THE PROBLEM CONCERNING THE SCATTERING OF LIGHT BY SUSPENSIONS OF BACTERIA

Translation No. *1706*

AUGUST 1965

D D C

ARCHIVE COPY

MAR 7 1967

C

U. S. ARMY
BIOLOGICAL LABORATORIES
FORT DETRICK, FREDERICK, MARYLAND

DDC AVAILABILITY NOTICE

Qualified requestors may obtain copies of
this document from DDC.

This publication has been translated from
the open literature and is available to the
general public. Non-DOD agencies may pur-
chase this publication from Clearinghouse
for Federal Scientific and Technical Informa-
tion, U. S. Department of Commerce, Springfield,
Va.

Technical Library Branch
Technical Information Division

THE PROBLEM CONCERNING THE SCATTERING OF LIGHT BY SUSPENSIONS OF BACTERIA

The article by Fikhman /1/ demonstrated conclusively the importance of studying the scattering of light by suspensions of bacteria and interesting results were presented for determining the spectral characteristics of light which is scattered by a number of bacterial preparations. The only objection is the assertion by the author that the light-scattering of suspensions of bacteria as comparatively coarsely-dispersed systems (their average sizes lie within the limits of 0.3--5 microns) is not subordinate to the Mie formula /2/. In actuality the Mie theory does not impose limitations on the size of particles. In literature calculations are cited for Mie functions for very large particles. For example, in the tables /3/ the Mie functions are tabulated up to the values of the argument $a = 2\pi r / \lambda$, equal to 400--600, which corresponds to the radius r of particles on an order of 30--50 microns (0.05 mm) during the scattering of visible light. In the work /4/ the Mie functions are tabulated very carefully and in detail exactly in the interval of radii of 0.3 microns; it is also stressed there /4/ that an examination of an extreme case of $r \rightarrow \infty$ in the frames of the Mie theory leads to the principles of geometric optics.

Besides this, the processing of the experimental data of Fikhman /1/ on the basis of conclusive theoretical treatments of the Mie theory makes it possible to determine the relative index of refraction m of bacterial sphere-shaped cells. Such a possibility is impressive if consideration is given to the importance of the problem of turbidimetry of bacterial suspensions on the whole, and also the phenomenon of the dependency of the refraction index of the bacterial cells on their metabolic activity (living and dead bacteria have different refraction indices).

The figure presents the theoretical curves, constructed according to the tables /5/, of the dependency of the index of the power n ($D = k \lambda^{-n}$) on m for the values $a = \pi d / \lambda$, corresponding to the average diameters d of the bacteria, determined by phase contrast microphotography /1/. For λ we used the average wavelength of maximum transmission in the utilized /1/ interval, λ 508 millimicrons/1.33. Based on the experimental values of n (table 2 from the work /1/) and the curves in the drawing it is possible to determine m of the bacterial cells. The table presents the values of m, determined in this way, for the species of bacteria studied in /1/.

1

Generally speaking, curves similar to those presented in the drawing, under the conditions of invariability of the degree of dispersion of the system, make it possible based on the experimentally determined index of the power n (with the help of the serial FEK-M-N device) to follow the change in the refraction index of the bacterial cell (and consequently, a change in the most important properties of microorganisms /$\overline{1}$;$\overline{6}$/) during various morphological changes of the population directly in the medium of residence of the bacteria (measuring cuvette), not being subjected to their complex preparative influences. On the other hand, based on the dimensions /$\overline{1}$/ of turbidity (at λ 5460 Å), determined experimentally from the spectral dependence of scattering, in the event of a constancy of m, it is possible with the help of the Mie formula to keep track of the number of bacterial cells in a unit of volume.

Literature

a. Fikhman, B. A., Biofizika, 8, 380, 1963.

b. Mie, G., Ann. Physik, 25, 377, 1908.

c. Gumpprecht, R. O., Sliepcevic', C. M., Light Scattering Functions for Spherical Particles. Willow Run Research Center, Univ. of Michigan Press, 1951.

d. Heller, W., Pangonis, W. J., T. Chem. Phys. 26, 498, 1957.

e. Heller, W., Bhatnagar, H., Nakagaki, M., J. Chem. Phys. 36, 1163, 1962.

f. Fikhman, B. A., Doklady AN USSR, 124, 1141, 1959.

2

m (curves 3, 4)
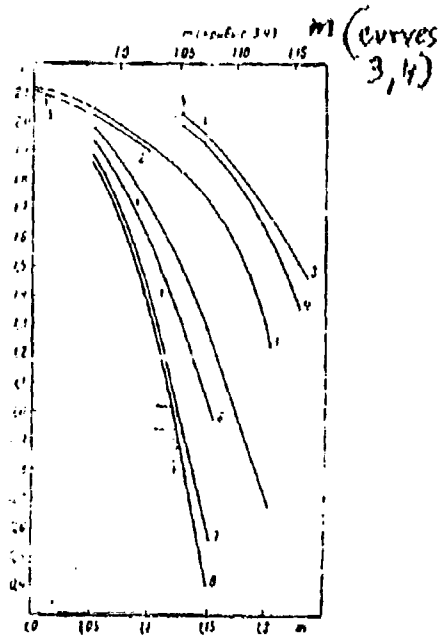
Species of micro-organism	Filkhman's data [1]		$a = \pi d / \lambda$	m
	Value of average diameter $\overline{d}, \mu$	Index of power		
Micrococcus 23	0.78	2.11	6.4	(1.01)
Staph. aureus 1	0.82	2.09	6.75	(1.01)
Staph. aureus K-1	0.89	2.02	7.3	1.05
Staph. aureus 2	0.97	1.92	8.0	1.07
Staph. albus 0-15	1.06	1.78	8.7	1.09
Staph. aureus 209	1.22	1.48	10.0	1.11
Staph. aureus 75	1.42	1.02	11.7	1.12
Sarcina lutea 1	1.48	0.94	12.2	1.12

3.