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PHOTOELECTRIC DOTEST MEMOTOR OF ODAMULAR SIZE DISTRIBUTION OF AN ACCOOL

[Following is a translation of an article by J. Bricard, M. Deloncle, J. Pradel, and G. Madelaine, appearing in the German-Language journal State, Vol 24, No 8, August 1964, pages 287-290.]

1. Principle of the Method

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The method is based on the measurement of light scattering by the individual particles (4). The advantage lies in the fact that a rapid determination of the number of particles of a given granule size per unit volume of air is possible, and also in the fact that all difficulties normally arising when aerosols are placed on a microscope slide are climinated.



Fig. 1 Principle of photoelectric particle size determination The principle of the method is shown in Fig.1. The il-

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lumination device consists of a source of very high brightness S and a condenser with a large aperture which is constructed in such a way that it uniformly illuminates the used portion of a light field of objective 0 whose axis is vertical with respect to that of the microscope. The particles which are to be examined are drawn up by a correspondingly d' ected air current and pass through the light field of the mi oscope. The light scattered by each particle is collected by objective 0, whereby the probability of two particles simultaneously migrating through the light field and thereby being counted as one particle of correspondingly larger diameter is extremely small. This small probability is obtained by dilution of the air (for instance in a Royco instrument for which a somewhat different illumination device is used) and by reduction of the light field of the microscope (1). The light intensity recorded by the objective is led through an optical system to the cathode of a photoamplifier. The signal emitted which has an amplitude which is proportional to the light intensity is subsequently correspondingly amplified and taken up in a multi-channel counting mechanism which permits the mutual separation and simultaneous counting of the various impulse heights to be made.

Since the optical and electrical properties of the instrument are known, the impulse height corresponding to a particle of given granule size and given composition can be calculated. At present, the calibration of the instrument with a known aerosol (spherical latex particles or stabilized water droplets of known dimensions) is under way. However, it is evident -- and this is the chief disadvantage of the method -that the results obtained with this instrument, in spite of all sharpness and accuracy of the method, depend on the dimensions of the aerosol particles, as well as on their refractive index and absorption coefficient. The smallest granule size which can still be determined by this method ranges, at present, from 0.3 to 0.6 μ m; it is limited chiefly by the noise of the photoamplifier and by stray light in the interior of the instrument. An additional device with two photoamplifiers in parallel is presently under construction; these two photoamplifiers should make possible a lowering of this range by elimination of the noise and the stray light.

2. Application of the Method in the Determination of the Filler Efficiency (2)

The Royco instrument used requires a prior dilution of the aerosol, but it is well suited for sampling behind a filter. An artificial aerosol with unobjectionably determined properties was used for the studies, which was quite similar

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to a natural aerosol. We do not with to overestimate the difficulties in the choice of such an aerosol, which in our case are reduced by the fact that we are able merely to determine the granulometric and not the total degree of efficiency of a filter, as it is the case with the chartical methods. Consequently, one must be satisfied to support any easily reproducible artificial aerosol yield is supporting any easily reproducible artificial aerosol yield is the Royco instrument a particle size distribution which is the average corresponds to the distribution of natural seconds (smoking hemp wick immersed in a solution of lactic acid, gum rubber , and potassium nitrate at a ratio of 2:2:5).



Fig. 2 Comparison of the particle distribution in the test aerosol and in the natural, atmospheric aerosol 1 = frequency, 2 = particle size; 3 = atmospheric aerosol; 4 = test aerosol

Simultaneously, it was possible to confirm by the microscopically, directly determined particle size distribution of the aerosol for particles of granule size > μ m that the classical method (collecting by thermal precipitation of the particles) corresponded essentially to the photoelectrical method. The corresponding particle size distribution is shown in Fig. 2.

On the basis of the recording of the instrument, the particles can be grouped into 15 granule classes [ranging] from 0.3 to 8 μ m.

For the determination of the filter efficiency, the experimental aerosol is placed into a spherical, air-tight container of 700 liter capacity and then drawn through the filters which are to be tested. Two types of tests were made:

a) The concentration (number of particles per cm^3) is alternatingly measured for each class of granules, prior to and after passage of the aerosol through the filter (Fig. 3). The average of a certain number of subsequent measurements in-

- 3 -

dicates the absolute permeability of a filter which is referred to the correlation between the input concentrations and the permeating concentrations as a function of the particle for an aspiration rate of 1 cm/second. Figs. 4 and 5 represent experimental results for a filter of average efficiency (Filter No1) and for a filter of high efficiency (Filter No 2). The total permeability represents the average of these results.



