NATIONAL BUREAU OF STANDARDS REPORT

4978

PERFORMANCE TESTS OF A MICROMAT
DRY-TYPE AIR FILTER

by

Thomas W. Watson
Henry E. Robinson

Report to
General Services Administration
Public Buildings Service
Washington 25, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Radio Standards. Radio Frequencies. Microwave Frequencies. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Calibration Center. Microwave Physics. Microwave Circuit Standards.

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Thomas W. Watson
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Heating and Air Conditioning Section
Building Technology Division

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1. INTRODUCTION*

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of dry-type air filters were determined to provide information to assist in the preparation of new air filter specifications.

The test results presented herein were obtained on a specimen dry-type air filter submitted by its manufacturer at the request of the Public Buildings Service and included determinations of dust arresting efficiency with two aerosols (atmospheric air and Cottrell precipitate), pressure drop and dirt load.

2. DESCRIPTION OF THE FILTER SPECIMEN

The filter was manufactured by the Microtron Corporation of Charlotte, North Carolina, and was of the renewable media type, identified as a standard "Micromat" air filter, 20 x 20 x 2 inches in nominal size. The filter consisted of a flat sheet of media approximately 20 inches square held in place in the filter frame by a spring clamp at the edges on the upstream face and supported on the downstream side by 2 3/4 x 1 1/8-inch expanded metal mesh. The filter had actual outside dimensions 19 5/8 x 19 11/16 x 2 inches, leaving a free opening 17 1/2 inches square (2.18 ft^2) and weighed 4.8 pounds when clean. Two types of media were submitted and were identified as three ounce per square yard Micromat media and two ounce per square yard Micromat media.

*This report is submitted for information only, and is not released for use in connection with advertising or sales promotion.

3. TEST METHOD AND PROCEDURE

Efficiency determinations were made by the NBS "Dust-Spot Method" using the following aerosols: (a) outdoor atmospheric air drawn through the laboratory without addition of other dust or contaminant; and (b) Cottrell precipitate, dispersed in the outdoor atmospheric air. The test method is described in the paper "A Test Method for Air Filters" by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

For these tests, the filter was installed in the apparatus and the desired rate of air flow through the cleaner was established. Samples of air were drawn from the center of the test duct, at points one foot upstream and eight feet downstream of the filter and passed through known areas of Whatman No. 41 filter paper. The areas of the filter papers used upstream and downstream and the times during which the air was sampled upstream and downstream were selected experimentally so that the change in transmission of light through the two filter paper spots would be about the same. The filter efficiency was calculated by means of the formula

$$\text{Efficiency, percent} = 100 \left[1 - \frac{A_2}{A_1} \cdot \frac{O_2}{O_1} \cdot \frac{T_1}{T_2} \right]$$

where A represents the dust spot area, O the change in light transmittance of the filter paper as measured before and after the deposition of dust, and T the time during which the air sample was drawn. Subscripts 1 and 2 refer to the upstream and downstream positions, respectively.

Three efficiency-measuring techniques or modifications based on the above formula were used, depending on the apparent efficiency of the filter with the different aerosols. For the tests made, techniques L, M and N were used, as indicated in table 2.

All light transmission measurements were made with the photometer illumination at a constant intensity as determined by measurement on a reference of constant transmission characteristics. The filter papers used upstream and downstream were selected to have equal light transmissions when clean.

The efficiency of the filter in arresting particulate matter in atmospheric air was determined by means of three tests of the M and L types, as described in table 2, with the filter clean. Following these, the efficiency of the filter in arresting Cottrell precipitate was measured by means of two N-type tests, after which was begun the process of loading the filter with a mixture of four percent of cotton lint and 96 percent of Cottrell precipitate, by weight, separately dispersed in the air stream. The lint used for this purpose was No. 7 cotton linters previously ground in a Wiley mill with a four-millimeter screen. At suitable periods as the loading progressed, the efficiency of the filter was determined using Cottrell precipitate in outdoor air. Pressure drops were recorded at intervals during the test. The dirt-loading was continued until the pressure drop increased to approximately 0.50 inch W. G. The efficiency was again determined with Cottrell precipitate and then with atmospheric air as the aerosols.

