NATIONAL BUREAU OF STANDARDS REPORT

9404

PERFORMANCE TEST OF A

FOUR-PLEAT DYNEL FIBER FILTER

Manufactured by

Union Carbide Corporation
Linde Division
270 Park Avenue
New York, N. Y. 10017

by

Charles M. Hunt

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, performance characteristics of a four-pleat Dynel fiber filter manufactured by the Linde Division of the Union Carbide Corporation were determined. The scope of the investigation included determination of the arrestance of the particulate matter in laboratory air and of Cottrell precipitate by the filter. Pressure drop across the filter at the rated flow of 1300 cfm was determined as the dust load was increased from zero to a final pressure drop in excess of 0.5 inches W. G., and the nominal dust holding capacity of the filter was determined.

2. Description of the Test Specimen

The filter consisted of a replaceable filter media which was formed into four vertical pleats, each about 11 inches deep. The filter fit into a heavy wire rectangular frame having face dimensions of 20 inches x 20 inches, corresponding to a face area of 2.77 ft^2.

The pleats were self-supporting, and were not held in place on the downstream side by the frame.

The filter media was white in color, and a scrim backing of about 4 threads per inch was cemented to the downstream surface. Under the microscope the fibers appeared somewhat flat with a typical thickness of about 15 microns and width of about 30 microns. The fibers would burn when held in a flame but extinquished immediately upon withdrawal.

3. Test Method and Procedure

The filter was tested at the rated capacity of 1300 cfm. The arrestance determination was 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 flow of air 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. Arrestance determinations were made with the particulate matter in laboratory air as the aerosol and also with Cottrell precipitate injected into the air stream at an average concentration of about one gram per 1000 cu ft of air.

The relative amount of light passing through the sampling papers was measured on the same area of each paper 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.

One of the requirements of the dust spot method is that the amount of light transmitted through the upstream and downstream dust spots be approximately equal. Since the test filter removes some of the dirt from the air, the downstream paper will nearly always be lighter unless means are taken to equalize the optical density of the two dust spots. This is accomplished by the unequal area method or the timer method. In the unequal area method, the downstream sample is drawn through a smaller area of paper than the upstream sample by means of unequal sampling plates. In the timer method the sampling areas are equal, but downstream sampling is continuous while upstream sampling is intermittent, and controlled by a timer with a 5 minute cycle. In most of the arrestance determinations reported here unequal sample areas were used to obtain dust spots of similar 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 relative change in the amount of light passing through the upstream and downstream papers due to the dust spots, and S_U and S_D represent the areas of sampling paper upstream and downstream. Two arrestances were made using the timer. In this case arrestance was calculated by the equation:

$$A = \left(1 - T \frac{\Delta D}{\Delta U}\right) \times 100, \qquad (2)$$

where T is the fraction of the time sampled upstream, and the other symbols have the same significance as before.

The filter was loaded with test dust consisting of 96 parts by weight of Cottrell precipitate and 4 parts of No. 7 cotton linters. The Cottrell precipitate was dispersed into the air stream at a rate of approximately 1 gram per 1000 cu ft 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 total dust fed, the pressure drop across the filter, and dust arrestance with atmospheric dust and Cottrell precipitate are given in Table 1. Individual arrestance values rather than averages are listed in this table because of the wide variation in individual values particularly with atmospheric dust. The data are also plotted

in Figure 1 where upper curve represents arrestance of Cottrell precipitate as a function of total dust fed, and the bottom curve is similar plot of pressure drop across the filter. Points are shown for atmospheric arrestance, but no curve is drawn because of the wide variations between replicate determinations, and no attempt was made to establish an average atmospheric arrestance. No entirely satisfactory explanation for the wide range of arrestances with atmospheric dust is offered, but the filter was of the dry type, of moderate efficiency, and may have released variable amounts of dust into the downstream duct by "unloading" during the test. About 6.5 grams of dust were collected from the first 5 feet of the floor of the duct downstream from the filter after completion of the test.

The initial arrestance of Cottrell precipitate was 80.3 percent, which is an average of the two determinations in Table 1. The average arrestance, based on the area under the upper curve in Figure 1, was 88.1 percent up to a pressure drop of 0.5 inches W. G. and 90.2 percent up to a pressure drop of 0.75 inches W. G.

The initial pressure drop across the filter was 0.245 inches. A pressure drop of 0.013 inches was obtained with an empty frame in the duct which had a 20 inch x 20 inch opening. This indicates that a small part of the pressure drop across the filter arose from the fact that it did not occupy the entire 2 ft x 2 ft duct area. The

filter reached a pressure drop of 0.5 inches W. G. after 860 grams of dust had been fed to the filter, and a final pressure drop of 0.754 inches W. G. was reached after 1362 grams of dust reached the filter. At 1300 cfm, 860 grams of dust corresponds to 660 grams per 1000 cfm of rated capacity.

In table 2 some of the important filter characteristics are compared with requirements for a type-C filter, according to General Services Administration Air Conditioning Standard of December 1964.

