NATIONAL BUREAU OF STANDARDS REPORT

7597

PERFORMANCE TEST OF THE FILTREX TYPE GFC-3
AUTOMATIC RENEWABLE AIR FILTER MEDIA

manufactured by
Drico Industrial Corporation
Passaic, New Jersey

by

Carl W. Coblentz and Paul R. Achenbach

Report to

Bureau of Facilities
Post Office Department
Washington, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Mechanical Systems Section
Building Research Division

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1. Introduction

At the request of the Post Office Department, Bureau of Facilities, the performance characteristics of two specimen rolls of the Filtrex type GFC-3 automatic renewable air filter media was determined. The scope of this examination included the determination of the arrestance and the dust-holding capacity of the media operated at a face velocity of 500 ft/min and at a pressure drop not exceeding 0.5 in. W. G. The performance of the media was observed using Cottrell precipitate only as the aerosol.

2. Description of Test Specimen

The two rolls of media were manufactured and supplied by the Drico Industrial Corporation of Passaic, New Jersey, and were identified as their Filtrex type GFC-3 automatic renewable air filter media. The media were supplied in rolls 3 ft wide and approximately 65 ft long and were made of glass fiber. The fiber mat was about 2 in. thick when it expanded after unrolling and it was noticeably less dense at the upstream face of the mat than at the downstream side. The fibers appeared to be bonded with an organic binder and were treated with an oily adhesive. A microscopic examination of the fibers indicated that most of them were between 30 and 50 microns in diameter and several inches long.

3. Test Method and Procedure

The media were tested at the rated face velocity of 500 ft/min. The arrestance determinations were made 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 two rolls of media were installed in turn in a

"Conomatic" roll-filter frame manufactured by Continental Air Filters, Inc., of Louisville, Kentucky, for the test. This mechanism was modified for use with the National Bureau of Standards air filter test apparatus by providing it with an air-tight enclosure and adapters to fit the upstream and downstream sections of the test duct. This roll-filter frame had been used previously for testing the manufacturer's own media and was representative of the apparatus used for this type of media. The Conomatic frame equipped with the Filtrex media was installed in the test apparatus and carefully sealed to prevent any bypass of air or inward leakage 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 areas of Whatman No. 41 filter paper. The arrestance determinations were made with Cottrell precipitate injected into the air stream at a ratio of one gram 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 used upstream and downstream of the filter in order to obtain a similar increase of opacity on the two sampling papers. The arrestance was then 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 paper, respectively.

Arrestance determinations were made at the beginning and at the end of the test of each specimen and at several intermediate loading conditions. 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 that amount of 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 pressure drop across the media was recorded at the beginning of the test of each specimen, 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.

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 record the pressure drop across the medium at the beginning and at the end of each advance cycle. The pressure switch was adjusted to commence the advance cycle when the pressure drop reached approximately 0.500 in. W. G.

4. Test Results

The pressure drop and arrestance values determined for the two rolls of media tested are shown in table 1. The first roll had an initial pressure drop of 0.160 in. W. G. and an initial arrestance of 60 percent. Later arrestance determinations made when the medium was being advanced periodically indicated 75 and 79 percent. The dust-holding capacity of this roll did not meet the specified 200 g/sq ft, as will be referred to later. Therefore, the test of this roll of media was discontinued and the manufacturer furnished another roll of media with modified characteristics.

The pressure drop of this second roll, when clean, was 0.125 in. W. G. and its arrestance 67 percent. Eight arrestance determinations, made at pressure drops between 0.460 in. W. G. and 0.498 in. W. G. and averaging 0.483 in. W. G., showed arrestance values from 73 to 75 percent, averaging 74 percent.

Tables 2 and 3 show the observed values of the mat travel, the dust load, and the pressure drop across the media before and after the advances for the first and second rolls, respectively.

Table 2 shows that the first roll received a dust load of 740 g per foot width, or 1480 g total for the 24-in. wide filter area while advancing a total of 46 inches. After an initial advance of 3 in. the mat advanced in 28 steps ranging from 1 in. to 2 in. The pressure drop across the mat at the start of the advance cycle ranged from 0.48 in. W. G. to 0.505 in. W. G. The maximum specified pressure drop of 0.5 in. W. G. was exceeded five times toward the end of the test even though no adjustment of the pressure switch was made.

Table 3 gives the corresponding values for the second roll. A total of 1688 g of dust was used and the medium advanced 22 times for a total of 38 inches, the first time 4 in. and then between 1 in. and 2 in. each time.