4. TEST RESULTS

Table 1 presents data as to the pressure drop of the clean filter at several rates of air flow for both the two-ounce and three-ounce media.

The performance of the filter for the two types of media at 800 cubic feet per minute is summarized in table 2 for two aerosols. The performance of the filter in regard to aerosol C (Cottrell precipitate in atmospheric air) is also shown graphically in figure 1. The efficiency of the filter in arresting aerosol A (atmospheric particulate matter), both initially, and after its pressure drop had been increased by dirt-loading to 0.5 inch W. G., is indicated in table 2.

Observation of the filters at the end of the dirt-loading tests revealed that the greater part of the arrested lint was found on the upstream faces and had not penetrated the media to any noticeable degree. The downstream faces of the media were uniformly darkened by dust. No lint was observed on the downstream face of either filter.

After the filters had been removed from the test duct, the section of the duct five feet long downstream of the unit, and upstream of a 3/4-inch wood strip fastened flat across the bottom of the test duct, was carefully swept out with a fine brush. The amount of material obtained from the duct by this sweeping was 1.2 grams or 2.9 percent for the three-ounce media, and 8.1 grams or 8.8 percent for the two-ounce media, of the dust load reaching the filter. This material consisted for the most part of large dust particles, and constituted the fall-out in the first five feet of the duct from the air passed through the filter.

Cellophane tapes, stretched across the test duct downstream of the filter with the adhesive side facing upstream, indicated upon visual and microscopic examination after exposure to the air stream that some particles of sizes up to approximately 125 microns had passed through each media in the dirt-loading tests. Particles smaller than five microns were observed in quantity by microscopic examination of the downstream filter papers obtained in tests on the two filters with each of the aerosols. No lint was observed on the tapes downstream of either filter during these tests.

At the conclusion of the dirt-loading tests, cellophane tapes also indicated that there was some release or escape of Cottrell precipitate from the media of the filters (see table 2) during the efficiency tests with atmospheric air as the aerosol. For the two-ounce media, this is also shown by the negative efficiency value and the pressure drop decrease from 0.515 to 0.505 inches W. G. as noted in table 2.

Table 1

Pressure Drop of Clean Filter

Air Flow cfm	Air Velocity Through Media fpm*	Pressure Drop, Initial inch, W. G.	
		2-oz. Media	3-oz. Media
1000	419	0.348	0.450
800	367	.250	.320
600	275	.158	.213

*Based on free face area of nominal 20 x 20-inch filter (2.18 ft^2)

