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NATIONAL BUREAU OF STANDARDS REPORT
6629

PERFORMANCE TESTS OF A FARR REPLACEABLE MEDIA AIR FILTER, MODEL HP-2

Manufactured by
Farr Company
Los Angeles, California

by

Carl W. Coblentz
and
Paul R. Achenbach

Report to

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

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Carl W. Coblentz and Paul R. Achenbach
Air Conditioning, Heating, and Refrigeration Section
Building Technology Division

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Performance Test of a Farr Replaceable Media Air Filter, Model HP-2

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1. INTRODUCTION

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of a Farr paper air filter, type HP-2, were determined. The scope of this examination included the determination of the arrestance of Cottrell precipitate, the pressure drop and dust holding capacity of the filter. Some determinations of the arrestance of atmospheric dust were also made.

2. DESCRIPTION OF TEST SPECIMEN

The filter was manufactured and supplied for test purposes by the Farr Company of Los Angeles, California. It was identified as their model HP-2 and consisted of a sheet steel frame into which the filter element was fitted. This filter element consisted of a pleated filter medium and a wire retainer that supported each of the ten 8-in. deep pleats of the filter medium and protected the medium from rupture or excessive dislocation due to the air pressure. The total filtering area of the pleated material was approximately 25 sq ft.

The filter medium was a paper product supplied in a folded condition. After unfolding the layers, they could be inserted into the wire retainer without great effort. A perforated steel panel was used to secure the filter element in the holding frame, and to provide an air seal between the reinforced edges of the filter media and the frame. This perforated panel served as a substitute for a pre-filter which was generally used with this filter, according to information of the representative of the manufacturer who attended the test. The test was conducted without a pre-filter.

The weight of the complete filter was 6870 g (15 lbs, 2 oz), when clean and it measured 20" x 20" on the outside with net dimensions of 17 5/8" x 18" and a net face area of 2.20 sq ft.

3. TEST METHOD AND PROCEDURE

Arrestance determinations were made by the NBS "Dust Spot Method" using the following aerosols: a) the particulate matter in the laboratory air and b) Cottrell precipitate. The test method is described in the paper, "A Test Method for Air Filters," by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

The sampling air was drawn from the center points of the test duct one foot upstream and eight feet downstream of the air filter assembly at equal flow rates and passed through known areas of Whatman No. 41 filter paper. The change of opacity of these areas was determined with a sensitive photometer which measured the light transmission of the same area on each sampling paper before and after the test. The two sampling papers used for each test were selected to have the same light transmission readings when clean.

For determining the arrestance of the filter with Cottrell precipitate, different sized areas of sampling paper were used upstream and downstream of the filter to collect the dust, in order to obtain a similar increase of opacity on both samplers. The arrestance, A (in percent) was calculated by the following formula:

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

where S_D and S_U are the downstream and upstream areas and ΔD and ΔU the observed changes in the opacity of the downstream and upstream sampling papers, respectively.

The arrestance of particulate matter in the laboratory air was determined by a slightly different procedure. In this case, a similar increase of opacity on the two samplers was obtained by using similar or equal areas of the upstream and downstream sampling papers and passing air through the upstream sampler only part of the time while operating the downstream sampler continuously. This was accomplished by operating the upstream sampler with an electric timer that controlled two solenoid valves, one in series with the sampler and the other bypassing the sampler. The timer could be set to open the solenoid valve in series with the upstream sampler any desired percentage of a 5-minute cycle while bypassing the sampler for the rest of the cycle. The arrestance, A (in percent) was then computed from the following

formula:

$$A = 100 - T \times \frac{\Delta D}{\Delta U} \times \frac{S_D}{S_U}$$

where T is the percentage of time during which air was drawn through the upstream sampler, the other values being the same as indicated in the first formula.

The following procedure was employed in the testing of the performance of this filter: After the filter was installed in the test apparatus, a series of pressure drop measurements were made with air flow rates ranging from 400 cfm to 1000 cfm (i.e., face velocities of 182 to 454 ft/min). Several arrestance determinations were then made at the rated face velocity of 250 ft/min (550 cfm), introducing Cottrell precipitate into the air stream at a rate of approximately 1 gram per 1000 cu ft of air. The filter was then gradually loaded with Cottrell precipitate and lint in a ratio of 96 parts of Cottrell precipitate to 4 parts of lint, by weight. Further arrestance determinations were made after about each additional 100 g of dust were introduced into the inlet duct. This procedure was continued until a pressure drop of 0.5 in. W.G. was reached across the filter. Then, two determinations of the arrestance of the filter were made, using the particulate matter in the laboratory air. Subsequently, a second filter medium was installed in the wire retainer of the filter. It was assumed that this second filter had the same characteristics as the first one when its weight and the pressure drop values over the full range from 400 cfm to 1000 cfm showed practically identical values as the first specimen, when clean. Two more determinations of the arrestance with the particulate matter in the laboratory air were then made on this specimen.

4. TEST RESULTS

Table 1 presents a summary of the performance data of the test specimen operated at 550 cfm, equivalent to 250 ft/min face velocity. The dust load shown in this table is the weight of Cottrell precipitate and lint introduced into the test apparatus divided by the face area of the filter and diminished by the percentage of dust fallout upstream of the filter. This fallout was determined at the conclusion of the test by sweeping out the test apparatus and calculating the ratio of fallout to the dust introduced into the system.

