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NATIONAL BUREAU OF STANDARDS REPORT

8571

PERFORMANCE TEST OF THE "KLEEN-AIR" GLASS FIBER
AUTOMATIC RENEWABLE FILTER MEDIA

manufactured by
the B & M Filter Sales & Service, Inc. of Houston
Texas

by

Joseph C. Davis and Paul R. Achenbach

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

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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* NBS Group, Joint Institute for Laboratory Astrophysics at the University of Colorado.
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IMPORTANT NOTICE

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1. Introduction

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of the "Kleen-Air" glass fiber roll-type filter media, manufactured by the B & M Filter Sales and Service, Inc. of Houston, Texas, were determined. The scope of the investigations included the determination of the arrestance of Cottrell precipitate diffused into the laboratory air, and the dust-holding capacity when the face velocity was maintained at 500 ft/min and while the media was intermittently advanced with a maximum setting for the pressure drop across the media of 0.5 in. W.G. Three different rolls of the media, each having been processed with a different amount of tricresylphosphate adhesive were investigated. A complete test was performed only on roll No. 2.

2. Description of Test Specimen

Each roll of the media was manufactured and supplied for test purposes by the B & M Filter Sales and Service, Inc. of Houston, Texas. The media was 32 inches wide and 2 in. thick, and was blue in color. It had a 4x4 mesh scrim backing on the downstream side of the media which, according to the manufacturer, was fire-retardant and mildew-proof. The purpose of the scrim backing was to provide support for the media during operation, in order to reduce deflection and tearing of the media and possible breakage of the glass fibers. The media was composed of spun glass fibers bonded with an organic bonding agent. According to the manufacturer, each roll was processed with a different amount of adhesive. The amount of adhesive on the three rolls as claimed by the manufacturer and as measured by the National Bureau of Standards is summarized in Table 1.

Table 1

	Unit Weight of T.C.P. added during man'f'ng g/ft^2	Unit Weight As Determined in the NBS Lab. g/ft^2
Roll No. 1	8	5
Roll No. 2	11	5
Roll No. 3	16	11

The disparity between the two columns of unit weights cannot be exactly accounted for. It is probable that most of it was caused by losses during shipment when some of the adhesive drained into a polyethylene bag covering the roll, by drainage due to gravity when the roll was under test and by handling during the cutting of the specimen to be analyzed. In the NBS analysis, determinations were made using two adjacent specimens, each having an area of 2x6 in. A Soxlett Extractor was used with absolute alcohol as the solvent. The unit weight of adhesive application was probably determined in the factory by measurement of the total amount of adhesive sprayed on a full roll. Thus the application may not be entirely uniform and small specimens may not be representative of the average.

Infrared analyses showed that the adhesive on all three rolls was tricresylphosphate (T.C.P.). Microscopic examination of the fibers indicated that the fibers in the main body were between 2 and 6.5 microns in diameter. The length of these fibers ranged from about 3 to 10 inches. The approximate unit weight of the mat, including scrim, was about 38 gram/ft^2.

3. Test Method and Procedure

The media on each roll was tested at a net face velocity of 500 ft/min. The arrestance determinations were made using the "NBS Dust Spot Method for Air Filters" (ASHVE Transactions, Vol. 44, p. 379, 1938). For the test, the roll of media was installed in a roll-filter frame constructed to fit the NBS test apparatus. This apparatus provided an airtight enclosure and adapters to fit the upstream and downstream sections of the test duct. This roll-filter frame has been used previously for testing various media of this type.

The frame had two openings, 2 ft x 2 ft, one upstream and the other downstream from the filter. The roll of filter media was placed at the top of the frame on a spool and arranged so the media passed immediately behind the downstream opening as it unrolled. The loaded media was rolled up on a similar spool at the bottom of the frame. The bottom spool was driven by a motor actuated manually when the pressure drop across the media reached 0.5 in. W.G. Nine vertical bars in the downstream opening served to prevent appreciable deflection of the media under the influence of the air pressure difference. The edges of the media were enclosed in metal groove-type tracks to restrict by-pass of air between the media and frame.

The frame and media were installed in the dust spot test apparatus and carefully sealed to prevent any by-pass of air or inward flow into the test apparatus, except through the measuring orifice. After establishing the correct air flow rate through the filter, samples of air were drawn from the center points of the test duct two feet upstream and eight feet downstream of the test specimen at equal rates and passed through known area of Whatman No. 41 filter paper. The arrestance determinations were made with Cottrell precipitate injected into the air stream with a ratio of one gram of dust per 1,000 cu ft of air.

The light transmission of the sampling papers was measured before and after the test on the same area of each paper, and the two sampling papers used for any one arrestance determination were selected to have the same light transmission when clean.

For determining the arrestance of the filter, different size areas of sampling paper were exposed upstream and downstream of the filter in order to obtain a similar increase of opacity on the two sampling papers. The arrestance was calculated by the formula:

$$A = \left(1 - \frac{S_D}{S_U} \times \frac{\Delta D}{\Delta U}\right) \times 100$$

where the symbols S_U and S_D are the upstream and downstream sampling areas and ΔU and ΔD are the observed changes in the opacity of the upstream and downstream sampling papers, respectively.