The pressure drop at the start of the advance cycle was adjusted to 0.500 in. W. G. during the earlier advance cycles but came up to 0.502 in. W. G. twice towards the end of the test. The pressure drop at the end of the advances was between 0.44 in. W. G. and 0.46 in. W. G., after an initial value of 0.49 in. W. G.

The dust-holding capacity of the specimens was determined as the slope of the straight line that best fitted the points of observation when plotting the mat travel against the respective dust load, as shown in Fig. 1. This figure shows the performance of the media after 1000 g of dust had been introduced into the test apparatus, i.e., 500 g per foot width, and a repetitive cyclic advance of the specimen media had been established. According to this graph, the first roll received 232 grams of dust/ft of width while moving 16 in., from the 30-in. to the 46-in. position, corresponding to a dust-holding capacity of

$$232 \times \frac{12}{16} = 174 \text{ g/sq ft.}$$

The second roll received a dust load of 358 g per foot width while advancing from 19 to 40 in., a distance of 21 in. The dust-holding capacity of this roll was

$$358 \times \frac{12}{21} = 205 \text{ g/sq ft}$$

Table 4 presents a summary of the observed performance data of the two specimens of media and the required values according to applicable federal specifications.

The dust-holding capacity of media of this type increases when the average pressure drop increases and when the individual advance lengths are kept small. During this test the pressure drop was adjusted so close to the maximum of 0.5 in. W. G. initially that this value was exceeded a number of times by a small amount and the advances during the steady state operation averaged approximately 1.5 in. These favorable test conditions were undoubtedly a factor in causing the performance of the test specimens to approach the specification requirements so closely.

Table 1

PRESSURE DROP AND ARRESTANCE OF FILTREX TYPE GFC-3 MEDIA

Pressure Drop, in. W. G.	Arrestance, %
ROLL #1	
0.160	60
0.162	61
0.484	75
0.461	79
ROLL #2	
0.125	67
0.127	67
0.485	75
0.460	74
0.464	74
0.492	74
0.495	73
0.498	74
0.482	74
0.485	74

Table 2

MAT TRAVEL, DUST LOAD, AND PRESSURE DROP OF THE
FILTREX GFC-3 FILTER MEDIUM, FIRST ROLL

Dust Load	Travel of Mat, in.		Pressure Drop, in. W. G.	
g/ft width	Advance	Total	Before Advance	After Advance
188	3	3	0.490	0.450
198	2	5	0.490	0.450
218	2	7	0.485	0.445
239	2	9	0.488	0.445
260	2	11	0.485	0.445
271	1	12	0.490	0.445
297	2	14	0.480	0.450
302	1	15	0.480	0.450
334	1 1/2	16 1/2	0.500	0.470
344	1 1/2	18	0.498	0.460
375	2	20	0.500	0.460
396	1 1/2	21 1/2	0.500	0.460
407	1	22 1/2	0.500	0.460
427	1 1/2	24	0.500	0.460
448	1	25	0.497	0.460
469	2	27	0.500	0.460
490	1 1/2	28 1/2	0.498	0.460
511	1 1/2	30	0.500	0.460
531	1	31	0.500	0.460
552	2	33	0.500	0.460
573	1	34	0.500	0.470
584	2	36	0.504	0.450
605	1 1/2	37 1/2	0.488	0.450
636	1 1/2	39	0.495	0.450
667	1 1/2	40 1/2	0.502	0.460
678	1	41 1/2	0.500	0.460
698	1 1/2	43	0.504	0.460
719	1 1/2	44 1/2	0.504	0.460
740	1 1/2	46	0.505	0.460

Table 3

MAT TRAVEL, DUST LOAD, AND PRESSURE DROP OF THE FILTREX GFC-3 FILTER MEDIUM, SECOND ROLL

Dust Load	Travel of Mat, in.		Pressure Drop, in. W. G.	
g/ft width	Advance	Total	Before Advance	After Advance
281	4	4	0.512	0.49
303	2	6	0.502	0.45
334	2	8	0.503	0.45
354	2	10	0.501	0.45
385	1 1/2	11 1/2	0.500	0.45
427	1 1/2	13	0.502	0.46
448	1 1/2	14 1/2	0.500	0.46
479	2	16 1/2	0.500	0.46
500	1 1/2	18	0.500	0.45
531	2	20	0.500	0.44
563	1	21	0.500	0.45
594	2	23	0.500	0.44
615	1 1/2	24 1/2	0.500	0.45
636	1 1/2	26	0.500	0.45
656	1	27	0.500	0.46
688	2	29	0.502	0.45
719	1	30	0.500	0.46
740	2	32	0.500	0.45
771	1 1/2	33 1/2	0.500	0.45
792	1 1/2	35	0.500	0.45
813	1 1/2	36 1/2	0.500	0.45
844	1 1/2	38	0.502	0.46

