NATIONAL BUREAU OF STANDARDS REPORT

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PERFORMANCE TEST OF A METAL VISCOUS IMPINGEMENT FILTER

Manufactured by

The Standard Filters Corporation
Florence, South Carolina

Report to

Defense Supply Agency
Defense Construction Supply Center
Columbus, Ohio

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards [1] was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in four broad program areas. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Measurement Services and the following technical divisions:

Applied Mathematics—Electricity—Metrology—Mechanics—Heat—Atomic and Molecular Physics—Radio Physics [2]—Radio Engineering [2]—Time and Frequency [2]—Astrophysics [2]—Cryogenics.[2]

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; develops, produces, and distributes standard reference materials; relates the physical and chemical properties of materials to their behavior and their interaction with their environments; and provides advisory and research services to other Government agencies. The Institute consists of an Office of Standard Reference Materials and the following divisions:

Analytical Chemistry—Polymers—Metallurgy—Inorganic Materials—Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government; cooperates with public and private organizations in the development of technological standards, and test methodologies; and provides advisory and research services for Federal, state, and local government agencies. The Institute consists of the following technical divisions and offices:

Engineering Standards—Weights and Measures — Invention and Innovation — Vehicle Systems Research—Product Evaluation—Building Research—Instrument Shops—Measurement Engineering—Electronic Technology—Technical Analysis.

THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center consists of the following divisions:

Reactor Radiation—Linac Radiation—Nuclear Radiation—Applied Radiation.

THE CENTER FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides technical services designed to aid Government agencies in the selection, acquisition, and effective use of automatic data processing equipment; and serves as the principal focus for the development of Federal standards for automatic data processing equipment, techniques, and computer languages. The Center consists of the following offices and divisions:

Information Processing Standards—Computer Information — Computer Services — Systems Development—Information Processing Technology.

THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System, and provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data—Clearinghouse for Federal Scientific and Technical Information [4]—Office of Technical Information and Publications—Library—Office of Public Information—Office of International Relations.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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PERFORMANCE TEST OF A METAL VISCOUS IMPINGEMENT FILTER

Manufactured by

The Standard Filters Corporation
Florence, South Carolina

by

Charles M. Hunt

Report to
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U.S. DEPARTMENT OF COMMERCE

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1. Introduction

At the request of the Defense Construction Supply Center of the Defense Supply Agency, the performance of a Standard Filters Corporation metal viscous impingement filter was determined. The performance tests were carried out at a face velocity of 360 ft./min. They included determination of arrestance of Cottrell precipitate dispersed in laboratory air and pressure drop across the filter as the dust load was increased stepwise from zero to an amount corresponding to a pressure drop greater than 0.5 in. W.G. The tests were performed with the filter in the as-received condition and again after cleaning and reapplication of an adhesive supplied by the manufacturer.

2. Description of Filter

The Standard Filters Corporation filter had nominal dimensions, 20 in. x 20 in. x 1 in. The actual gross dimensions were 19 1/2 in. x 19 1/2 in. x 7/8 in., while the area of the screen was 17 3/4 in. x 17 3/4 in., corresponding to a face area of 2.19 ft^2.

The media consisted of three layers of 18-mesh per inch aluminum wire screen folded into corrugations. The corrugations were about 5/8 inch deep and about 1 inch from peak to peak on the front screen, and about 1/8 inch deep and 5/16 inch from peak to peak on the other two screens. The corrugations on the latter two screens were oriented perpendicular to one another. The screens were coated with an adhesive.

3. Test Method and Procedure

The filters were tested at a face velocity of 360 ft./min. The arrestance determinations were made by means of the NBS Dust Spot Method described in a paper by R. S. Dill entitled, "A Test Method for Air Filters" (ASHVE Transactions, Vol. 44, page 379, 1938). The filter under test was installed in the test apparatus and carefully sealed to prevent any by-pass of air around the media. After establishing the correct air flow rate through the filter, samples of air were drawn from the center points of the test duct 1 foot upstream and 8 feet downstream of the test specimen. Each sample of air was passed through known areas of Whatman No. 41 filter paper. Arrestances were measured with Cottrell precipitate dispersed in laboratory air as the test aerosol.

