The purpose of this communication is to determine the disperse composition of artificial aerosols, including by the radioactive method of multilayer filters and using a newly developed cascade assembly.

**Materials and Methods.** Three analytical filters – AFA-3DA-0.15, AFA-3DA-0.25, and AFA-RMA-20 – were used in the present study. They were placed in an air flow in order of increasing standard aerodynamic resistance 15, 25, and 200 Pa, respectively. The aerodynamic resistance of the first two filters, the flow velocity and the retained matter fraction serve as the initial data for finding the parameters of the log-normal distribution. These analytical filters were made of the material FPA-70, and a third filter of FPA-15-2.0. All materials consist of diacetate cellulose fibers and are manufactured by the technology described in [1].

The cascade assembly for determining the disperse composition of radioactive aerosols was based on a personal impactor, whose final cascade is replaced by a packet of fibrous filters made of the material FP [2]. Since each filter plays the role of a cascade, the total number of cascades in the assembly increases. Such a replacement makes it possible to lower the aerodynamic resistance of the entire assembly as compared with the personal impactor. The fibrous filters make it possible to lower the lower limit of the measured particle size approximately to 0.1 μm.

The characteristics of a multilayer filter were studied on a TSI 3160 automated stand. This stand makes it possible to determine the effectiveness of the filters to 99.999% for 0.015–0.8 μm particles in a wide range of linear filtration rates with a pressure difference no greater than 2 kPa. The settling of sodium chloride aerosol particles with density 2.167 g/cm³ and filtration rate 0.3–1.7 m/sec was studied.

A selenium aerosol generator makes it possible to obtain 0.1–1 μm particles with high monodispersity (the standard geometric deviation from the mean does not exceed 1.3). The fluctuations of the particle number in the measuring channels of a laser counter do not exceed 5%. A particle distribution with mass median diameter 0.36 μm and standard geometric deviation ~1.3 was used to study the characteristics of a multilayer filter. The linear filtration rate was 1 m/sec and the exposure time 5 min. Given the flow rate and the particle concentration in 1 cm³, the number of particles settling on each filter over the exposure time can be determined. The selenium particle density was taken to be 4.5 g/cm³.

A radioactive aerosol generator was used to obtain polydisperse particles with diameter less than 10 μm. The aerosols were obtained by bubbling solutions of nitric acid salts of the corresponding radioactive isotopes $^{239}$Pu and $^{90}$Sr + $^{90}$Y.

---

D. A. Pripachkin, A. K. Budyka, V. O. Hmelevskiy, and A. I. Rizin

EXPERIMENTAL STUDY OF THE DISPERSE COMPOSITION OF AEROSOLS BY THE MULTILAYER FILTER METHOD AND USING A CASCADE ASSEMBLY

1 Institute of Problems in the Safe Development of Nuclear Energy, Russian Academy of Sciences (IBRAE RAN), Moscow.
2 Karpov Physicochemical Research Institute (NIFKhI), Moscow.
3 Doza Scientific-Industrial Enterprise, Zelenograd.
4 Specialized Research Institute for Instrumentation Engineering (SNIIP), Moscow.

The volume activity of the aerosols was $3.3 \times 10^{-2} - 3.7 \times 10^4$ Bq/m$^3$ for $^{239}$Pu and $5.4 - 4 \times 10^5$ Bq/m$^3$ for $^{90}$Sr + $^{90}$Y with relative measurement error no greater than 5%.

The aerosol particle size distribution was determined on the TSI stand using a built-in differential mobility analyzer with a particle measurement limit $10^7$ cm$^3$. An LAC-P laser counter with measurement limit 100 cm$^3$ was used in the work with a selenium aerosol generator. The activity of the aerosol particles on the filters and in the inertial cascades of the assembly was measured with a MKS-07 setup with a BDKS-12P detection block for separate detection of $\alpha$-, $\beta$-, and $\gamma$-radiation.

**Results and Discussion.** The calculations showed that the unimodal spectrum of NaCl aerosol particles obtained on the TSI stand can be approximated by a log-normal distribution, whose parameters – the mass-average aerodynamic parameter and the standard geometric deviation – were calculated using the method of multilayer filters (Fig. 1). The initial experimental spectrum with mass-average aerodynamic diameter 0.18 $\mu$m is described well by the computed log-normal distribution with mass-median aerodynamic diameter 0.19 $\mu$m and standard geometric deviation 1.4.