Table 4

SUMMARY OF TEST RESULTS AND SPECIFICATION REQUIREMENTS

	Arrestance %	Dust-Holding Capacity g/sq ft
Roll #1	77	174
Roll #2	74	205
Specification Requirement	75	200

Mat Travel vs. Dust Load

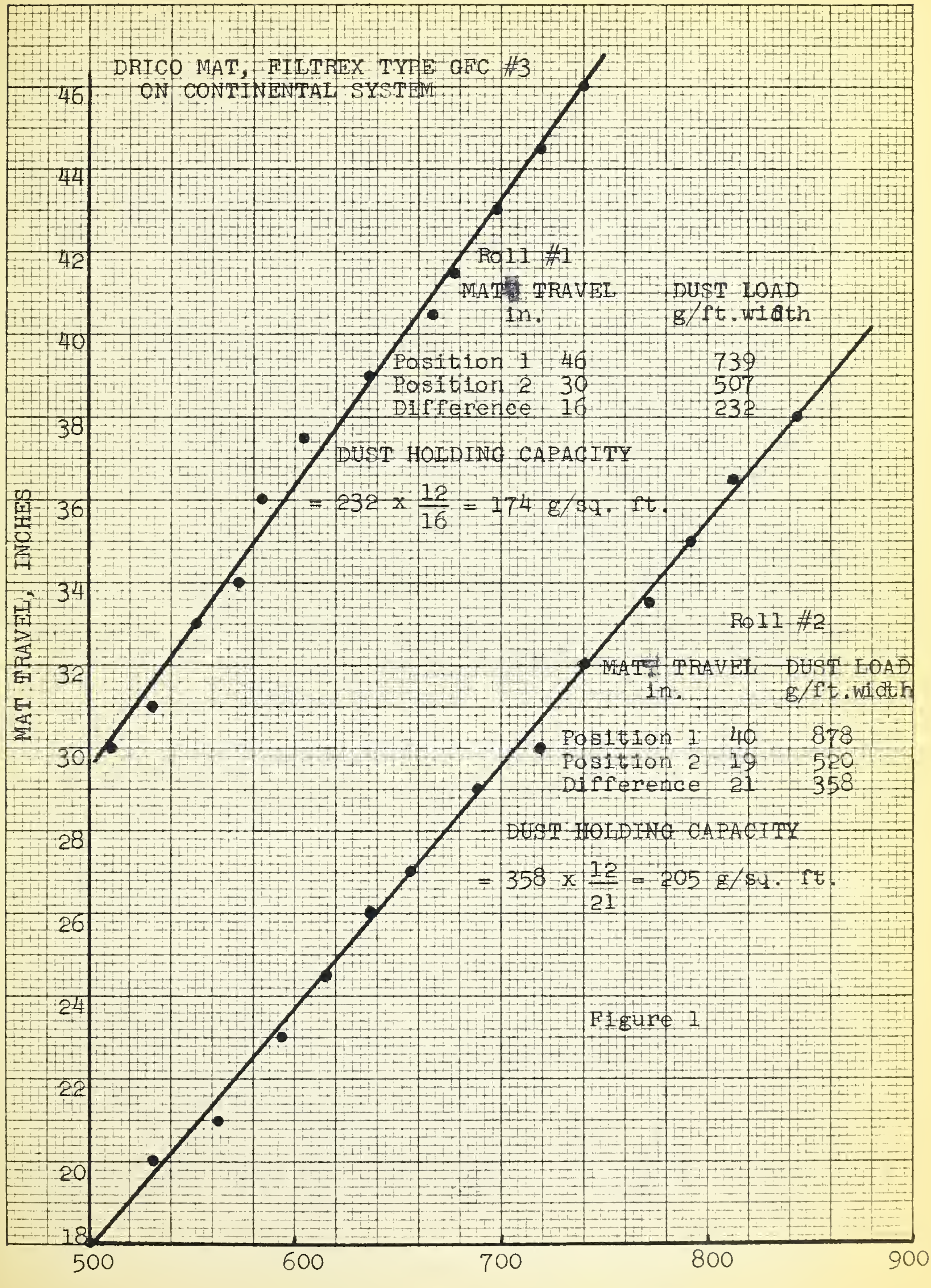

Figure 1

Dust Load, grams per foot width

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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