The amount of light passing through the sampling papers was measured on the same area of each paper with a photometer before and after each test. The two sampling papers used for any one arrestance determination were selected to have the same light transmission when clean.

In determining arrestance, the areas of sampling paper upstream and downstream were selected so as to obtain dust spots of similar optical density. The arrestance was then calculated by the equation:

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

where A represents the percent arrestance, ΔU and ΔD represent the change in the amount of light transmitted through the upstream and downstream papers due to the dust spots, as indicated by the photometer readings, and S_U and S_D represent the areas of sampling paper upstream and downstream.

The test dust consisted of 96 parts by weight of Cottrell precipitate, and 4 parts of No. 7 cotton linters which had previously been ground in a large Wiley mill having a 4-mm. exit screen. The Cottrell precipitate was dispersed into the air stream at a rate of about 1 gram per 1,000 cubic feet of air, and the cotton linters were dispersed separately after each 20-gram increment of Cottrell precipitate. Arrestance determinations were made initially and at selected intervals in the dust loading process.

4. Results

The amount of dust fed to the filter, the pressure drop across the filter, and the dust arrestance are presented in Table 1. The first series of values were obtained with the filter in the as-received condition. The second set of values were obtained after washing and reapplying adhesive. The results are presented graphically in Figure 1.

It was estimated gravimetrically that the filter contained 29 g of adhesive in the first set of measurements and 18 g in the second set. This latter value was obtained after applying the entire contains of an aerosol spray can to the cleaned filter and redrying. A slight amount of lint (less than 1 g) was retained in the filter after washing.

The average arrestance based on the area under the curve was 41.7 percent in the first test and 48.4 percent after cleaning and reoiling.

From the lower curves in Figure 1, the original filter reached a pressure drop of 0.5 in. W.G. when 340 g of dust had been fed to the filter. Correcting for loss of dust due to fallout and dividing by the area of the filter, the filtration capacity was found to be

$$\frac{340 \times 0.928}{2.19} = 144 \text{ g/ft}^2 \quad . \tag{2}$$

For the cleaned and reoiled filter the value was

$$\frac{269 \times 0.909}{2.19} = 112 \text{ g/ft}^2 \quad . \tag{3}$$

In Table 2 the filtration capacity, average arrestance of Cottrell precipitate, and initial pressure drop are compared with requirements for a 1-inch Type-I viscous impingement filter according to Federal Specification FF-300a.

Table 1

Performance of Standard Filter Corporation Metal Viscous Impingement Filter at 360 ft/min.

Measurement of filter as received

Dust[1] fed to filter (grams)	Pressure drop (in. W.G.)	Arrestance[2] of Cottrell precipitate (percent)
0	0.035	40.8, 33.1, 38.2
50	.055	-
133	.106	38.7, 39.2
263	.260	30.0, 42.5, 44.6
309	.368	-
330	.453	50.0, 48.9
355	.572	50.0, 50.4
361	-	-

Measurement after cleaning and application of fresh adhesive

0	0.034	47.0, 39.2, 44.6
48	.050	-
131	.114	-
173	.163	48.5, 48.0
197	.204	-
260	.447	58.8, 57.1, 57.3
286	.634	-

1. At the end of the first test 26.1 grams of dust were collected from the duct upstream from the filter. If it is assumed that the fraction of dust lost due to fallout was uniform throughout the test, the corrected amount of dust reaching the filter would be obtained by multiplying each of the values from the first test by the factor 0.928. At the end of the second test 26.0 grams of dust were collected upstream, and the factor to be applied to the second set of values is 0.909.

2. Two grams of dust were required for each arrestance determination. These weights are included in the subsequent dust fed to the filter.

Table 2

Comparison of Performance of Standard Filter Corporation Viscous Impingement Filter with Requirements for a 1-inch Type I Filter According to Federal Specification FF-300a

	Filtration capacity (g/ft^2)	Average Arrestance Cottrell ppt. (percent)	Initial pressure drop (inches)
Filter as received	144	41.7	0.035
Washed and reoiled filter	112	48.4	0.034
FF-300a requirement	150	50	0.08

