NATIONAL BUREAU OF STANDARDS REPORT

6428

PERFORMANCE TESTS OF TWO CLEANABLE IMPINGEMENT AIR FILTERS TYPE P-5

MANUFACTURED BY
AIR-MAZE CORPORATION
CLEVELAND, OHIO

by

Carl W. Coblentz and Paul R. Achenbach

Report to

Bureau of Yards and Docks
Office of the Chief of Engineers
Headquarters, U. S. Air Force
Washington, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS

PERFORMANCE TESTS OF TWO CLEANABLE IMPINGEMENT AIR FILTERS TYPE P-5, 1 IN. AND 2 IN. THICK

MANUFACTURED BY
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1. INTRODUCTION

The performance characteristics of two cleanable viscous impingement air filters were determined to provide information for evaluating the relative economy of cleanable versus throw-away types of filters. This investigation was requested by the Defense Department through the Tri-Service program of research and development at the National Bureau of Standards to obtain the required data for the preparation of new air filter specifications.

The test results presented in this report were obtained on two new filters and include determination of the arrestance and pressure drop as related to the specific dust load for face velocities of 360 ft/min and 540 ft/min and information on the cleanability of the test specimens.

2. DESCRIPTION OF TEST SPECIMENS

The two test specimens were of the cleanable viscous impingement type and were manufactured and supplied by the Air-Maze Corporation of Cleveland, Ohio. They were both identified as their type P-5, but were of different thicknesses. Both filters measured 19 1/2 in. square on the outside and had a free face area of 18 in. square, i.e., 2.25 sq ft. The nominal 1 in. thick filter had an actual thickness of 15/16 in. and the nominal 2 in. thick filter was 1 7/8 in. thick.

The filter media consisted of strips of 16-mesh crimped screen wire. The width of these strips was 7/8 in. and 1 3/4 in., respectively, and the strips were 19 in. long after crimping and were piled up 19 in. to cover the area of the filters. There were three 1/8 in. thick steel rods placed through the middle of

the pile of strips to provide rigidity in the direction of the air flow. The frames were made of 21 gage sheet steel bent into a continuous U-shaped channel.

The filters were oiled with an adhesive furnished by the manufacturer, identified as "Filterkote G."

3. TEST METHOD AND PROCEDURE

The performance of the filters was determined at 360 ft/min and 540 ft/min face velocity, i.e., at an air flow rate of 810 cfm and 1215 cfm, respectively. The clean filters were immersed in the adhesive and left to dry in the laboratory at least 16 hours before being weighed and installed in the test apparatus. The initial pressure drop at each air velocity was measured and then the initial arrestance at the air velocity desired for that test was determined with the NBS "Dust Spot Method" as described in the paper, "A Test Method for Air Filters," by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

The aerosol used for the arrestance determinations was Cottrell precipitate which had been sifted through a 100-mesh wire screen. In order to simulate actual operating conditions when loading the filters, four percent by weight of #7 cotton linters, previously ground in a Wiley mill with a four-millimeter screen, was fed simultaneously with the Cottrell precipitate. The pressure drop of the filters was recorded after each increment of 20 g of dust introduced into the apparatus. Whereas the arrestance measurements were made with 100 percent Cottrell precipitate, cotton linters were added to retain a ratio of four parts by weight to every 96 parts of Cottrell precipitate, including that amount used for the arrestance measurements. Arrestance determinations were made at the beginning and at the end of the loading period for each filter and at several intermediate load conditions. The filters were loaded with a dust concentration of approximately 1 g dust in 1000 cu ft of air until the pressure drop reached 0.5 in. W.G. in 360 ft/min face velocity tests and 0.8 in. W.G. in the tests with 540 ft/min face velocity.

After the filters had been loaded to capacity, they were cleaned with water and allowed to dry; then, oiled again as previously described, weighed and installed in the test apparatus for determining any change in pressure drop and in some cases for a new performance test.

4. TEST RESULTS

The data on pressure drop and arrestance observed for different dust loads are summarized in Tables 1 to 4, inclusive. An asterisk (*) behind the value of arrestance indicates that this value presents the average of two test runs.

