NATIONAL BUREAU OF STANDARDS REPORT

4505

PERFORMANCE TESTS OF A DOLLINGER
MODEL WKE-8 DRY PANEL FILTER

by

Henry E. Robinson
Thomas W. Watson

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

NBS

U. S. DEPARTMENT OF COMMERCE
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- Office of Basic Instrumentation
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Heating and Air Conditioning Section
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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 Dollinger Corporation of Rochester, New York, and was of the renewable media type, identified as a "Model WKE-8 Dry Panel Filter". The filter cell and frame had overall dimensions of 24x24x8 3/8 inches deep, and had six ply flameproofed Feltex paper filtering media (6 PF), 26 inches wide, arranged in vee-folds approximately 5 1/2 inches deep, supported downstream by a 4-mesh wire retaining screen and held in place in the troughs by thin retaining strips supported by the top or upstream section of the frame. The upstream face of the filter was covered by an 8-mesh flat screen and had a net face area of 3.46 sq. ft. The area of the medium effective for filtering was approximately 24 sq. ft. and the length of paper medium required for one filling of the frame was 14 ft. 2 in.

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,

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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 two tests of the L and M 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 4-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.

The performance of the filter at 1000 cfm is summarized in Table 2, for both aerosols A and C. 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 resistance had been increased to 0.5 inch W.G., is indicated in Table 2.

Observation of the media at the end of the dirt-loading test revealed that the greater part of the arrested dirt was found uniformly distributed on the upstream face. The downstream face of the media was slightly darkened by dust. No lint was visible on the downstream face of the media.

After the unit 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 6.5 grams, consisting chiefly of relatively large dust particles.

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 up to approximately 80 microns in size had passed through the filter during the dirt-loading tests. Particles smaller than five microns were observed in quantity by microscopic examination of the downstream filter papers obtained in tests with both aerosols. No lint was observed on the tapes during these tests.

It was observed in the test on atmospheric air following the dirt-loading tests that some large dust particles up to 75 microns in size were caught on cellophane tapes exposed downstream of the filter. These particles had apparently been released from the dirt burden on the media. The atmospheric air efficiency, however, was nevertheless considerably greater than it was found to be initially with clean filter media.

TABLE 1

PRESSURE DROP OF CLEAN FILTER

Air Flow	Air Velocity Through Media	Pressure Drop
cfm	fpm	inch W.G.
1200	50	0.130
1000	42	.101
800	33	.074
600	25	.051

TABLE 2

PERFORMANCE OF FILTER AT 1000 CFM

Aerosol (1)	Total Dirt Load (2)	Pressure Drop	Eff. Meas. Technique (3)	Efficiency
	grams	inch W.G.		percent
A	-	0.105	L	14
	-	.107	M	10
C	9	.113	N	80
	19	.117	N	82
	67	.142	N	80
	183	.199	N	85
	279	.262	N	87
	395	.355	N	86
	512	.495	N	86
	522	.500	N	87
A	522	.507	M	26

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

(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.

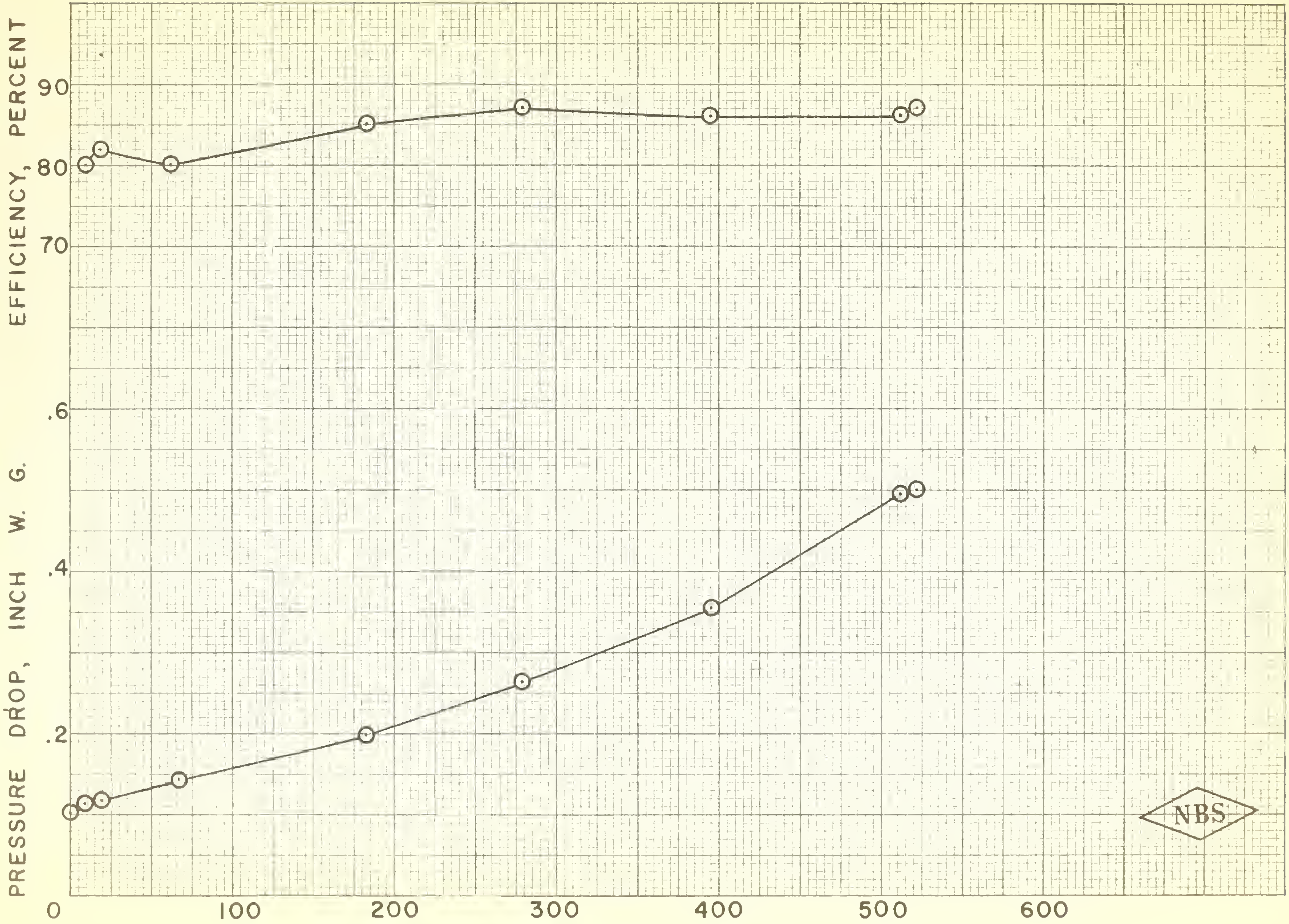
EFFICIENCY, PERCENT
90
80
70
.6
.4
.2
PRESSURE DROP, INCH W. G.
0
100
200
300
400
500
600
LOAD REACHING FILTER, GRAMS
NBS

FIG. 1

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. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.

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