NATIONAL BUREAU OF STANDARDS REPORT

7555

PERFORMANCE TEST OF THE BLUE BALANCE TYPE
AUTOMATIC RENEWABLE FILTER MEDIA

supplied by
Electro-Air Cleaner Company
McKees Rocks, Pennsylvania

by

Carl W. Coblentz 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 PROJECT		NBS REPORT
1003-30-10630	July 20, 1962	7555

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Carl W. Coblentz and Paul R. Achenbach
Mechanical Systems Section
Building Research Division

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1. Introduction

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of an automatic renewable air filter media, identified as Blue Balance media, was determined. The scope of this examination included the determination of the arrestance and the dust-holding capacity of the media when operated at a face velocity of 500 ft/min and at a pressure drop not to exceed 0.5 in. W.G. The arrestance was determined of Cottrell precipitate and also of the particulate matter in the laboratory air.

2. Description of Test Specimen

The roll of filter media was supplied by the Electro-Air Cleaner Company of McKees Rocks, Pennsylvania. It was produced by the Standard Electric Company of San Antonio, Texas, and identified as the Blue Balance type media for automatic renewable media air filters. The media was supplied in a 3 ft wide roll, approximately 65 ft long. The mat was made of glass fiber, of blue color, and was about 1 3/4 in. thick. The fibrous mat was looser at the upstream face of the media than at the downstream side. The fibers were bonded with an organic binder and treated with an adhesive, said to be tricresyl phosphate. The weight of the mat was approximately 32 grams per square foot and a microscopic examination indicated that most of the fibers were between 30 and 50 microns in diameter and several inches long.

The media was tested on an "Auto Roll" filter frame, manufactured by the Electro-Air Cleaner Company, which had been modified for installation in the National Bureau of Standards air filter test apparatus. The modification consisted mainly of a complete sheet metal enclosure which covered the clean roll of media at the top of the filter frame as well as the loaded media wound on the lower roll, and two flanges that permitted an airtight connection to the two sections of the test duct. The air flow passage was 24 in. square and had a vertical stationary grid on the downstream side of the mat to prevent excessive deflection of the media. The advance of the filter mat was controlled by a pressure switch which closed an electric circuit when the pressure drop across the filter approached 0.5 in. W.G. The pressure switch had a fixed differential setting and operated an electric motor that was connected to the lower spool.

3. Test Method and Procedure

The filter media was tested at the rated face velocity of 500 ft/min. The arrestance determinations were made in accordance with the NBS Dust Spot Method described in a paper by R. S. Dill entitled "A Test Method for Air Filters" (ASHVE Transactions, Vol. 44, p. 379, 1938). The filter under test was installed in the test apparatus and carefully sealed to prevent any by-pass of air or inward air 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 2 feet upstream and 8 feet downstream of the test specimen at equal rates and passed through known areas of Whatman No. 41 filter paper. Arrestance determinations were made periodically with the particulate matter in the laboratory air as the aerosol and also with Cottrell precipitate injected into the air stream at a ratio of 1 gram per 1,000 cu ft of air.

The light transmission of the sampling papers was measured on the same area of each paper before and after the test 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 particulate matter in the laboratory air, equal sampling areas were used in the upstream and downstream samplers. A similar increase of the opacity of the two sampling papers was obtained by passing the sampling air through the upstream paper only part of the time while operating the downstream sampler continuously. This was accomplished by installing one solenoid valve in the upstream sampling line and another one in a line by-passing the sampler. The solenoid valves were operated by an electric timer and a relay so that one was open while the other one was closed during any desired percentage of the 5-minute timer cycle, reversing the position of the two valves during the remainder of the cycle. The arrestance, A (in percent), was then determined with the formula:

$$A = 100 - T \times \frac{\Delta D}{\Delta U}$$

where T is the percentage of time during which air was drawn through the upstream sampler, and ΔU and ΔD are the observed changes in the opacity of the upstream and downstream sampling papers, respectively.

For determining the arrestance of the filter with Cottrell precipitate as the test dust, different size areas of sampling paper were used upstream and downstream of the filter in order to obtain a similar increase of opacity on both sampling papers. The arrestance was then calculated by the formula:

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

where the symbols A, ΔU and ΔD are the same as indicated above and S_U and S_D are the upstream and downstream sampling areas, respectively.