Table 1

Performance of P-5 Filter (1 in. thick) at 360 ft/min Face Velocity

Dust Load g/sq ft	Pressure Drop in. W. G.	Arrestance %
0	0.055	-
3	0.056	50*
46	0.086	55
88	0.132	61
130	0.240	64
173	0.450	67
182	0.526	74*

Table 2

Performance of P-5 Filter (1 in. thick) at 540 ft/min Face Velocity

Dust Load g/sq ft	Pressure Drop in. W. G.	Arrestance %
0	0.125	-
5	0.130	52*
59	0.225	64
105	0.375	70
132	0.530	80
162	0.850	81*

Table 3

Performance of P-5 Filter (2 in. thick)
at 360 ft/min Face Velocity

Dust Load g/sq ft	Pressure Drop in. W. G.	Arrestance %
0	0.046	-
3	0.048	52*
54	0.072	53
102	0.102	58
149	0.132	60
197	0.190	61
244	0.290	63
300	0.525	71*

Table 4

Performance of P-5 Filter (2 in. thick)
at 540 ft/min Face Velocity

Dust Load g/sq ft	Pressure Drop in. W. G.	Arrestance %
0	0.128	-
5	0.129	57*
59	0.172	61
114	0.220	66
168	0.290	73
221	0.406	76
270	0.640	-
293	0.820	81*

The dust load per square foot net face area is the weight of dust and lint introduced into the test apparatus minus the fall-out in the upstream portion of the test duct divided by the net face area of the filter. The total fall-out was determined at the end of each test by sweeping out the upstream portion of the test duct. For computing the dust load per square foot net face area the amount of dust and lint introduced into the test apparatus was multiplied by one minus the ratio of fall-out to the total dust introduced according to the following

formula:

$$L = \frac{D \times (1 - F)}{A}$$

where: L = dust load, g/sq ft
D = dust and lint introduced, g
A = net filter area, sq ft

$$F = \frac{\text{total fall-out}}{\text{total dust and lint introduced}}, \text{ at the end of the test}$$

The values of the above tables are graphically presented in Fig. 1 and Fig. 2 as smooth curves that approximate the curves of the least mean square distances of the individual points of observation.

It will be noted that the arrestance increased with increasing dust loads, but the rate of increase varied for the two filters and also with the face velocity. For both filters the increase of the arrestance was from 20 to 30 percent, and the arrestance at equal dust loads was higher at the higher air velocity.

The dust loads indicated by these graphs at 0.5 in. W.G. pressure drop for 360 ft/min face velocity and at 0.8 in. W.G. for 540 ft/min face velocity are shown in Table 5 as "Dust Holding Capacity". Also shown in this table are the mean arrestance values of each filter for each of the two face velocities during the period in which the capacity dust load was being deposited. As was to be expected, the dust holding capacity of the 1 in. thick filter was considerably lower than that of the two-inch thick one. However, the mean arrestance was found to be the same for both filters at either face velocity.

Air Maze - P-5 (1 in. thick)