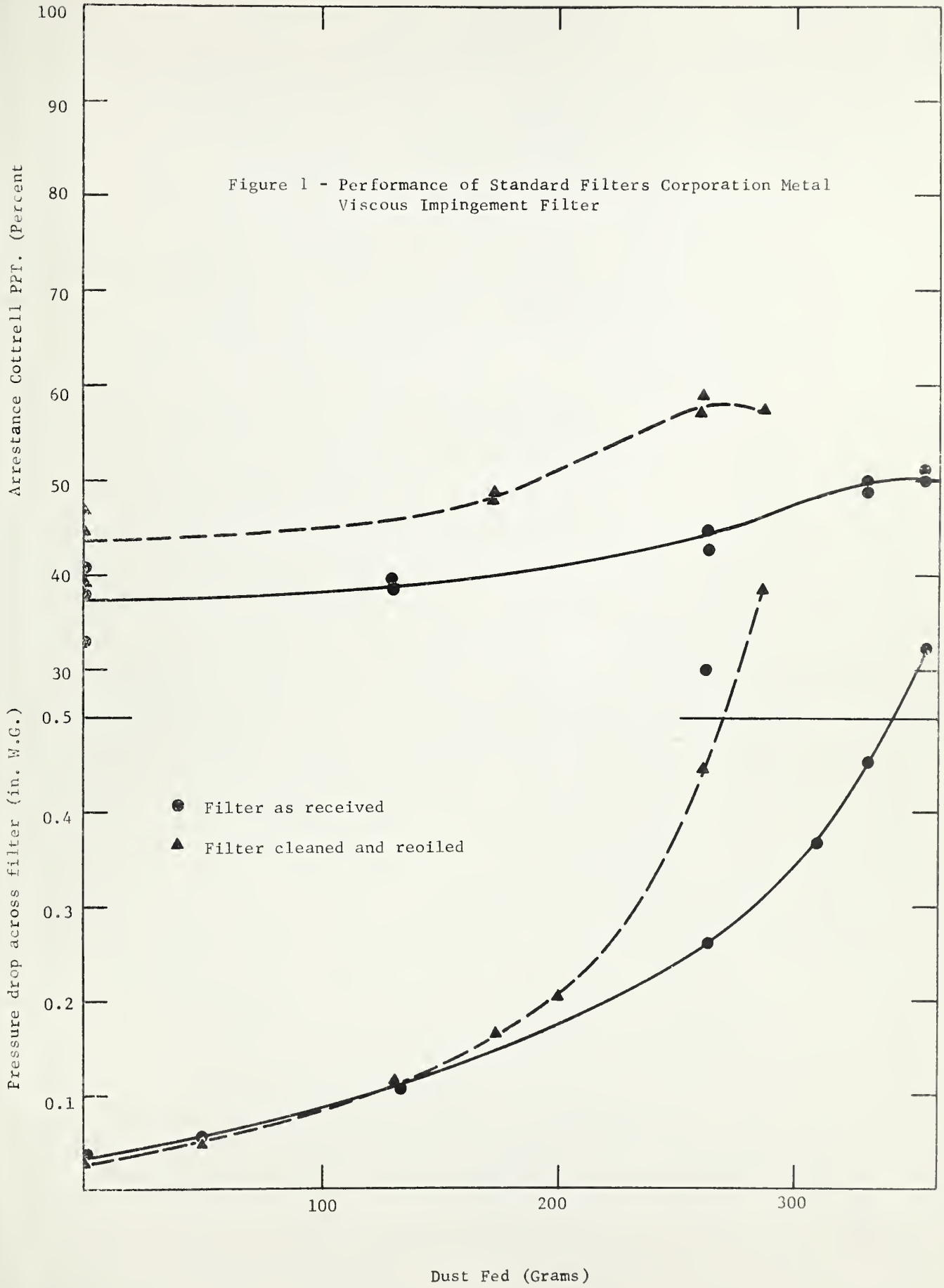
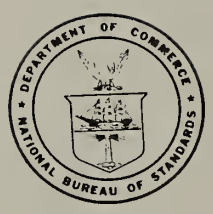


Figure 1 - Performance of Standard Filters Corporation Metal Viscous Impingement Filter
Arrestance Cottrell PPT. (Percent
100
90
80
70
60
50
40
30
0.5
0.4
0.3
0.2
0.1
Pressure drop across filter (in. W.G.)
Filter as received
Filter cleaned and reoiled
100
200
300
Dust Fed (Grams)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