Table 1

Performance of Union Carbide Four-Pleat,
Dynel Filament Filter at Rated Capacity of 1300 cfm

Total dust fed[a] (grams)	Pressure drop (inches W.G.)	Percent Arrestance Atmospheric dust	Percent Arrestance Cottrell precipitate
0	0.245	22.9	79.9
---	----	40.3	80.7
---	----	30.3	----
---	----	30.2	----
120	.282	----	----
203	.305	30.6	85.7
---	.304[b]	58.8	84.0
---	----	46.7	----
---	----	56.8	----
---	----	48.1	----
370	.364	----	----
453	.386	33.5	87.0
---	.386[b]	35.5	89.2
---	----	28.5[c]	----
495	.403	----	----
598	.442	----	----
---	.436[b]	----	----
620	.468	----	----
810	.483	----	----
870	.505	37.2	94.3
---	.498[b]	35.8	92.3
---	----	20.4[c]	----
995	.545	----	----
1110	.597	----	97.0
----	----	----	92.1
----	----	----	92.0
1247	.670	----	----
1362	.754	----	93.2
----	----	----	93.2

a. 0.8g of dust was recovered upstream from the filter after the conclusion of the test. From this it is assumed that practically all dust fed reached the filter.

b. These pressure values were obtained after shutting down test duct overnight or over weekend and restarting.

c. These arrestance values were obtained with the timer, while all other values were obtained with plates of unequal area.

Table 2

Performance of Union Carbide Four-Pleat, Dynel Filament Filter compared with GSA Requirements for type-C filter

	Union Carbide filter	Requirement type-C filter
Nominal dust holding capacity when 0.5 inches W.G. is reached (grams per 1000 cfm capacity)	660	357
Average arrestance of Cottrell precipitate	88.1	80

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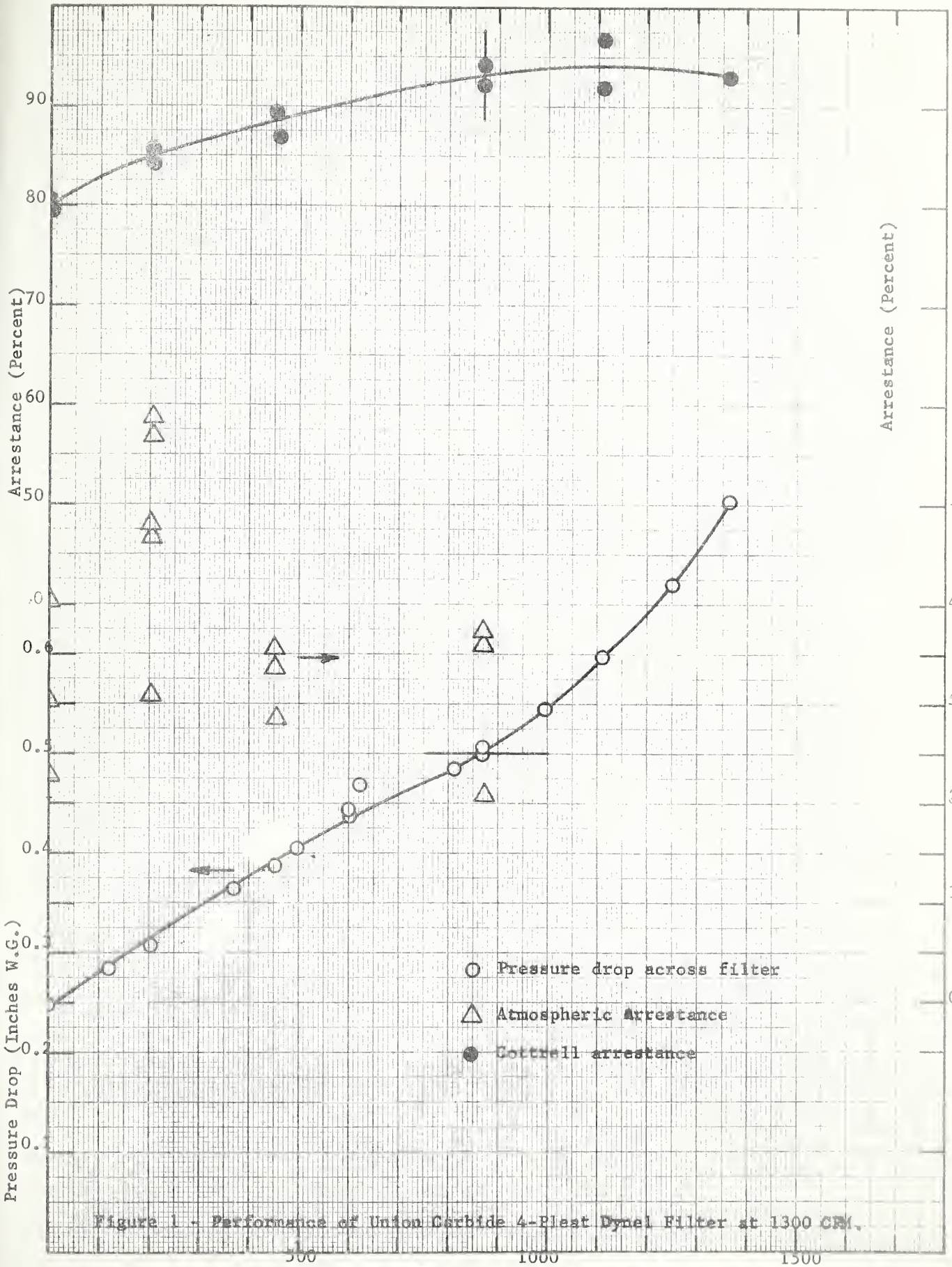

Figure 1 - Performance of Union Carbide 4-Plast Dynel Filter at 1300 CFM.


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