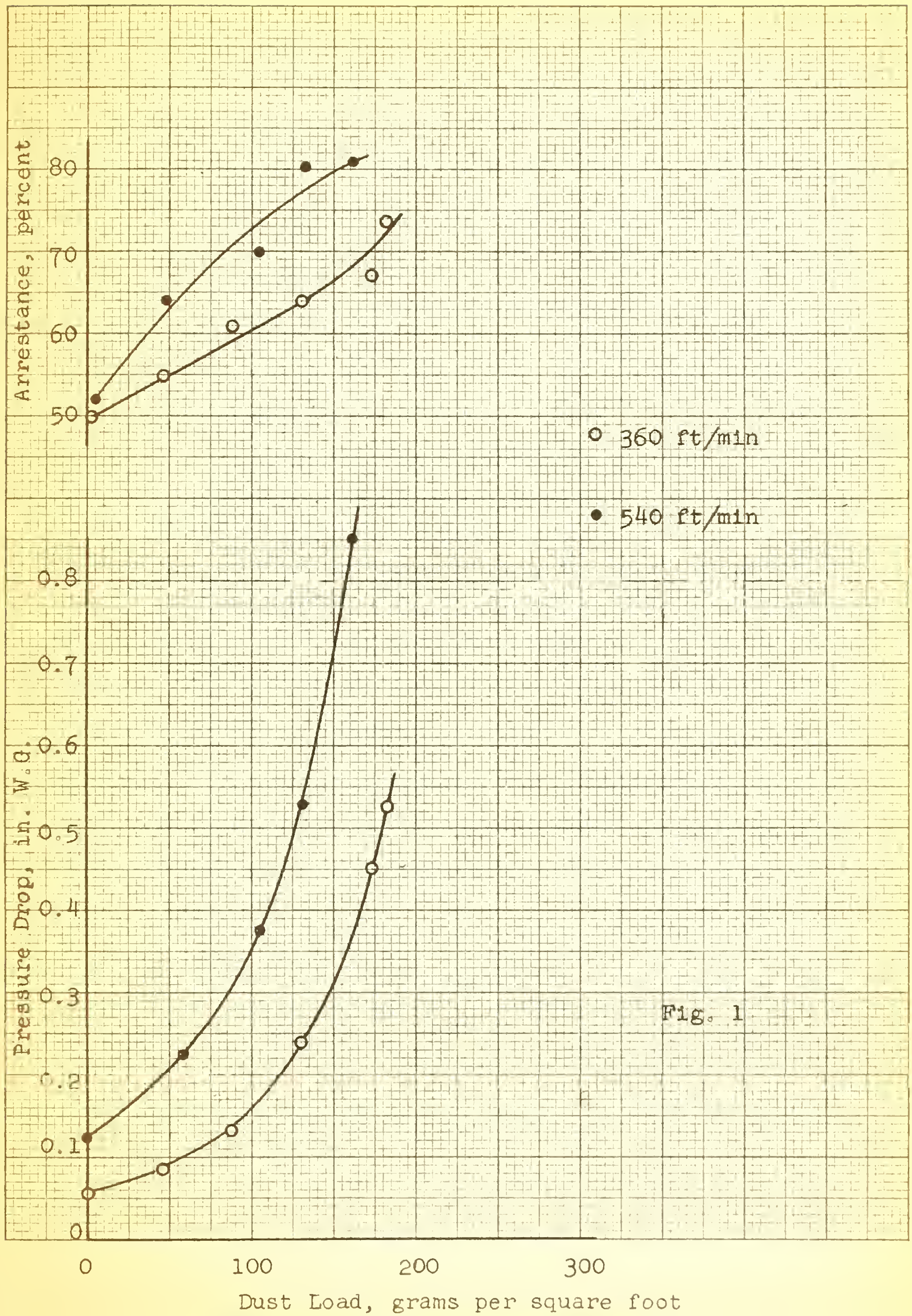

Fig. 1

Air Maze - P-5 (2 in. thick)

