NATIONAL BUREAU OF STANDARDS REPORT

9474

Performance Test at 2000 cfm

of Model HP-2A Dry Type Replaceable Filter

Manufactured by

Farr Company

Los Angeles, California

by

Charles M. Hunt

Report to

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

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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1. Introduction

At the request of the Public Buildings Service of the General Services Administration the performance characteristics of a Farr HP-2A filter were determined at an airflow rate of 2,000 cfm. A previous HP-2A filter was tested at 1,000 cfm and the results were reported in NBS Report No. 9332 of May 27, 1966. In the present tests arrestances were determined with the dust in laboratory air as the test aerosol as well as with Cottrell precipitate dispersed in laboratory air. The pressure drop across the filter was determined as the dust load was increased from zero to a final value corresponding to a pressure drop greater than 0.5 in. W.G.

2. Description of Test Specimen

The HP-2A filter was similar to the previous specimen described in Report 9332. It consisted of a permanent rubberized wire frame approximately 24 x 24 in. in face dimensions and 12 inches deep in which was mounted a replaceable filtering media formed into twelve vertical pleats

about 11-1/2 in. deep. The pleats fit into and were supported by the frame. The same frame was used in both the earlier tests described in Report No. 9332 and the present tests. The working face dimensions of the filter proper were 22 x 22 inches, giving a face area of about 3.4 ft^2. Due to the pleats the effective media filter surface was 40 ft^2 or more. According to Farr Company Bulletin B-1300-4E the rated capacity of the 24 x 24 x 12 inch HP-2A filter is 2000 cfm. In NBS Report 9332 1000 cfm was erroneously quoted as the rated capacity of this filter.

The filtering media was about 0.1 inch thick, and a light square-weave net fabric having a thread count of about twelve threads per inch was attached to the downstream side. Seen under the microscope, the fibers of the media appeared to be cotton. When they were mounted in water, patches of insoluble non-fibrous material could be seen, which may be some kind of chemical treatment, possibly a binder or fire retarder. The upstream face of the filter was treated with a material which imparted a blue color. The present media appeared to have less non-fibrous material than the previously tested media, and there was no easily removable excess of blue material on the upstream face. The media would burn when held in a flame but combustion ceased immediately upon withdrawal.

3. Test Method and Procedure

The filters were tested at 2,000 cfm. 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 2 feet upstream and 8 feet downstream of the test specimen. Each sample of air was passed through known areas of Whatman No. 41 filter paper. With one filter arrestances were measured with the particulate matter in laboratory air as the test aerosol and also with Cottrell precipitate. With a second filter only Cottrell precipitate was used.

The amount of light passing through the sampling papers was measured on the same area of each paper in a photometer before and after test, and 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:

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

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 filter was loaded with test dust consisting 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. Test Results

Two filters were tested for arrestance and pressure drop as the dust load was increased from zero to a terminal value. The results obtained with the first filter are shown in Table 1. In this case arrestance was determined with both atmospheric dust and Cottrell precipitate as the test aerosols. Most of the arrestance determinations were done in duplicate, and the individual values are presented from left to right in the table in the order which they were determined. The data indicates that initial arrestance improved rapidly with repetition even when the amount of dust added to the filter was quite small. This was true with both atmospheric dust and Cottrell precipitate, although the first two values with the latter were imprecise due to poor match between the upstream and downstream dust spots as mentioned in footnote d of Table 1.

Table 1. Performance of First Farr HP-2A Filter at 2000 cfm

Dust[a] Fed (grams)	Pressure Drop[a] Across Filter (inches W.G.)	Arrestance: Atmospheric[a,b] Dust (percent)	Arrestance: Cottrell[a] Precipitate (percent)
0	0.170	0, 5.4[c], 14.8	54.0[d], 66.9[d], 72.4, 74.0
16	.176	--------	--------
141	.224	32.4, 25.0	75.6, 76.6
266	.284	--------	--------
391	.327	-15.1[c], -39.3	80.0

a. The dust fed and pressure drop values were obtained before determining corresponding arrestance values shown at right. The small amounts of dust added in determining Cottrell arrestance are included in the subsequent dust load.

b. The duct and filter frame without media were tested for atmospheric dust arrestance. A value of zero was obtained before installing the filter.

c. After making these arrestance determinations the upstream section of the duct was removed and the filter mounting inspected for leaks. None were found. The upstream section of the duct was replaced and the next arrestance determination was made.

d. The precision of these arrestance values is less than that of the other Cottrell arrestances in the table because of poor match between the upstream and downstream dust spots. Nevertheless they demonstrate an increase in arrestance with repetition.