Arrestance determinations were made when the media was clean at the beginning of the test, and at selected intervals of loading until the intermittent advance of the media became representative of a steady-state operation. The arrestance determinations were made with Cottrell precipitate only, while cotton linters were added during the loading process in a ratio of 4 parts to every 96 parts of Cottrell precipitate, including the Cottrell precipitate used for arrestance measurements. The Cottrell precipitate had been previously sifted through a 100-mesh screen and the lint was prepared by grinding No. 7 cotton linters through a Wiley mill with a 4-millimeter screen.

The advance of the filter media was observed through a window in the test apparatus by determining the position of a marker, attached to the mat, relative to a yardstick mounted in the filter housing, adjacent to the mat. A pilot light connected in parallel with the electric motor enabled the operator to note the position of the media and to record the pressure drop across the medium at the beginning and at the end of each advance cycle. The advance cycle, which was actuated by a manually operated switch, began when the pressure drop across the filter reached approximately 0.50 in. W.G. and stopped when the drop was about 0.45 in. W.G.

The position of the media at the beginning of each advance cycle was recorded as well as the corresponding cumulative dust load at the time of advance. From this information a plot was made of the advance of the media vs. dust load, and when the relation between the two parameters became very nearly linear, more determinations of advance as related to load were made, from which it was possible to draw a straight line from which the dust-holding capacity in grams/ft^2 was determined.

The pressure drop across the media was recorded at the beginning of the test, after each arrestance determination, after introduction of each 20-gram increment of Cottrell precipitate and lint into the test duct, and at the beginning and end of each advance cycle.

4. Test Results

Tests on the first roll were not completed when it became evident that the dust-holding capacity would be considerably lower than 200 g/ft^2, the minimum value specified by the General Services Administration for Type E, roll-type media. Tests on the second roll were completed, but since the value for dust-holding capacity was only slightly below 200 g/ft^2, a third roll having appreciably more T.C.P. adhesive was tested.

The initial results of the tests on the third roll, however, showed that the roll had a lower dust-holding capacity than the second, and the tests were discontinued. During the test of the third roll, the dust, due to the heavy concentration of adhesive, failed to penetrate into the media and rapidly formed a film on the upstream face which caused the pressure drop to rise rapidly to 0.50 in. with a relatively low dust load. This situation militated against a high dust-holding capacity and preliminary observations indicated a very low capacity.

Following this initial test run on the third roll, the roll was advanced about 10 ft to new clean media, and the same procedures followed. The performance observed for the two portions of the third roll, approximately 10 feet apart, was essentially the same.

The test results obtained on the second roll of the "Kleen-Air" media at the design air flow rate of 2000 cfm are summarized in Tables 2 and 3.

Table 2

Performance of the "Kleen-Air" Roll Filter Media at an Air Flow Rate of 2000 cfm

Cumulative Dust Load	Total Advance of Media	Pressure Drop	Arrestance
grams	inches	in. W.G.	percent
0	0	0.200	69.0
629	15.75	0.504	85.2
883	24.00	0.502	84.1
1012	28.00	0.450	84.4
1157	32.50	0.448	85.0
1295	36.50	0.450	84.9

It will be noted that the arrestance of the clean filter media of the second roll was 69 percent and the average arrestance under steady-state conditions was 84.7 percent using Cottrell precipitate in the laboratory air as the aerosol.

Table 3

Dust Load, Mat Travel, and Pressure Drop of "Kleen-Air" Glass Fiber Media

Dust Load grams	Mat Travel inches		Pressure Drop, In. W.G.	
	Advance	Total	Before Advance	After Advance
0	0	0	0.200	---
754	2.00	20.00	0.494	.452
816	2.00	22.00	0.500	.452
883	2.00	24.00	0.502	.448
945	2.00	26.00	0.496	.450
1012	2.00	28.00	0.498	.450
1085	2.50	30.50	0.496	.448
1158	2.00	32.50	0.498	.448
1224	2.25	34.75	0.500	.468
1287	1.75	36.50	---*	.450
1378	2.00	38.50	0.502	.450

*Value unknown

The first movement of the media was approximately 5 1/4 inches and was initiated when the dust load was 375 grams and the pressure drop was 0.498 in. W.G. The pressure drop at which advance cycles were initiated after steady-state conditions had been reached (at 754 grams) ranged from 0.494 to 0.502 in. W.G. The average was 0.498 in. W.G. At the end of the advance cycles, the pressure drops ranged from 0.448 to 0.468 in. W.G. with an average of 0.452 in. W.G.

