10.00

NATIONAL BUREAU OF STANDARDS REPORT

7891

PERFORMANCE TEST OF
AN AUTOMATIC RENEWABLE FILTER MEDIA

manufactured by
United States Gypsum Company
Des Plaines, Illinois

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

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. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and the Central Radio Propagation Laboratory Ionospheric Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
1003-30-10630	May 27, 1963	7891

PERFORMANCE TEST OF AN AUTOMATIC
RENEWABLE FILTER MEDIA

manufactured by
United States Gypsum Company
Des Plaines, Illinois

by

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

to

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

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

PERFORMANCE TEST OF AN AUTOMATIC RENEWABLE FILTER MEDIA

manufactured by
United States Gypsum Company
Des Plaines, Illinois

by

Carl W. Coblentz and Paul R. Achenbach

1. Introduction

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of an automatic renewable air filter media manufactured by the United States Gypsum Company 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 up to 0.50 in. W.G.

2. Description of Test Specimen

The test specimen was manufactured and supplied by the United States Gypsum Company of Des Plaines, Illinois. It was a roll of a blue fiber glass mat, about 30 in. long and 16 in. in diameter. The mat was designed as an automatic renewable type filter medium for the G. S. A. designation type E filter. The media was compressed to approximately 1/4 in. thickness in the roll, but it expanded to about 2 3/4 in. thickness when unrolled. The glass fiber mat was treated with an organic binder and the mat was denser at the downstream side than on the upstream. The mat had been treated with an oily adhesive and weighed about 39 grams/sq. ft. A microscopic examination showed that the glass fibers were between 25 and 60 microns thick and several inches long.

3. Test Method and Procedure

The medium was 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 roll of media was installed 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 U. S. Gypsum 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 area 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:

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

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 the 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 the 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 test specimen are shown in table 1.

Table 1

Pressure Drop and Arrestance

Pressure Drop, in. W.G.	Arrestance %
0.140	64*
0.450	76
0.455	77
0.470	78
0.475	78

*initial, with clean medium

It will be noted that the pressure drop of the clean medium was 0.140 in. W.G. and showed an arrestance of 64 percent. At steady state, i.e., after several advance cycles, when the pressure drop varied between 0.485 in. W.G. and 0.440 in. W.G. a series of arrestance determinations produced values ranging from 76 percent to 78 percent, averaging 77 percent. The arrestance values were approximately proportional to the pressure drop of the medium and it may be assumed that the average value would have been about one percent higher if the media had been operated closer to the 0.500 in. W.G. maximum permissible pressure drop.

Table 2 presents the cumulative dust weights received by the 2 ft. wide media, the individual and cumulative lengths of mat travel and the pressure drop before and after each advance cycle.

Table 2

Dust Load, Mat Travel, and Pressure Drop of the U. S. Gypsum Company Glass Fiber Media

Dust Load	Mat Travel, in.		Pressure Drop, in. W.G.	
Grams	Advance	Total	Before Advance	After Advance
562	4	4	0.480	0.440
625	2 1/2	6 1/2	0.485	0.445
666	2 1/2	9	0.480	0.440
729	1 1/2	10 1/2	0.485	0.445
791	1 1/2	12	0.485	0.445
833	2	14	0.480	0.440
895	1	15	0.480	0.440
937	2	17	0.480	0.445
979	1	18	0.480	0.445
999	1	19	0.480	0.445
1083	2	21	0.485	0.450
1125	1 1/2	22 1/2	0.485	0.445
1167	1	23 1/2	0.485	0.445