Table 1

Performance of Farr HP-2 Air Filter
at 250 ft/min Face Velocity

Dust Load g/sq ft	Pressure Drop in. W.G.	Arrestance %	Aerosol Used**
0	0.044	19*	A
14	0.049	80*	B
42	0.069	82	B
76	0.118	87	B
116	0.229	97	B
162	0.482	98	B
162	0.494	54*	A

* Average of two tests

** A - Particulate matter in laboratory air
B - Cottrell precipitate in laboratory air (Rate of feed = 1 gram per 1000 cu ft)

It will be noted that the pressure drop increased from 0.044 in. W.G. with a clean filter to 0.482 in. W.G. after a dust load of 162 g/sq ft had reached the filter. The arrestance values determined with Cottrell precipitate increased from 80 percent with the clean filter to 98 percent when the filter was loaded to about 0.5 in. W.G. The arrestance of the filter when using the particulate matter in the laboratory air as the aerosol was 19 percent and 54 percent at the beginning and end of the loading period, respectively.

The values of Table 1 are presented graphically in Figure 1 in which both pressure drop and arrestance are plotted against the specific dust load and shown as smooth curves that approximately fit the individual points of observation. Figure 1 also shows a vertical dashed line which indicates that the specific dust load at 0.50 in. W.G. pressure drop would be 164 g/sq ft. The horizontal dashed line indicates the mean arrestance, during the period in which the capacity dust load was accumulated, to be 89 percent.

FARR HP-2

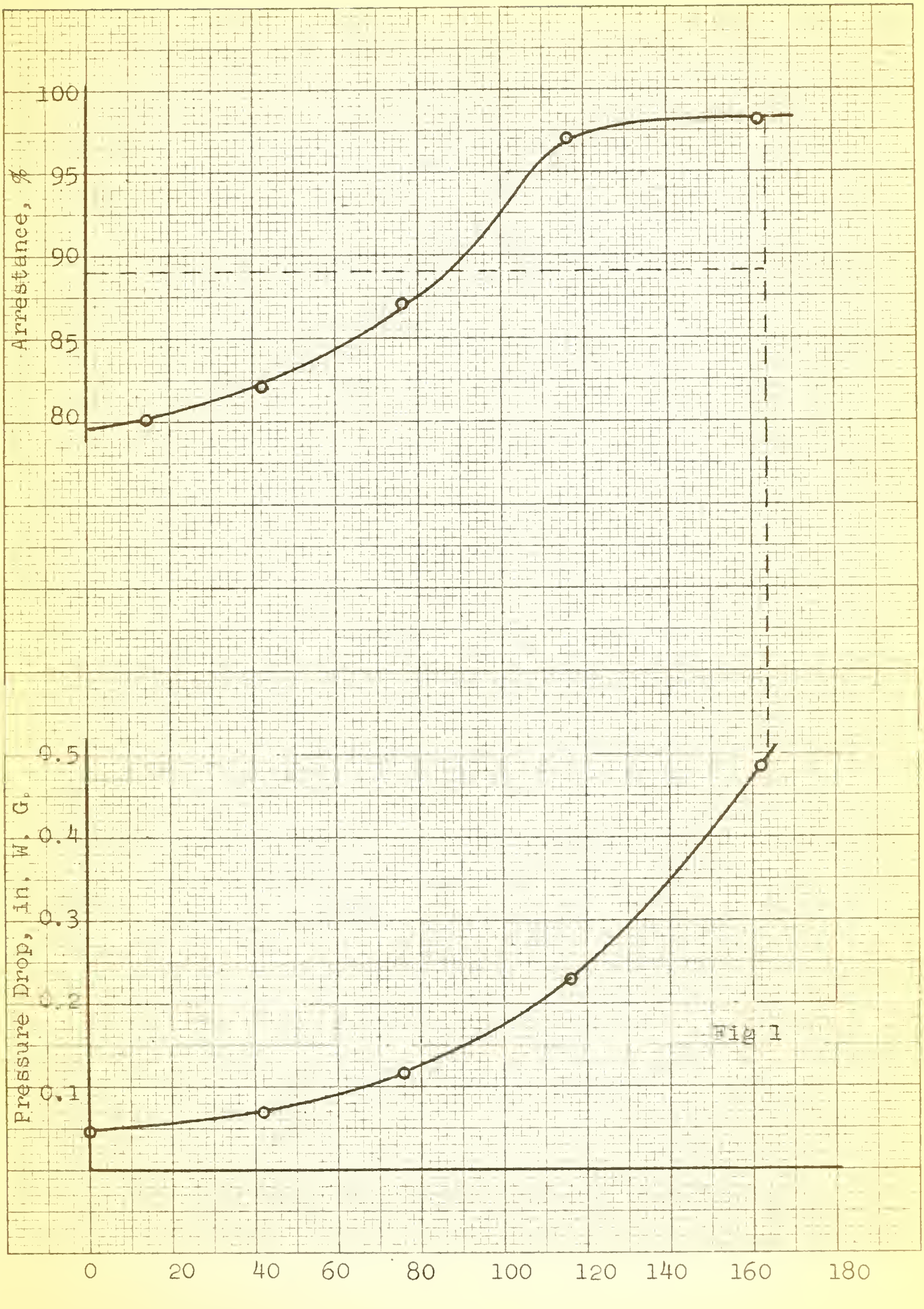

Fig 1

Table 2

Pressure Drop of Clean Filter at Different Air Flow Rates

Face Velocity ft/min	Pressure Drop, in. W.G. 1. Specimen	2. Specimen
182	0.027	0.027
250	0.044	0.044
318	0.067	0.064
386	0.091	0.087
454	0.115	0.110

The pressure drop observed on the two clean specimens at five different face velocities ranging from 182 ft/min (400 cfm) to 454 ft/min (1000 cfm) is shown in Table 2. The values observed for the two media at the two lower air velocities agreed exactly whereas the deviation ranged from 0.003 in. W.G. to 0.005 in. W.G. at the higher velocities.

U.S. DEPARTMENT OF COMMERCE
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