Fig. 3 Principle of the experimental arrangement for the measurement of the degree of efficiency of a filter. 1 = Royco instrument; 2 = aspiration



Fig. 4 Permeability of a filter of average efficiency (Filter No 1) as a function of particle size. 1 = permeability 2 = particle size



Fig. 5 Permeability of a filter of high efficiency (Filter No 2) as a function of particle size. 1 = permeability 2 = particle size

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b) For a constant aerosol concertration on the filter, the concentration permeating through iso parallel filters of

- 4 -

known efficiency is compared this indicates the relative permeability of two different filters (Fig. 6). Fig. 7 represents the change in permeability of Filter No 1 as a function of the throughput rate for particles of dimensions between 0.3 and 0.4 µm (upper curve) and for the entire particle size distribution of the aerosol. As is evident, the curves run close to one another and coincide when the aspiration rate surpasses 8 meter/second. of the number of the control of the

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Fig. 6 Principle of the experimental set-up for a comparative determination of the permeability of two filters. l = Royco instrument



Fig. 7 Permeability of a filter of average efficiency (Filter No. 1) as a function of the input rate (upper curve for particles of 0.3 to 0.4 µm [diameter], lower curve for the entire test aerosol. 1= permeability (relative units); 2=input rate - 5 -

3. Studies of Volatile Aerosols (3)

The dilution necessary for the above-described measuring device makes it impossible to study volitile aerosols. However, a system has been developed by means of which it is possible to make a direct study of aerosols with concentrations of less than a few thousand particles per cubic centimeter. In this case, the aerosol is directly drawn through the device [and] remains, at the most, for a few one-hundredths of a second within the instrument. After it had been confirmed with an artificial aerosol that the results obtained with this system are in good agreement with particle size determinations of the cascade impactor within the experimental range of the instrument, the following important studies were carried out with this arrangement.

3.1. Composition of Natural Clouds (from the Puy deDome Peak)

Fig. 8 shows the results of this case. the ordinate indicates the number of particles migrating within ten seconds through the light field of the microscope as a function of the



Fig. 8 Particle size distribution of natural clouds. 1 = particle size

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diameter indicated on the abscissa. It is seen that within the region of small particle diameter, a maximum is followed by a minimum at approximately 1.5 μ m and subsequently again by a steep increase. This result had hitherto not been found with the classical sampling methods (collecting by collision, wire meshes, et cetera).

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3.2. Composition of City For

When the same experimental method is applied to natural fogs, as they are formed, for instance, in Paris, a particle size distribution similar to that one shown in Fig. 8 is found; however, the maximum is less pronounced [and], at times, it disappears entirely, thereby resulting in a curve with continuously increasing particle number with decreasing particle diameter. It is found that city fog occurs only and is stable only when the air humidity of the surrounding areas is below 100 per cent. This fact may be explained when it is assumed that the atmospheric droplets form at particles produced in combustion processes, which are floating in the air; these particles consist essentially of SO₂.

The following Table shows in [terms of] number of drops per cubic centimeter the particle size distribution of a fog at an atmospheric humidity of 70 per cent.

T/cm ³	1070	16.0	0.746	0.021	0.059	0.076	0.058
diameter (µm)	0.8-2	2-4	4-6	' 6-8	, 8-10	10-12	12-14
T/cm ³	0.014	· 0.00)6 ' 0.01	04 1 0.0	02		
diameter (µm)	' 14-16	16-2	L8 18-	20 / 20	t 1 1		

Since the relative humidity of the air is known at the time the measurement is made, the mass m of the matter dissolved in one particle which is in a state of equilibrium can be calculated. The calculation shows that the amount of SO₃ necessary for the equilibrium is 506 μ g/cubic meter. Direct chemical measurements yield a value of 584 μ g/cubic meter, that is an amount which is only slightly above the result of our calculation, which is, however, absolutely of the same order of magnitude. The difference is obviously caused by the possible presence of other

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substances in the solution, which bring about a lowering of the vapor pressure, and by the presence of smaller droplets (which probably amount to 15 per cent of the total mass of droplets), which cannot be detected.

[English Summary appearing on p. 290 of the original article:]

The principle of a method for evaluation of the particle--size distribution of an aerosol is first described; in this method the scatter-light emitted from each individuel particle is measured. As examples of the applicability of the method results are presented for the efficiency of filters and also investigations on the composition of natural clouds and town mist.

Literature References

- 1. J. Bricard, M. Deloncle, and G. Israel, <u>Ann. Geophys</u>, Vol 15, 1959, page 415.
- 2. G. Madelaine, Etude du pouvoir d'arret de differents filtres. (Study of the retaining capacity of filters). Contribution presented at the Conservatoire National des Arts et Metiers in fulfillment of the engineering diploma CNAM, 1963.
- 3. M. Deloncle, Dissertation, Paris, 1963.

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