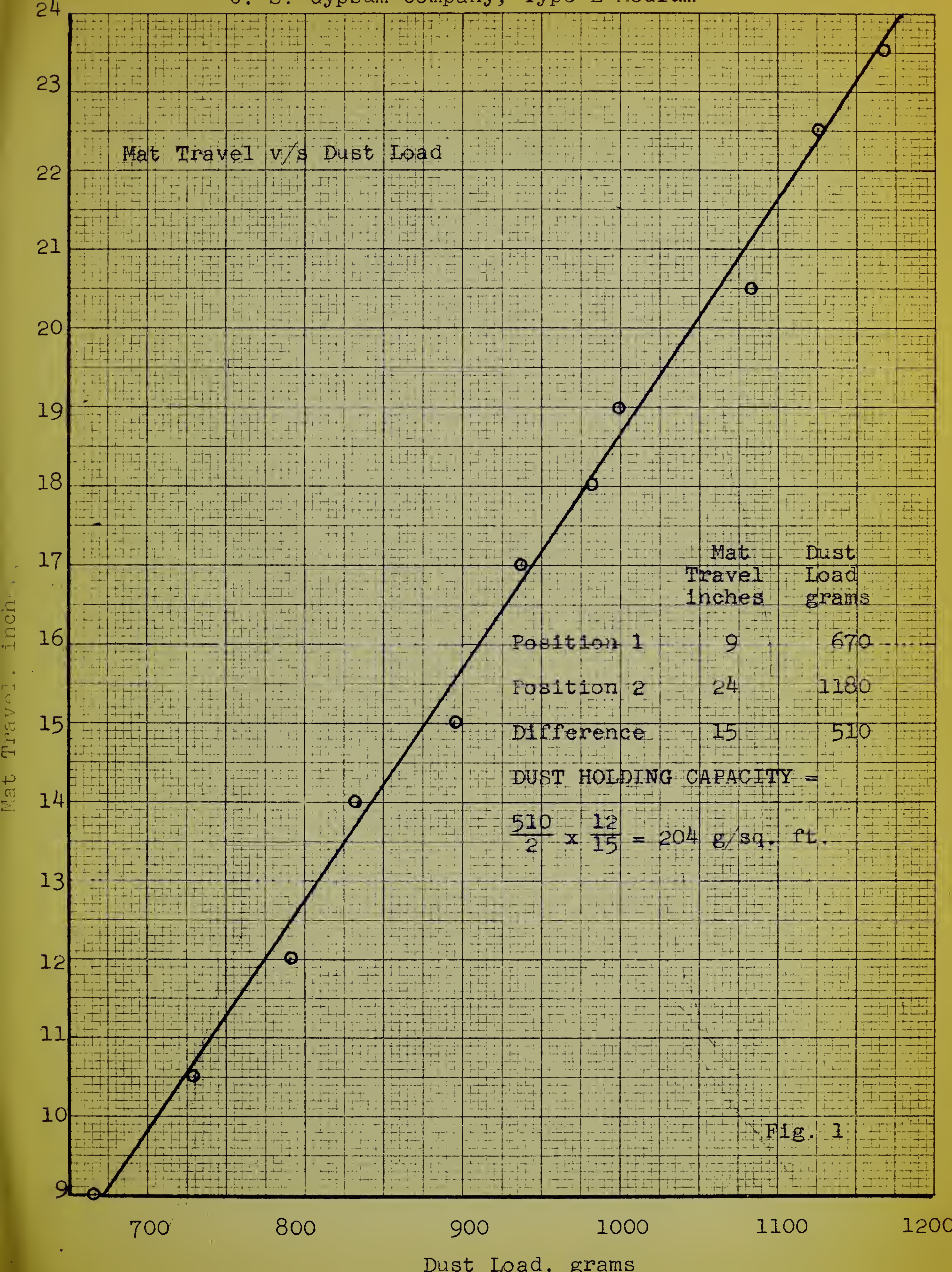
The first movement of the media was 4 in. and occurred with a dust load of 562 grams and at a pressure drop of 0.480 in. W.G. across the 4 sq. ft. of exposed mat. The two succeeding advance lengths were both 2 1/2 in. and, thereafter, ten further movements advanced the mat between 1 in. and 2 in. each, a total of 14 1/2 in. The pressure drop at the beginning of the advance cycles was from 0.480 to 0.485 in. W.G. and ranged from 0.440 to 0.450 in. W.G. at the end of the cycles. The average pressure differential was 0.038 in. W.G.

The dust-holding capacity per unit area of the test specimen was determined as the slope of a straight line that best fitted the observed values of mat travel and dust load as plotted in Figure 1. The graph shows the performance of the media after the two first advance cycles. It will be noted that the individual points of observation are scattered from the straight line to an equivalent of up to 20 grams dust load which is caused by the fact that the indicated dust load values are based on an integral number of 20.83 gram increments of dust and lint and, also, that the advance distances could not be observed on the scale to better than the nearest half-inch mark. According to the straight line in Figure 1, which represents the average advance movement of the media which would maintain the pressure drop across the mat between 0.444 and 0.482 in. W.G. on the average all times, it is shown that after 9 in. of mat travel the dust load was 670 g and after 24 in. travel the dust load was 1,180 g. Thus, a mat travel of 24 - 9 = 15 in. was caused by the introduction of 11,180 - 670 = 510 g of dust. The dust-holding capacity was calculated by dividing the dust load per foot width by the length of advance in feet, i.e.,

$$\frac{510}{2} \times \frac{12}{15} = 204 \text{ g/sq. ft.}$$

The requirements specified for the type E media are 75 percent average arrestance and 200 g/sq. ft. dust-holding capacity. The performance values determined for the test specimen were 77 percent average arrestance and 204 g/sq. ft. dust-holding capacity.

U. S. Gypsum Company, Type E Medium



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. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

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. 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. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

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

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING LABORATORY

Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

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.

Troposphere and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

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

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

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

Joint Institute for Laboratory Astrophysics-NBS Group (Univ. of Colo.).

NBS