An atmospheric dust arrestance of zero was obtained initially, but this increased with time as air was drawn through the filter. Somewhat similar behavior was observed in the earlier test of an HP-2A filter at 1,000 cfm (NBS Report 9332, May 27, 1966). Increased arrestance was obtained after 141 grams of dust had been fed to the filter, but negative values were obtained after 391 grams of dust were added. This suggests that some unloading may have occurred at the higher dust load. At this point an arrestance of 80% was obtained with Cottrell precipitate, and the test was discontinued. A little dust was found on the floor of the duct downstream from the filter, enough to show a streak when the finger was drawn across the surface. However, the amount was small compared with that found after testing some typical prefilters. Since the concentration of dust in normal air is low during an atmospheric dust spot determination, release of a very small amount of dust would be enough to produce a negative arrestance value.

A second HP-2A filter was then tested, determining arrestance with Cottrell precipitate only. The results are shown in table 2. Data from table 1 and table 2 are also plotted in figure 1. The upper curve in the figure represents arrestance of Cottrell precipitate and the lower curve pressure drop across the filter, both plotted as functions of dust fed.

According to table 2 the initial pressure drop of the second filter was 0.166 in. W.G. Dust was fed to the filter until a pressure drop of 0.565 in. W.G. was obtained and 760 grams of dust had been fed to the filter.

Table 2. Performance of Second Farr HP-2A Filter at 2,000 cfm

Dust[a,b] (grams)	Pressure Drop[a] Across Filter (in. W.G.	Arrestance[a] of Cottrell Ppt. (Percent)
0	0.166	70.7[d], 77.0, 78.8
12	.174[c]	-------
95	.212	-------
137	.229	80.0, 77.3
270	.284	-------
333	.315	-------
395	.337	80.0, 80.0
528	.389	-------
---	.410[c]	77.1, 80.0
607	.459	-------
669	.495	82.3, 83.9
677	.517	-------
760	.565	82.5, 84.3

a. The dust fed and pressure drop values were obtained before determining corresponding arrestance values shown at right. The small amounts of dust added in determining Cottrell arrestance are included in the subsequent dust load.

b. 0.2 gram of dust were recovered from the duct upstream from the filter. From this it is concluded that essentially all of the dust fed reached the filter.

c. These values were obtained when measurements were resumed after shutting down overnight.

d. The precision of this arrestance value is less than that of the other values in the table because of poor match between the upstream and downstream dust spots.

From figure 1 a dust holding capacity of 670 grams up to a pressure drop of 0.5 inches W. G. is obtained. This corresponds to 335 grams per 1,000 cfm of air flow at the rated capacity of 2,000 cfm. The dust holding requirement for a type C filter is 275 grams per 1,000 cfm of air flow when loaded up to a pressure drop of 0.5 in. W. G. at the rated capacity of 2,000 cfm.

The initial arrestance of the second filter was 75.5% based on the average of the first three values in table 2. The average arrestance up to a pressure drop of 0.5 in. W.G. was 79.7 ± 1.3%. The measure of repeatability used here is the pooled standard deviation (1) of all of the duplicate Cottrell arrestance determinations in both tables, omitting those values where poorly matching dust spots were obtained. A rounded estimate of the average arrestance is 80 ± 1%. The GSA requirement for a type C filter is 80% average arrestance with Cottrell precipitate.

5. References

1. "Statistical Methods for Chemists", W. S. Youden, Wiley & Sons, Inc., pages 12, 16.

