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NATIONAL BUREAU OF STANDARDS REPORT

8115

PERFORMANCE TEST OF A "DUSTFOE" DEEP-BED
DISPOSABLE AIR FILTER, MODEL B-2000

manufactured by
Mine Safety Appliances Company
Pittsburgh, Pennsylvania

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

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

NATIONAL BUREAU OF STANDARDS
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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, D.C., 20402.

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1. INTRODUCTION

At the request of the Public Buildings Service, the performance characteristics of a "Dustfoe", Model B-2000, disposable deep-bed air filter manufactured by the Mine Safety Appliances Company of Pittsburgh, Pennsylvania, were determined. The scope of the investigations included the determination of the arrestance of the particulate matter of the laboratory air by the filter and the pressure drop of the filter at the rated air-flow rate of 2000 cfm as the dust load was gradually increased from zero to a final value corresponding to a pressure drop of 1.0 W. G.

2. DESCRIPTION OF TEST SPECIMEN

The filter was manufactured and supplied for test purposes by the Mine Safety Appliances Company of Pittsburgh, Pennsylvania. It was identified as "Dustfoe", Model B-2000. The outside dimensions of the filter unit were 23-1/2" x 23-1/2" x 11-5/8" deep. Four pieces of 1/8" cement-asbestos board 23-1/2" x 11-5/8", with galvanized metal angles front and back formed a rigid box frame. The filter media area was approximately 160 ft^2 and consisted of glass mat. The diameter of the glass fibers in the mat were approximately 5 microns. The filter media was folded into 45 pleats, 11 inches deep, and supported on separators of corrugated aluminum, 10-3/4 inches wide and 0.015" thick. The gross face area of the filter unit was 3.84 ft^2, but the enclosing edges of the metal frames reduced the net face dimensions to 22-1/2" by 22-1/2" and the net face area to 3.52 ft^2.

At a rated air-flow rate of 2000 cfm the net face velocity was 597 ft/min and the average air velocity through the filter media was about 12.5 ft/min. The weight of the clean filter was about 19.5 lb.

3. TEST METHOD AND PROCEDURE

The filter was tested at the rated air flow rate of 2000 cfm. 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 filter under test was installed in the test apparatus and carefully sealed to prevent any by-pass 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 2 feet upstream and 8 feet downstream of the test specimen. Each sample of air was passed through Whatman No. 41 filter paper. The arrestance determinations were made with the particulate matter in the laboratory air as the aerosol and with the filter loaded with a mixture of Cottrell precipitate and lint 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 filter papers. A similar increase of the opacity of both 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 time proportioning was accomplished by the use of one solenoid valve in the upstream sampling line and another 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 a 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:

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

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

Arrestance determinations were made at the beginning and at the end of the test and at several intermediate loading conditions as indicated in Table 1. The loading was done incrementally, each increment consisting of 96 parts Cottrell precipitate and 4 parts cotton linters, by weight. 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 under test was recorded at the beginning of the test, after each arrestance determination, and after each increment of Cottrell precipitate and lint that was introduced into the test duct. The test was terminated when the pressure drop across the filter reached 1.0 in. W. G.

4. TEST RESULTS

The test results obtained on the air filter specimens at the air flow rate of 2000 cfm are summarized in Table 1.

Table 1

Performance of a Mine Safety Appliances Company "Dustfoe" Disposable Air Filter B-2000 at an Air Flow Rate 2000 cfm

Cottrell Precipitate Grams	Lint Grams	Cumulative Load Grams	Arrestance of Atmospheric Aerosol Percent	Pressure Drop In. W.G.
0	0	0	72.5	0.598
100	4.15	104.2	75.5	0.629
300	12.45	312.5	78.4	0.678
500	20.75	520.8	81.2	0.718
700	29.05	729.0	84.4	0.768
940	39.01	979.0	88.2	0.836
1180	48.97	1229.0	89.8	0.910
1480	61.42	1541.4	90.9	1.012

It will be noted that the pressure drop increased from 0.598 in. W. G. with a clean filter to 1.015 in. W. G. after a dust load of 1541 grams had been reached for the filter. The arrestance of the dust in the atmospheric air increased from 72.5 percent to 90.9 percent during the loading period, and averaged approximately 84 percent. The dust load of Cottrell precipitate and lint corresponding to a pressure drop of 1.0 in. W. G. was 426 grams/sq ft of net face area and about 9.4 grams/sq ft of filter media.

