NATIONAL BUREAU OF STANDARDS REPORT

7530

PERFORMANCE TEST OF FARR TYPE 83 MEDIA WITH THE "ROLL KLEEN" AUTOMATIC RENEWABLE MEDIA AIR FILTER

manufactured by
Farr Company
Los Angeles, California

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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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.

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1003-30-10630	July 20, 1962	7530

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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 the Farr type 83 media was determined on a "Roll-Kleen" automatic renewable media type air filter. The scope of this examination included the determination of the dust-holding capacity and the arrestances of Cottrell precipitate and of the particulate matter in the laboratory air when the face velocity was maintained at 500 ft/min and the pressure drop across the media did not exceed 0.5 in. W.G.

2. Description of Test Specimen

The filter media was supplied by the Farr Company of Los Angeles, California, and was identified as their Roll-Kleen Type 83 Media. The roll of media was 3 feet wide and approximately 65 feet long and the media expanded to a thickness of about 2 inches when unrolled. The mat was made of glass fibers, bonded with an organic binder and was reinforced on the downstream side by a rigid scrim that was secured to the mat by the bonding material. The mat was treated with a viscous adhesive, said to be tricresyl phosphate. The weight of the mat was approximately 35 grams per square foot and a microscopic examination of the glass fibers indicated that most were between 30 and 50 microns in diameter and several inches long.

The filter mat was installed in a Roll-Kleen filter frame, model 3-70, which had been modified for use with the National Bureau of Standards air filter test apparatus. The modification of the apparatus consisted principally of a metal enclosure which covered the spool of clean material at the top as well as the loaded spool at the bottom. The inlet and outlet openings in the filter apparatus were 24-inch square to match the size of the test duct, and two flanges permitted the connection of the device to the two sections of the air filter test duct. The advance of the filter mat was controlled by a pressure switch which operated an electric motor, connected to the lower spool. The pressure switch had an adjustable range, but a fixed differential of approximately 0.08 in. W.G.

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, Voll. 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, and after introduction of each 20-gram increment of Cottrell precipitate into the test duct.

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 housein, 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 0.500 in. W.G. or a slightly lower value.

4. Test Results

The test results are summarized in Tables 1 and 2. Table 1 shows the arrestance of the media at different pressure drop values for both the particulate matter in the laboratory air and Cottrell precipitate as the initial section of media was being loaded before the first advance and immediately after the first advance of the media. The pressure drop of the clean medium was 0.160 in. W.G. The arrestance of the clean media for the particulate matter in the laboratory air was 7 percent and for Cottrell precipitate was 70 percent. The arrestance of the mat increased as the dust load increased and ranged from 81 percent to 86 percent for Cottrell precipitate at pressure drop values between 0.4 and 0.5 in. W.G. Two arrestance determinations with the particulate matter in the laboratory air at a pressure drop above 0.4 in. W.G. showed 21 percent and 19 percent, respectively.

Table 2 shows the mat travel, the dust load, and the pressure drop across the filter immediately before and after each advance of the media. It will be noted that the incremental advance was between 2 in. and 3 1/2 in., averaging 2 5/8 in. The pressure drop at the beginning of the advance cycle ranged from 0.500 in. W.G. to 0.468 in. W.G.; averaging 0.486 in. W.G. and the pressure drop at the end of the advance cycle ranged from 0.425 in. W.G. to 0.390 in. W.G., averaging 0.406 in. W.G. The average differential was 0.080 in. W.G.

The dust loads shown in Table 2 are the cumulative weights per foot width of Cottrell precipitate and lint that had been introduced into the test duct at the beginning of each advance cycle.

The dust load per unit area of filter medium provides a relative measure of the rate of consumption of mat material during actual use. The dust load per unit area at steady state operation has been defined as the "Dust-Holding Capacity. This value has been obtained by plotting the cumulative advance values against the cumulative dust load after the medium had advanced a number of times. The mat travel was plotted against the dust load in Figure 1 and a straight line was drawn that best fitted the individual points of observation. Disregarding the insignificant mass of particulate matter collected on the media during the arrestance determinations with laboratory air, the slope of this line expresses the dust-holding capacity of the medium. According to the graph, while the mat advanced 15 inches, from the 35-inch position to the 50-inch position, the cumulative dust load increased from 638 g/ft width to 893 g/ft width, or by 255 g/ft width. The dust-holding capacity was therefore:

$$255 \times \frac{12}{15} = 204 \text{ g/sq ft}$$

The test results obtained with the Roll Kleen Type 83 media at a face velocity of 500 ft/min. are summarized below:

1.	Pressure drop of clean mat	0.160 in. W.G.
2.	Average operating pressure	0.486 to 0.406 in.W.G.
3.	Arrestance of clean mat:	
	Particulate matter in laboratory air	7 percent
	Cottrell precipitate	70 percent
4.	Average arrestance at steady state:	
	Particulate matter in laboratory air	20 percent
	Cottrell precipitate	83 percent
5.	Dust-Holding Capacity	204 g/sq ft.