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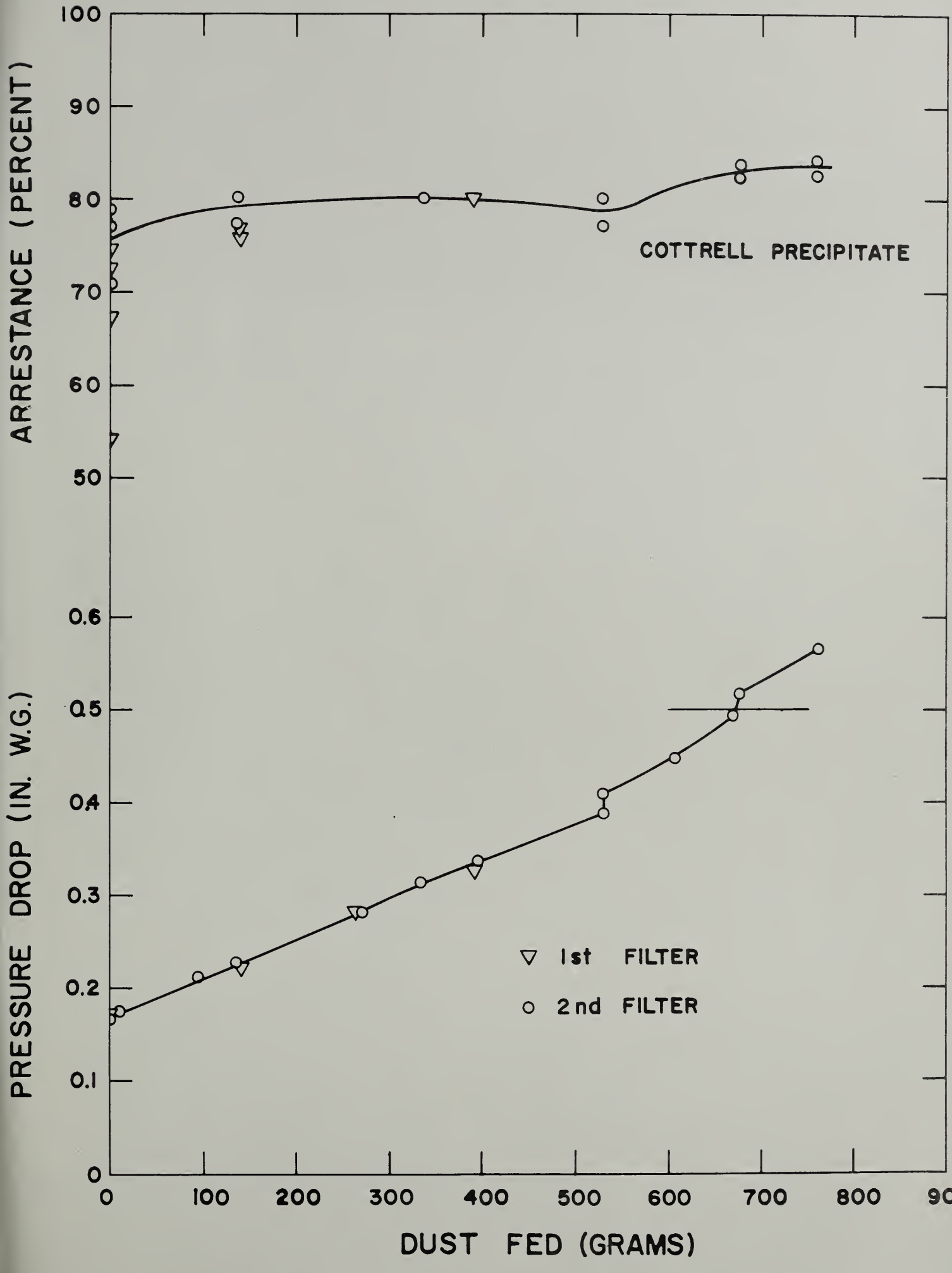

FIG. 1. PERFORMANCE OF FARR HP-2A FILTER AT 2000 CFM.


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