Table 2

Performance of Filter at 800 CFM

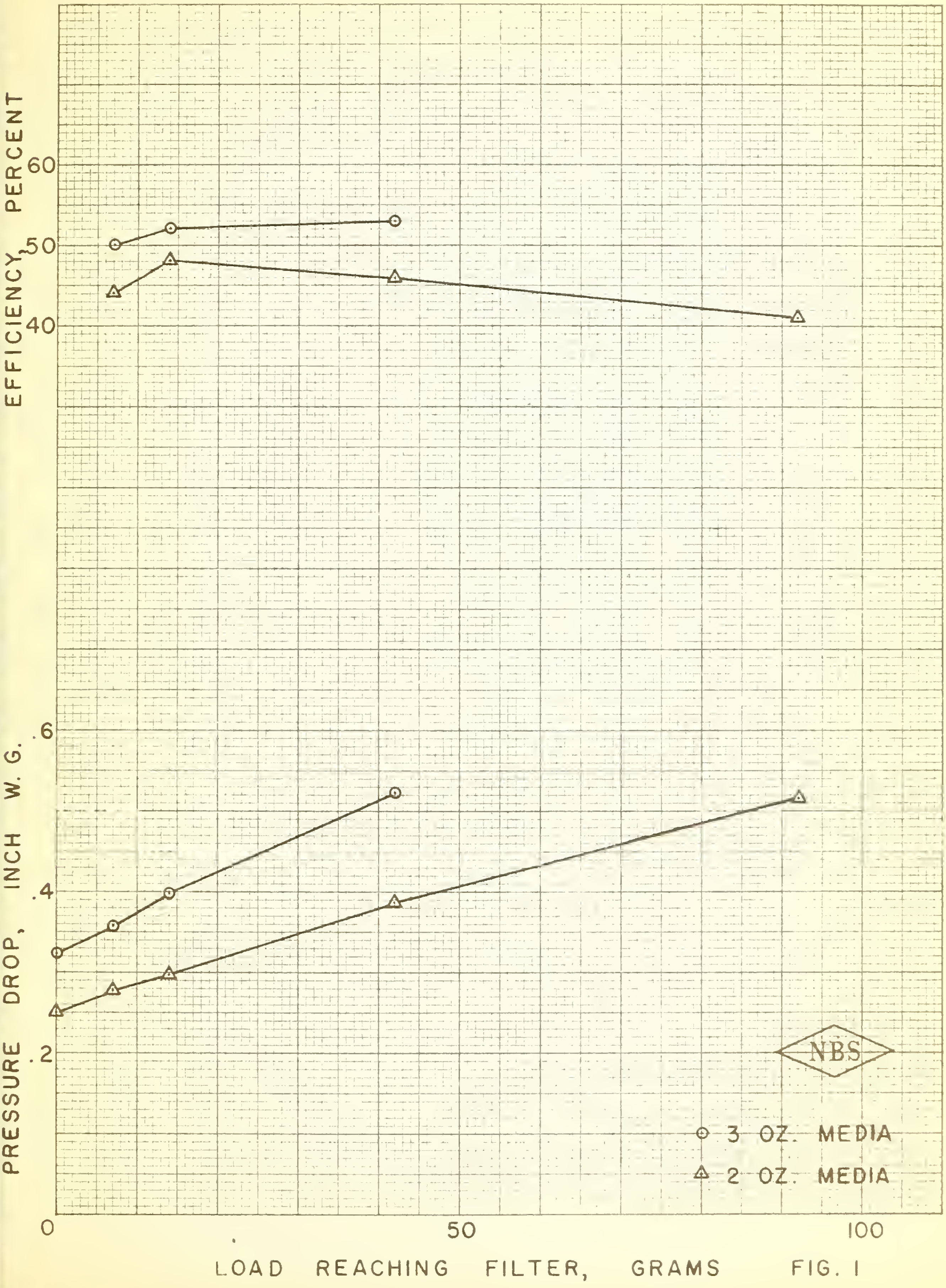
Aerosol (1)	Total Dirt Load (2) grams	Pressure Drop inch W. G.	Eff. Meas. Technique (3)	Efficiency percent
		3-ounce Micromat Media		
A	-	0.323	M	22
	-	.360 (4)	M	15
	-	.362 (4)	L	20
C	7	.359	N	50
	14	.398	N	52
	42	.523	N	53
A	42	.528	M	15
		2-ounce Micromat Media		
A	-	0.250	M	6
C	7	.278	N	44
	14	.298	N	48
	42	.388	N	46
	92	.515	N	41
A	92	.505	M	-11

(1) Aerosol A: Particulate matter in atmospheric air at NBS.
Aerosol C: Cottrell precipitate in atmospheric air (1 gram per 1000 cubic feet).

(2) Average mixture: 4.0 percent lint, 96.0 percent Cottrell precipitate by weight.

(3) Efficiency measuring technique:
L: Air sampled at equal rates through equal areas; upstream sampling time selected to yield approximately equal dust-spot opacities of the upstream and downstream filter papers.
M: Air sampled at equal rates through equal areas for equal times.
N: Air sampled at equal rates for equal times; downstream areas selected to yield approximately equal dust-spot opacities of the upstream and downstream filter papers.

(4) A different piece of 3-ounce media was used for these two measurements after completion of the tests using the first 3-ounce media.



EFFICIENCY, PERCENT
60
50
40
PRESSURE DROP, INCH W. G.
.6
.4
.2
0
50
100
NBS
3 OZ. MEDIA
2 OZ. MEDIA
LOAD REACHING FILTER, GRAMS

FIG. I

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($0.75), available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Inquiries regarding the Bureau's reports should be addressed to the Office of Technical Information, National Bureau of Standards, Washington 25, D. C.

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