ICE NUCLEUS TESTING OF THE AIRBORNE JET SEEDER

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The airborne jet seeder was designed in 1971 and 1972 at the Naval Weapons Center to burn solutions of silver iodide, ammonium iodide, water and acetone (Carroz, 1973). Based on the findings of Donnan, et al., (1970) the generator was constructed so as not to heat the silver iodide nuclei to too high a temperature. The burner design is similar to the stratified combustion engine being developed by Honda Corporation for automobiles. In the jet seeder, solution is sprayed and mixed with a small portion of air, and combustion begins in this "rich" mixture. The burning mixture is then rapidly mixed with an excess of air, which cools the mixture so that the temperature does not rise above 700°C.

The jet seeder was tested at the Cloud Simulation and Aerosol Laboratory, Fort Collins, Colorado, in April, 1972. The counts of freezing nuclei at temperatures between -5 and -8C were the highest ever measured at the Simulation Laboratory (Garvey, 1974). Blair (1974) and Davis and Johnson (1974) show that these high nucleus counts are the result of controlled combustion which produces particles of silver iodide containing a trace of ammonium iodide.

Because of questions at the Fourth Conference on Weather Modification in Fort Lauderdale, regarding the reproducibility of the ice crystal counts obtained in the 1972 tests, the jet seeder was returned to the Simulation Laboratory in 1975 in order to verify the results.

The jet seeder can be operated with varying sizes of cone nozzles, varying solution pressures and concentrations, and at varying airspeeds. These variables affect the ice nucleus counts, both the nuclei per gram of silver iodide and the nuclei produced per unit time. There are practically a limitless number of combinations of the above variables and only a few of these have been tested. One set of the variables which yielded very high nucleus counts in 1972 was as follows: a

Delavan Manufacturing Co. WDB 4.0 gph, 30^{o} nozzle, a solution pressure of 100 pounds per square inch, a solution 5.4% by weight of silver iodide and an airspeed of 100 knots (51 meters per second). This combination resulted in 9.3 grams of silver iodide being dispensed per minute. For the 1975 tests, the same set of variables was employed. Of course, different batches of "weather modification grade" silver iodide and ammonium iodide were used to prepare the solution, and, in addition, it should be noted that a new WDB 4 gph nozzle resulted in a slightly higher (~2%) solution flow rate.

Table 1 shows a summary and comparison of the results of the 1972 and 1975 tests. The values given are averages of at least two tests at these temperatures. These results along with those of Blair (1974) show that the proper combustion of a silver iodide and ammonium iodide in acetone solutions results in very large numbers of ice nuclei per gram of silver iodide effective in the important temperature range between -5C and -10C.

TABLE 1

Summary of Tests Results for the Airborne Jet Seeder

Cloud Chamber Temperature (C)	Nucleus Counts Per Gram of Silver Iodide	
	1972	1975
-5	1.5×10^{12}	2×10^{12}
-7	-	1.5×10^{13}
-7.5	3×10^{13}	-
-8	-	2×10^{13}
-10	3×10^{13}	2×10^{13}
-15	5×10^{14}	2×10^{14}

Agreement to within a factor of 2.5 was achieved at all temperatures. The most striking similarity in the two sets of data is the plateau in the effectiveness curves for temperatures between -7C and -10C. For the 1972 data this plateau is about 1.5 times higher than that for the 1975 data. The good agreement between the 1972 and 1975 data confirms the reproducibility of the ice nucleus test procedures employed at the Cloud Simulation and Aerosol Laboratory and the stability of the jet seeder ice nucleus output when using one specific set of jet seeder variables.

REFERENCES

Blair, D. N., 1974: Flame temperature effects on AgI nuclei produced from acetone generators. J WEA MOD, 6, pp. 238-245.

Carroz, J. W., 1973: Airborne jet seeder solution burner. J WEA MOD, 5, pp. 166-177.

Davis, B. L. and L. R. Johnson, 1974: An explanation for the unusual nucleating ability of aerosols produced from the AgI-NH_4I-acetone system. Preprints Fourth Conf. Wea. Mod., Fort Lauderdale, Florida, AM METEOR SOC, pp. 218-223.

Donnan, J. A., D. N. Blair, W. G. Finnegan and P. St.-Amand, 1970: Nucleation efficiencies of AgI-NH_4I and AgI-NaI acetone solutions and pyrotechnic generators as a function of LWC and generator flame temperature, a preliminary report. J WEA MOD, 2, pp. 155-164.

Garvey, D. M., 1974: Testing of cloud seeding materials at the cloud simulation and aerosol laboratory, 1971-1973. Preprints Fourth Conf. Wea. Mod., Fort Lauderdale, Florida, AM METEOR SOC, pp. 176-182.