Ice Nucleation Efficiency of Silver Iodide at -20°C on a Particle Count Basis

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Silver iodide powder¹ was dispensed continuously into a wind tunnel and a fraction of it was diverted into a cloud chamber. Measurements were made of the number of silver iodide particles entering the chamber and of the number of ice crystals formed. The percentage of silver iodide particles that nucleated was found to be low. The reason for this was not established, but the results are deemed of sufficient interest for a short note.

The experimental arrangement is shown in Fig. 1. The silver iodide powder was dispersed with a Wright Dust Feeder (set at 10 psig) and the stream was immediately diluted to give a final concentration in the tunnel of 5–20 particles cm^{-3} . The concentration was measured with an I.I.T. Research Institute automatic particle counter, based on the light-scattering principle (Katz *et al.*, 1956), which senses particles down to $0.5\ \mu$ at $200\ \text{cm}^3\ \text{min}^{-1}$ flow rate. An NCAR ice nucleus counter (Langer *et al.*, 1967) was used to determine the activity of the silver iodide aerosol. Good mixing across the tunnel was verified visually, but to avoid any bias the aerosol sample inlets for both counters were adjacent.

¹ Fisher Laboratory Chemicals Catalog No. S-178, Purified, Lot No. 734050.

A typical size distribution of the silver iodide aerosol from purified AgI powder is given in Fig. 2. It can be seen that on assuming a log probability distribution, 40% of the particles have a diameter of less than $0.5\ \mu$. The particles consist of agglomerates of much smaller particles ($0.06\ \mu$) as shown by the electron microscope photograph in Fig. 3.

The experimental procedure was as follows. The dust feeder was allowed to operate until steady output was reached, as shown by uniform concentration and size distribution data on repetitive measurements. At the same time, the ice nucleus counter was turned on and allowed to stabilize at -20°C . Then the I.I.T. particle counter was operated for consecutive 1-min periods to obtain particle size distribution and number concentration. The ice crystal count was recorded continuously during that time. Usually such a run was continued for 10–20 min to obtain a good average.

The results (Fig. 4) of the four successful tests were averaged, and the ratio of the number of silver iodide particles entering the ice nucleus counter to the number of ice crystals counted was found to be approximately 1000. Since the former does not include particles below

FIG. 1. Wind tunnel for evaluating efficiency of ^1AgI powder.

FIG. 2. Typical size distribution of AgI aerosol.

FIG. 3. Electron microscope photograph of typical AgI powder particle. Long dimension approximately 1.45 μ .

0.5 μ , which were estimated to constitute 40% of the aerosol, the corrected ratio is approximately 1600:1.

To explain this discrepancy, one may question the efficiency of the ice nucleus counter. It has been shown that the device is 35% efficient when compared to a 3-m³ cloud chamber using a visual ice crystal count.² (The calibration was carried out with silver iodide smoke.) When this correction is applied, the ratio of silver iodide particles to ice crystals is approximately 600:1.

According to Fletcher (1962), even the smallest primary particles which make up the powder particles should be active at -21°C . The only conclusion at

present is that the powdered silver iodide is not as active as particles from silver iodide smoke. The smoke yields nearly the number of ice crystals estimated by Fletcher's theory.³

The occasional, almost complete, cessation of ice nucleus counts is also of interest (Fig. 4). That this was not a matter of overseeding could be concluded from visual observation of the cloud, and the automatic particle counter showed no drastic changes in particle size distribution during these periods. However, it should be noted that the degree of chemical homogeneity of the silver iodide surface is not known.

Attempts to activate more silver iodide powder particles by weak ultraviolet radiation were unsuccessful. Exposure to ammonia gave some increase in counts. Visual observation shows that silver iodide smoke particles activate sooner than silver iodide powder particles. Although silver iodide should act by sublimation only (Fletcher, 1962), it may be speculated that the surface of the smoke particles is different than that of the powder particles, and that the smoke particles are contaminated by combustion products, giving them different hygroscopicity and thus greater activity than the uncontaminated powder.

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³ Steele, R., 1967: A calibration of the NCAR acoustical ice nucleus counter. Presented at the American Meteorological Society meeting, Ann Arbor, 20-22 March.

² Steele, R., 1967: Personal communication.

FIG. 4. Ice crystal count vs. AgI particle count.

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