The settling efficiency does not exceed 30% for aerosol particles with aerodynamic diameter less than 0.5 $\mu$m on FPA-70-0.15 and FPA-70-0.25 with filtration rate 1 m/sec and 3% for 0.1 $\mu$m. The settling efficiency reaches 99.9% for aerosol particles with aerodynamic diameter less than 0.5 $\mu$m in FPA-15-2.0 material and filtration rate 1 m/sec and 67% for 0.06–0.07 $\mu$m.

If the distribution of the aerosol particles is unimodal and the mass or activity of the particles settling on the filters is given, then the method of multilayer filters can be used to calculate the parameters of the log-normal distribution approximating the initial experimental spectrum. However, it should be noted that a unimodal distribution is probably an exception, because the generator in the TSI 3160 stand initially creates aerosols with a polymodal distribution. A unimodal particle spectrum was obtained for selenium aerosols (Table 1) and radioactive $^{239}$Pu and $^{90}$Sr + $^{90}$Y aerosols [3].

Analysis shows that the computed mass median aerodynamic diameter of the selenium aerosol agrees with the determination based on measurements of the experimental spectrum (Fig. 2). The initial experimental spectrum with mass medi-

![Fig. 1. Initial experimental (1) and computed (2) spectra of sodium chloride aerosols on the TSI 3160 stand.](image)

**TABLE 1. Initial Data for Calculating the Characteristics of Selenium Aerosols**

<table>
<thead>
<tr>
<th>Filter No.</th>
<th>Material</th>
<th>Number settling on filter, $10^6$</th>
<th>Mass fraction of settled particles, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FPA-70-0.15</td>
<td>4.6</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>FPA-70-0.25</td>
<td>6.2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>FPA-15-2.0</td>
<td>27</td>
<td>65</td>
</tr>
</tbody>
</table>

The volume activity of the aerosols was $3.3 \times 10^{-2} - 3.7 \times 10^4$ Bq/m$^3$ for $^{239}$Pu and $5.4 - 4 \times 10^5$ Bq/m$^3$ for $^{90}$Sr + $^{90}$Y with relative measurement error no greater than 5%.

The aerosol particle size distribution was determined on the TSI stand using a built-in differential mobility analyzer with a particle measurement limit $10^7$ cm$^3$. An LAC-P laser counter with measurement limit 100 cm$^3$ was used in the work with a selenium aerosol generator. The activity of the aerosol particles on the filters and in the inertial cascades of the assembly was measured with a MKS-07 setup with a BDKS-12P detection block for separate detection of $\alpha$-, $\beta$-, and $\gamma$-radiation.

**Results and Discussion.** The calculations showed that the unimodal spectrum of NaCl aerosol particles obtained on the TSI stand can be approximated by a log-normal distribution, whose parameters – the mass-average aerodynamic parameter and the standard geometric deviation – were calculated using the method of multilayer filters (Fig. 1). The initial experimental spectrum with mass-average aerodynamic diameter 0.18 $\mu$m is described well by the computed log-normal distribution with mass-median aerodynamic diameter 0.19 $\mu$m and standard geometric deviation 1.4.

The settling efficiency does not exceed 30% for aerosol particles with aerodynamic diameter less than 0.5 $\mu$m on FPA-70-0.15 and FPA-70-0.25 with filtration rate 1 m/sec and 3% for 0.1 $\mu$m. The settling efficiency reaches 99.9% for aerosol particles with aerodynamic diameter less than 0.5 $\mu$m in FPA-15-2.0 material and filtration rate 1 m/sec and 67% for 0.06–0.07 $\mu$m.

If the distribution of the aerosol particles is unimodal and the mass or activity of the particles settling on the filters is given, then the method of multilayer filters can be used to calculate the parameters of the log-normal distribution approximating the initial experimental spectrum. However, it should be noted that a unimodal distribution is probably an exception, because the generator in the TSI 3160 stand initially creates aerosols with a polymodal distribution. A unimodal particle spectrum was obtained for selenium aerosols (Table 1) and radioactive $^{239}$Pu and $^{90}$Sr + $^{90}$Y aerosols [3].

Analysis shows that the computed mass median aerodynamic diameter of the selenium aerosol agrees with the determination based on measurements of the experimental spectrum (Fig. 2). The initial experimental spectrum with mass medi-