The graph of Figure 1 shows the performance of the media for the observations taken after steady-state conditions were established. It will be noted that some of the individual points of observation do not lie on the straight line. These deviations occurred partly because the advance distance could be observed on the scale only to the nearest quarter-inch mark, and partly because it was not possible always to close or open the manually-operated switch at exactly identical pressure drop values. It is shown in the slightly extrapolated straight line of Figure 1 that after 20 inches of mat travel, the dust load was 750 g. and after 39.7 in. of travel, the dust load was 1400 g. Thus, a mat travel of 19.7 in. was caused by the introduction of 650 g. of dust. The dust-holding capacity of the media was calculated by dividing the dust load increment by the incremental length of advance in feet and by the width of the media.

$$\text{Dust-holding capacity} = \frac{650}{2} \times \frac{12}{19.7} = 198 \text{ g/ft}^2$$

Because the value for dust-holding capacity was very close to the requirement of 200 g/ft^2, a "best fit" of a straight line through the ten points was determined with the use of the "least-squares" technique. Using this line for the calculation, the value for dust-holding capacity was found to be 198 g/ft^2, a value which agreed with that obtained with the use of the line on the graph.

The performance values determined for the best of the three rolls of media submitted were 84.7 percent average arrestance and 198 g/ft^2 dust-holding capacity. The current General Services Administration requirement for average arrestance when Cottrell precipitate is used as the test dust, is 75 percent and for the dust-holding capacity, 200 g/ft^2.

USCOMM-NBS-DC

MAT TRAVEL VERSUS DUST LOAD
"KLEEN-AIR" GLASS FIBER AUTOMATIC
RENEWABLE FILTER MEDIA

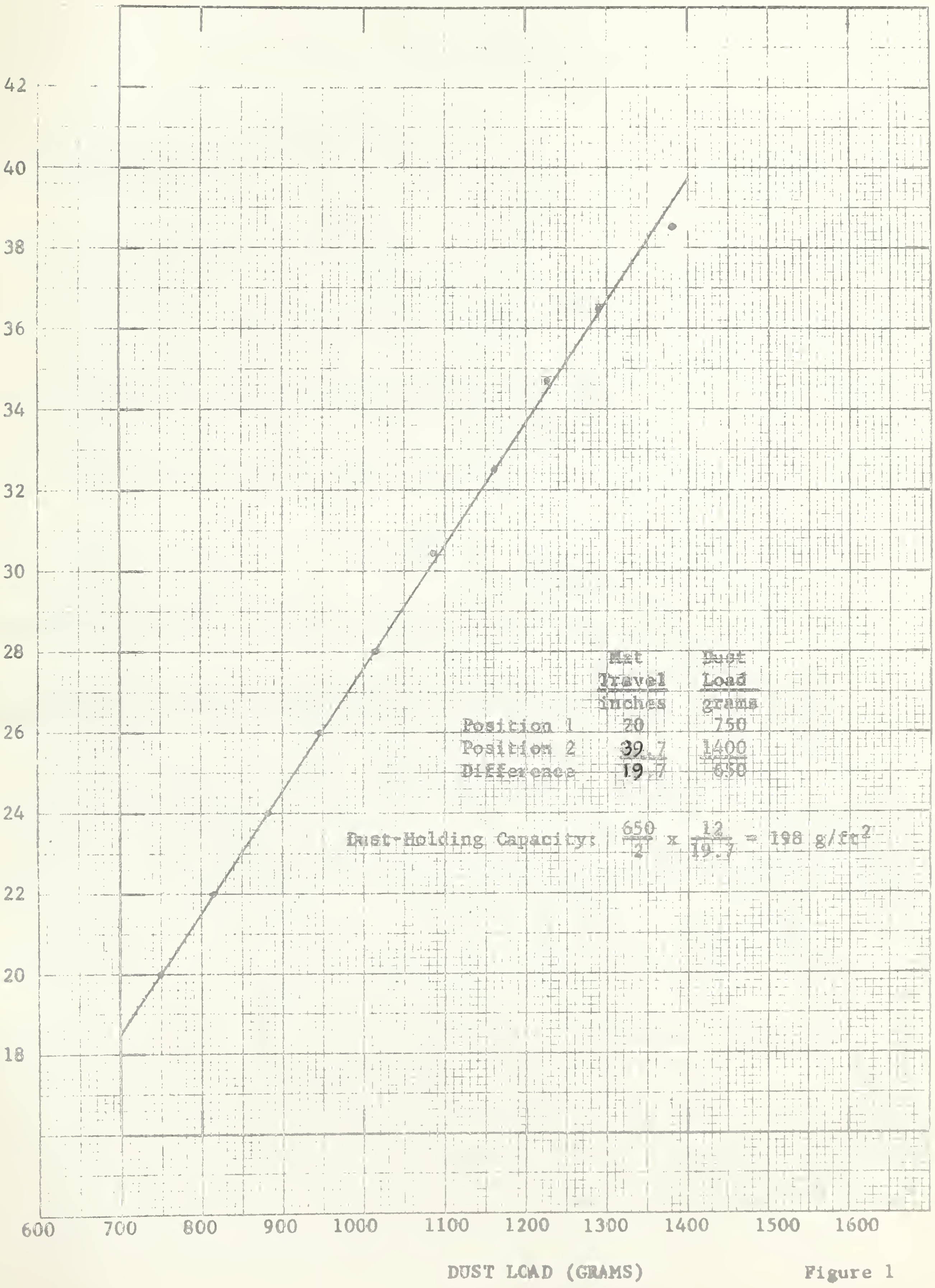

Figure 1

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