual fields were looked through for each spectrum. For each area, we counted the number of single pollen grains and agglomerates containing more than one pollen grain. Agglomerates containing two, three and more spores were counted separately. In each of ten sectors, the particles sedimented whose velocity varied from V_i to V_{i+1}. The latter were counted from the following equation

$$V_i = \frac{H}{t_i} \text{ cm /s, } i = \text{от 3 до 10} \quad (1)$$

$$t_i = 20\cdot(i\text{-}2) \text{ sec} \quad (2)$$

because the zone of nonuniform motion is substantially smaller than the length of sedimetation cylinder. In this case, H=90 cm is the sedimentation cylinder height. Further, from eq. (3), we calculated the arithmetical mean of sedimentation velocity which characterizes the particles sedimenting within the chosen sector (V_i)

$$\overline{V_i} = \frac{V_i + V_{i+1}}{2} \quad (3)$$

where V_i and V_{i+1} are the maximum and minimum values of the sedimentation velocity of particles in the i-sector.

Results and analysis

The data of microscopic counting and the characteristics of the set-up allow us to calculate the sedimentation velocity for the individual particles of a birch and agglomerates containing the different number (j) of individual spores. Table 1 summarizes the results of treatment.

Table 1. Results of determination of the sedimentation velocity of the pollen grains of birch and agglomerates of these particles.

	j=1	j=2	j=3	j=4	j=5	j=6	j=7
Collection of particles, pieces	22163	3880	1413	629	287	127	64
Arithmetic mean sedimentation velocity $\langle\overline{V_i}\rangle$, cm/s	1,88	1,47	1,60	1,71	1,76	1,80	1,88
Quadratic mean deviation of sedimentation velocity $\sigma_{\overline{Vi}}$, cm/s	0,37	0,36	0,32	0,27	0,24	0,22	
Relative quadratic mean deviation $\sigma_{\overline{Vi}}/\langle\overline{V_i}\rangle$,%	30	24	20	16	14	12	

The table summarizes the calculation results of statistic characteristics of sedimentation velocity for each of the seven association groups. We have calculated the arithmetic means for sedimentation velocity ($\langle\overline{V_j}\rangle$), quadratic mean deviation ($\sigma_{\overline{V_j}}$) and the variation coefficient ($\sigma_{\overline{V_j}}/\langle\overline{V_j}\rangle$) in per cent. The above values are in the last three lines, respectively. The upper line of the Table shows the total number of individual particles and agglomerates of different sizes that were calculated experimentally. Experimental data can be described by the following regression relationship

$$\langle\overline{V_i}\rangle = 1{,}24\cdot i^{0{,}216}, \quad r=0{,}994 \quad (4)$$

Conclusions

1. The set-up is created and the method is developed for measuring sedimentation rate of pollen and its agglomerates containing of the different number of particles.

2. The values of sedimentation rate are determined for birch pollen and its agglomerates containing up to seven individual spores. The empirical formula of the dependence of agglomerate sedimentation rate on its size is proposed.

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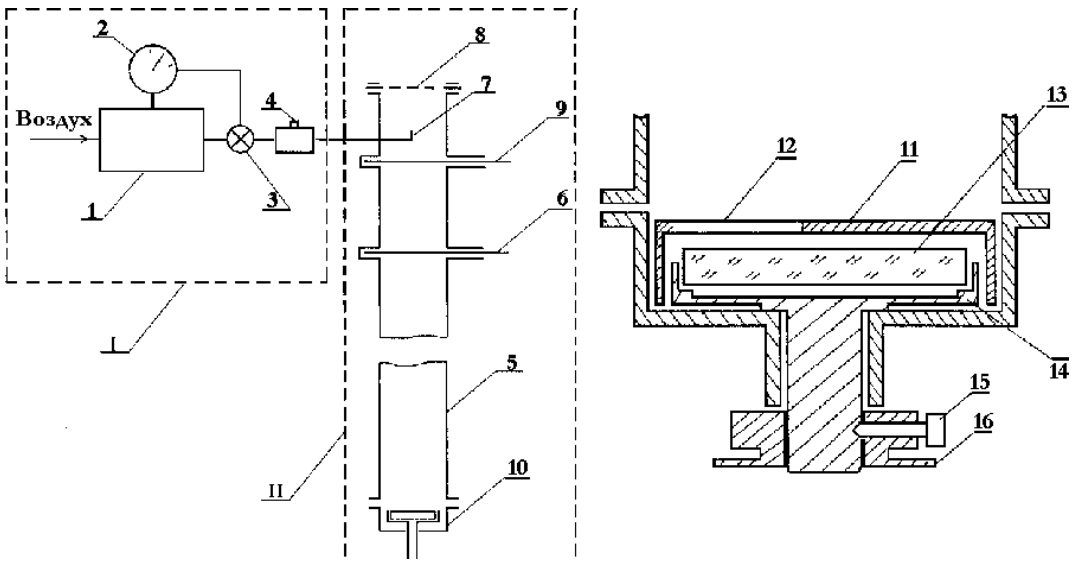

Fig. 1. The scheme of experimental set-up and ratchet mechanism.