Arrestance determinations were made with Cottrell precipitate when the media was clean, at intervals thereafter during the loading of the initially-exposed section of media, and several times after incremental advance of the media began. The media was loaded with cotton linters and Cottrell precipitate in the ratio of 4 to 96 parts by weight. When an arrestance determination was made with Cottrell precipitate, the linters were not added, but this interruption in linter addition was compensated for later to maintain the selected ratio of the two contaminants. 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 pressure drop across the filter media under test was observed and recorded after each arrestance determination, after introduction of each 20-gram increment of Cottrell precipitate into the test duct, and at the beginning and end of each advance cycle.

4. Test Results

The test results are summarized in Tables 1 and 2. Table 1 shows the arrestance values for Cottrell precipitate as the initially-exposed section of media was being loaded and at a later time when the media was being advanced incrementally. The pressure drop of the clean mat at the rated face velocity of 500 ft/min was 0.210 in. W.G. and the initial arrestance of Cottrell precipitate was 68 percent. It will be noted, that the arrestance increased with the pressure drop and that the arrestance of Cottrell precipitate ranged from 78 percent to 82 percent for pressure drop values between 0.4 and 0.5 in. W.G., averaging 80 percent. The arrestance of the particulate matter in the laboratory air at 0.436 in. W.G. pressure drop was 12 percent.

Table 2 shows the mat travel, the dust load, and the pressure drop across the filter before and at the end of each advance of the media. It was found that the increments of mat travel varied between 2 1/2 in. and 4 in., averaging 3.16 in.

The cumulative dust load values in Table 2 are expressed in grams per foot width and represent the amount of Cottrell precipitate and lint introduced into the test apparatus. The "Dust-Holding Capacity" provides a relative measure of the rate of media consumption under operating condition. The observed dust load values were plotted against the cumulative advance of the media in Figure 1 and the dust-holding capacity was determined as the slope of a line through the plotted points. The dashed line in Figure 1 indicates the average dust-holding capacity obtained by using all of the data for mat travel and dust load beginning with a mat position of 17 in. and ending with a total mat movement of 69 1/2 in. The dust-holding capacity for the over-all operation was 200 g/sq ft.

An inspection of Table 2 shows that the increments of mat travel were not entirely consistent. Also the change in the pressure drop caused by advancing the mat varied from 0.052 to 0.100 in. W.G. at different periods during the test. In particular, the increments of mat travel between mat positions of 17 in. and 25 in. and between 58 1/2 in. and 69 1/2 in. were below the average, and the change in pressure drop during these same periods was below average. The slope of lines faired through the plotted points in Figure 1 corresponding to these portions of the test is somewhat lower than the dotted line shown for the entire test. The dust-holding capacities indicated by these flatter slopes are 232 and 238 grams/sq ft. These results indicate that a pressure switch with a smaller pressure differential would provide an appreciably higher dust-holding capacity in any given case. Discounting the first two increments of mat travel for this specimen, the average effective differential of the pressure switch was 0.080 in. W.G. for this test.

Probably the average dust-holding capacity of 200 grams/sq ft computed for the mat travel from 17 in. to 70 in. is a more reliable measure of the performance of the test specimen than the two short periods of better performance.

Table 1

PRESSURE DROP AND ARRESTANCE OF "BLUE BALANCE" MEDIA

Pressure Drop in. W.G.	Arrestance %	Aerosol*
0.210	68	C
0.212	69	C
0.348	76	C
0.485	78	C
0.486	82	C
0.436	12	A
0.447	79	C
0.460	81	C

*Aerosol A - Particulate matter in laboratory air.
C - Cottrell precipitate in laboratory air.

Table 2

MAT TRAVEL, DUST LOAD, AND PRESSURE DROP
OF "BLUE BALANCE" FILTER MEDIA

Dust Load	Travel of Mat, in.		Pressure Drop, in. W. G.	
g/ft width	Advance	Total	Before Advance	After Advance
208	3	3	0.497	0.445
240	2 1/2	5 1/2	0.495	0.435
281	4	9 1/2	0.500	0.415
333	4	13 1/2	0.495	0.415
386	3 1/2	17	0.490	0.410
438	2 1/2	19 1/2	0.495	0.415
490	3	22 1/2	0.497	0.417
542	2 1/2	25	0.495	0.425
573	2 1/2	27 1/2	0.497	0.420
625	4	31 1/2	0.495	0.409
688	3 1/2	35	0.490	0.390
729	3	38	0.489	0.400
781	3	41	0.498	0.410
833	3 1/2	44 1/2	0.490	0.415
885	3 1/2	48	0.488	0.410
937	3	51	0.489	0.410
989	3 1/2	54 1/2	0.500	0.410
1041	4	58 1/2	0.496	0.410
1104	2 1/2	61	0.495	0.425
1156	3 1/2	64 1/2	0.495	0.423
1208	2 1/2	67	0.500	0.430
1260	2 1/2	69 1/2	0.498	0.429