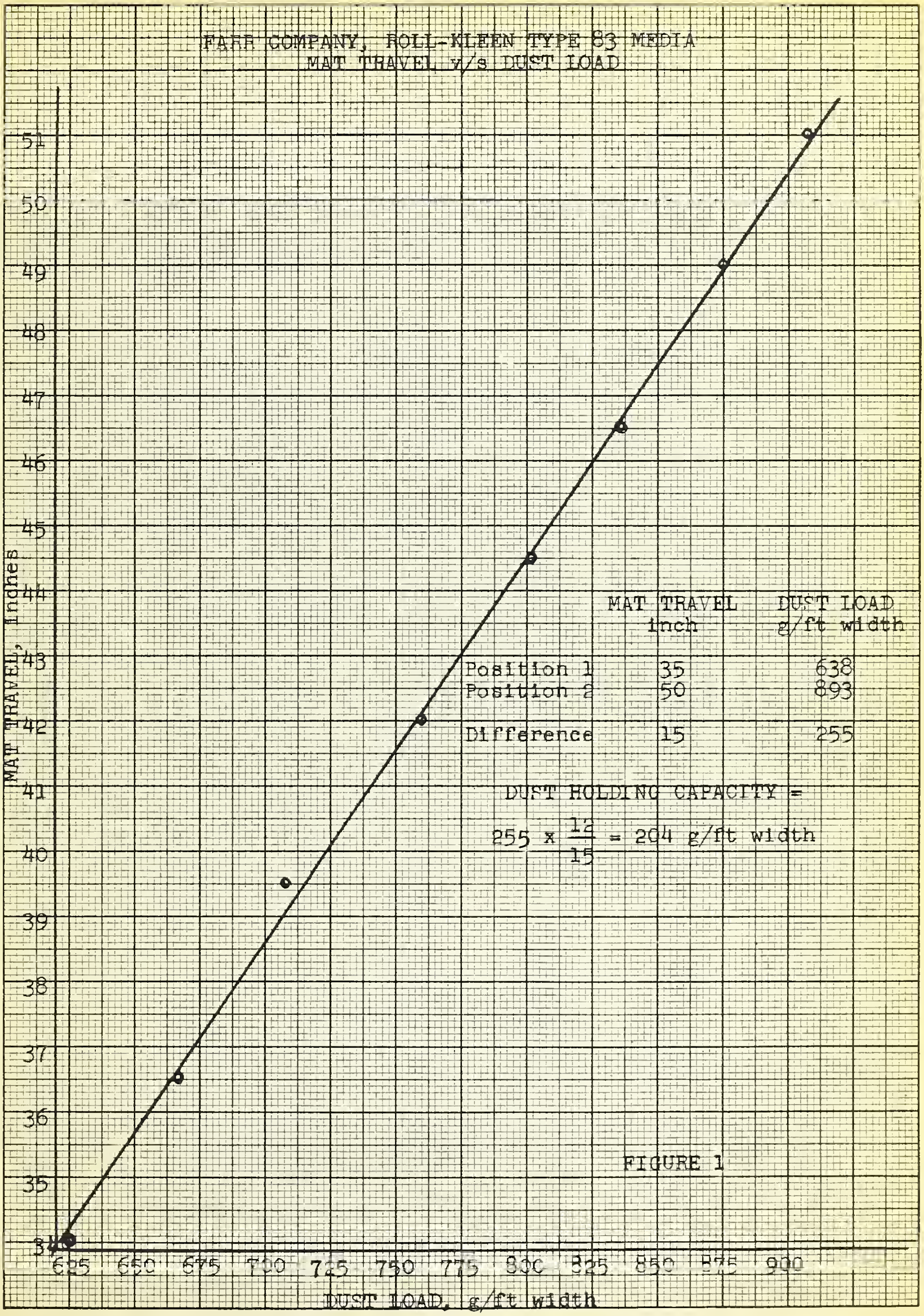
TABLE 1

Arrestance and Pressure Drop at the start of the loading process

FARR "ROLL KLEEN" TYPE 83 MEDIA

Pressure Drop in. W.G.	Arrestance percent	Aerosol*
0.160	7	A
0.163	70	C
0.165	69	C
0.170	69	C
0.308	71	C
0.425	81	C
0.428	81	C
0.475	84	C
0.500	85	C
0.430	21	A
0.438	83	C
0.479	19	A
0.483	86	C

*Aerosol A - Particulate matter in laboratory air
C - Cottrell Precipitate in laboratory air


FARR COMPANY, ROLL-KLEEN TYPE 83 MEDIA
MAT TRAVEL v/s DUST LOAD

	MAT TRAVEL inch	DUST LOAD g/ft width
Position 1	35	638
Position 2	50	893
Difference	15	255

DUST HOLDING CAPACITY =

$$255 \times \frac{12}{15} = 204 \text{ g/ft width}$$

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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