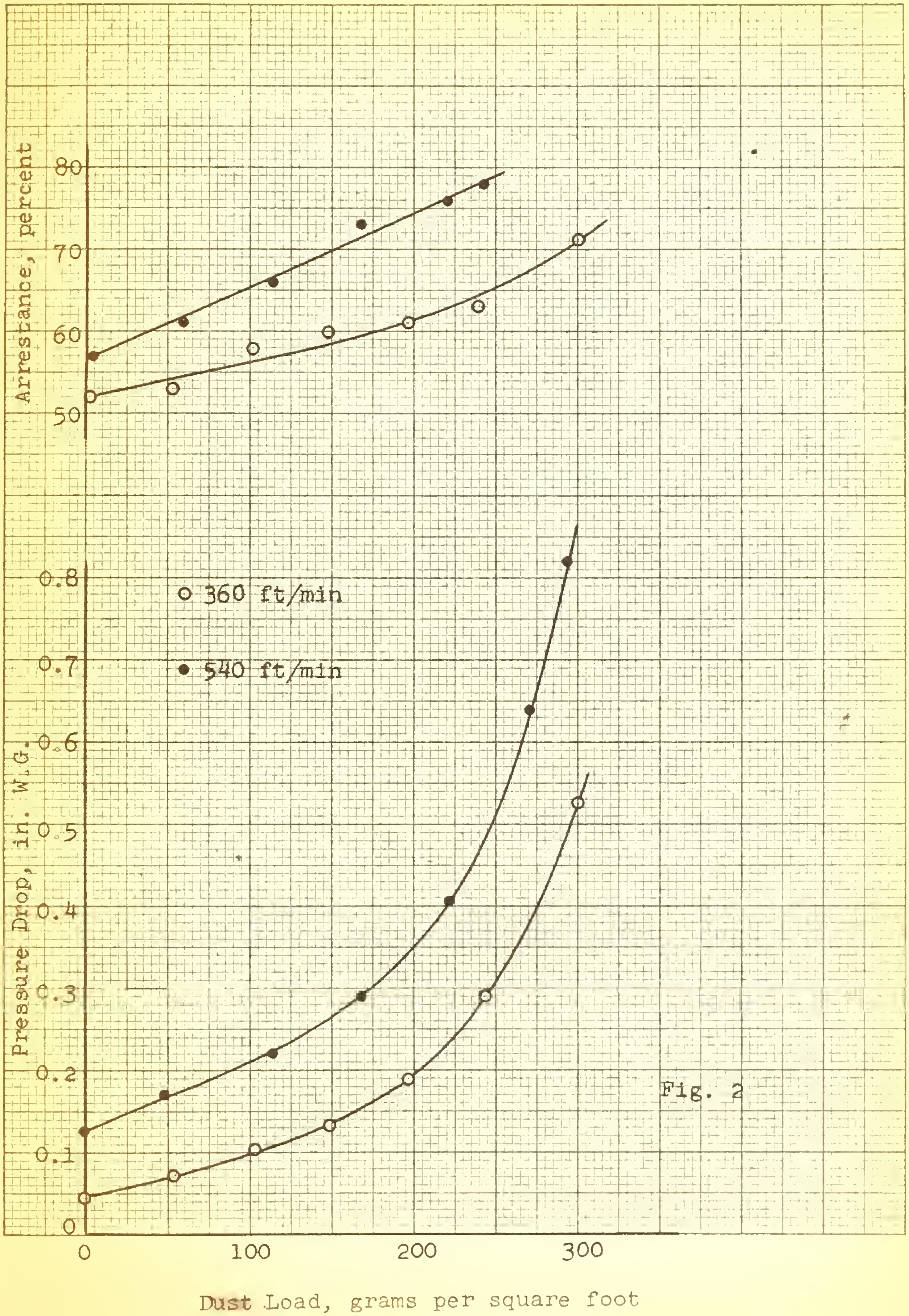

Fig. 2

Table 5

Dust Holding Capacity and Mean Arrestance

Thickness of Filter, in.	1		2	
Face Velocity, ft/min	360	540	360	540
Final Pressure Drop, in. W.G.	0.5	0.8	0.5	0.8
Dust Holding Capacity, g/sq ft	180	158	296	293
Mean Arrestance, %	60	68	60	68

The weights of the oiled and drained filters determined before installation in the test apparatus and also their pressure drop at both face velocities are shown in Table 6 for the new filters and after each loading and cleaning cycle.

Table 6

Cleanability of Filters

Thickness and Condition of Filter	Weight of Filter grams	Pressure Drop, in. W.G. at Face Velocity 360 ft/min	540 ft/min
1 in. thick			
New	2412	0.055	0.110
After 1 loading and cleaning	2477	0.060	0.125
After 2 loadings and cleanings	2535	0.085	0.170
2 in. thick			
New	3455	0.046	0.105
After 1 loading and cleaning	3630	0.060	0.128
After 2 loadings and cleanings	3815	0.071	0.141

The cleaning of the filters was performed with a stream of about 150 F water and was continued until the waste appeared clean. The increase of the weight of the filters after each loading and cleaning cycle indicates that a considerable part of the dust had not been removed by careful washing of the filters. This fact is corroborated by the steady increase of the pressure drop values of the filters after each loading and cleaning cycle.

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THE NATIONAL BUREAU OF STANDARDS

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Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

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Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

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