MAT TRAVEL VS DUST LOAD

OF

BLUE BALANCE MEDIA

supplied by

Electro-Air Cleaner Company

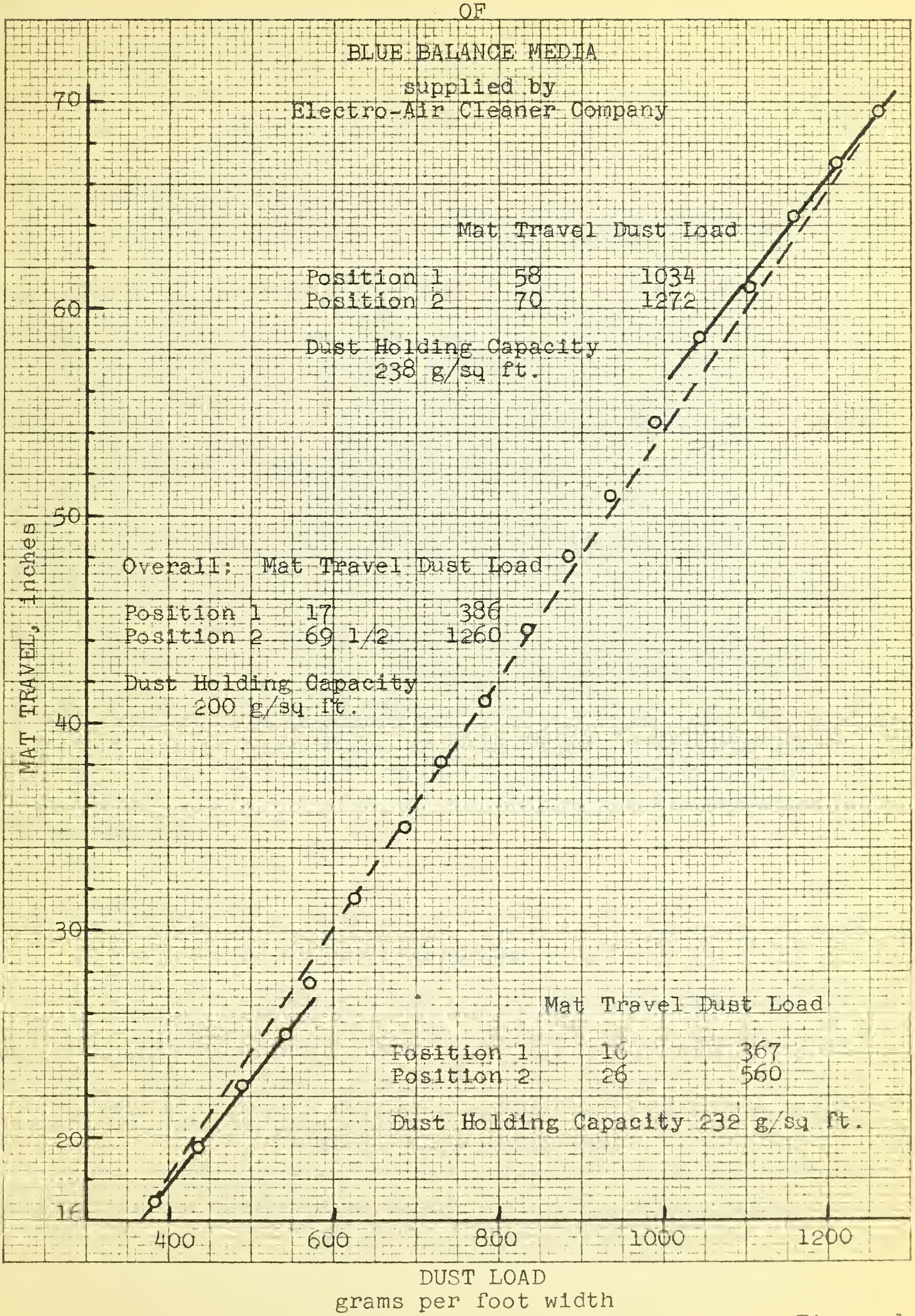

Figure 1

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Microscopy and Diffraction. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering Laboratory. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Physics. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Millimeter-Wave Research.

Circuit Standards. High Frequency Electrical Standards. Microwave Circuit Standards. Electronic Calibration Center.

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