The values shown in Table 1 are graphically presented in Figure 1. In this figure the arrestance of the particulate matter in the laboratory air and the pressure drop are both plotted against the dust load.

PERFORMANCE CURVES FOR MINE SAFETY
APPLIANCES "DUSTFOE" MODEL B-2000
DISPOSABLE AIR FILTER
AIR FLOW RATE - 2000 CFM

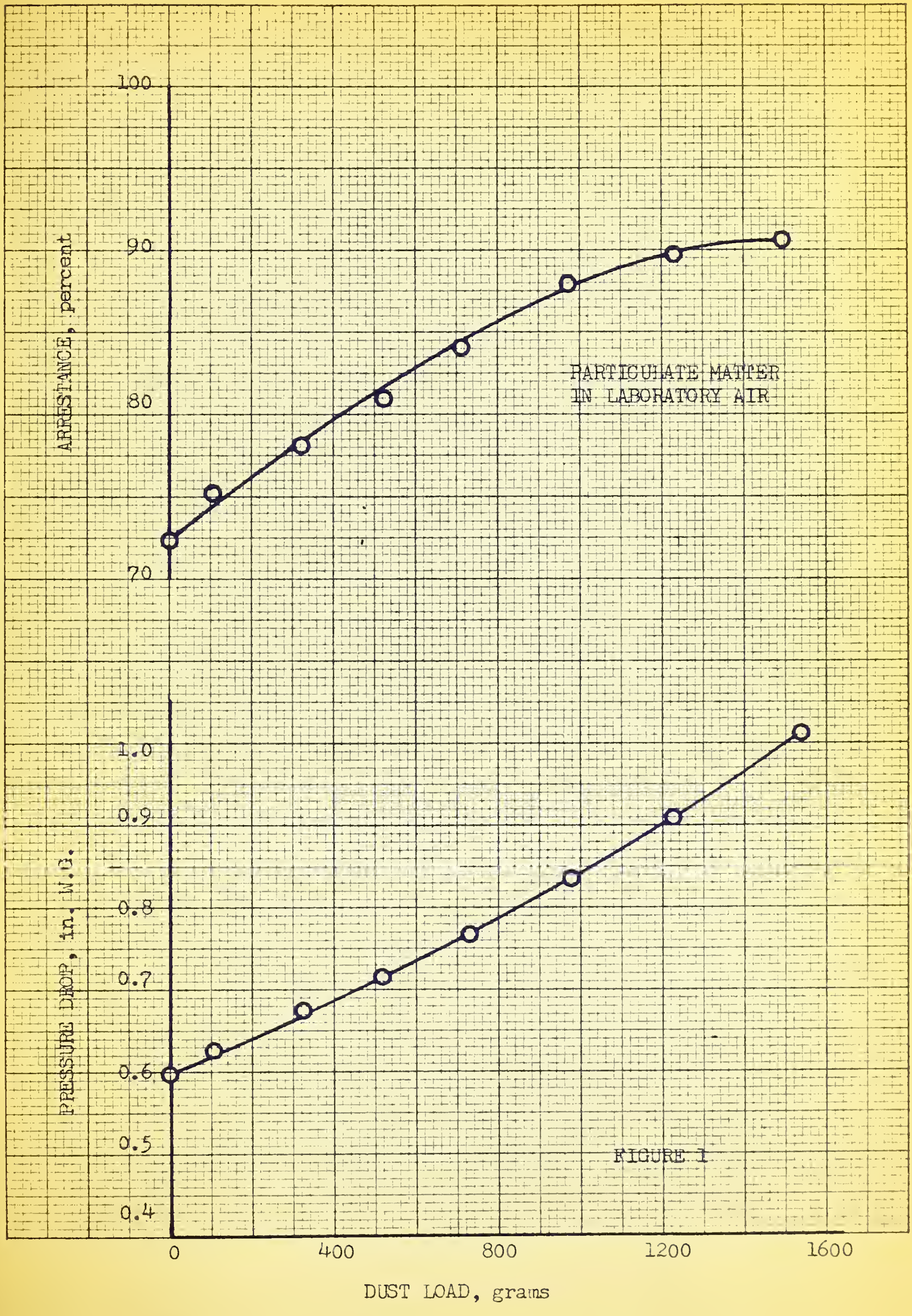

FIGURE 1

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.).

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