NATIONAL BUREAU OF STANDARDS REPORT

6400

PERFORMANCE TESTS OF TWO CLEANABLE IMPINGEMENT
AIR FILTERS TYPES ALH-1 AND ALI-2

MANUFACTURED BY
AMERICAN AIR FILTER COMPANY
LOUISVILLE, KENTUCKY

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.

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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NATIONAL BUREAU OF STANDARDS

PERFORMANCE TESTS OF TWO CLEANABLE IMPINGEMENT AIR FILTERS TYPES ALH-1 AND ALI-2 AMERICAN AIR FILTER COMPANY

by

C. W. Coblentz and P. R. Achenbach

1. Introduction

The performance characteristics of a group of cleanable impingement type 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 a function of the specific dust load at face velocities of 360 ft/min and 540 ft/min and information on the cleanability of the filters.

2. Description of Test Specimens

The two test specimens were of the cleanable viscous impingement type and were manufactured and supplied by the American Air Filter Company of Louisville, Kentucky. They were identified as types ALH-1 and ALI-2. The frames of these filters were made of U-shaped channels of aluminum, approximately 0.063 in. thick. The filter media consisted of 4 in. wide strips of corrugated and expanded aluminum sheet, approximately 0.010 in. thick. Six of these strips were laid side by side with overlapping edges to form each layer of the media. There were two of these layers in the 1-in. thick type and 3 layers of this material in the 2-in. thick filter. The direction of the strips and the corrugations in adjacent layers was oriented by 90 degrees with respect to each other. The ALH-1 type filter had steel wire grids on the upstream and downstream sides, made of wire with a diameter of 0.1 inch. The grids were comprised of five wires running in each direction and welded at the cross-overs to form

4 in. squares. The ALI-2 type had grids of expanded steel sheet on both sides. The outside of the filters measured 19 7/16 in. square and the free inside area was 18 in. square. The actual thickness of the ALH-1 type filter was 7/8 in. and that of the ALI-2 type filter was 1 7/8 in. The weights of the specimens were 2 lbs (902 grams) and 5 lbs, 2 oz (2330 grams), respectively, when oiled and ready for use.

The adhesive used during the tests was supplied by the manufacturer and was identified as "Viscosine BA".

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 drops and arrestances determined during the tests at both face velocities are summarized in Tables 1 through 4. It should be noted that an asterisk (*) behind the values of arrestance indicates that this value is the average of two tests.

Table 1

Performance of Type ALH-1 at 360 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.055	-
3	0.056	38*
96	0.095	45*
181	0.150	48*
249	0.215	52*
334	0.405	52*
368	0.508	52*

Table 2

Performance of Type ALH-1 at 540 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.120	-
5	0.122	46*
68	0.139	47*
186	0.182	47
249	0.216	46*
321	0.263	48
457	0.390	47*
601	0.589	45*
692	0.807	46*

Table 3

Performance of Type ALI-2 at 360 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.105	-
3	0.110	47*
63	0.120	53*
156	0.170	54*
266	0.225	57
385	0.350	60*
471	0.508	62*

Table 4

Performance of Type ALI-2 at 540 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.240	-
5	0.240	57*
68	0.255	57
123	0.277	57*
195	0.309	57*
330	0.385	57*
457	0.465	57*
583	0.560	58*
710	0.705	59*
773	0.802	52*

Fig. 1 and Fig. 2 show the values of the pressure drop and arrestance plotted against the specific dust load, using smooth curves to approximately fit the individual points of observation.

The test results show that for both types of filters, the pressure drop increased more slowly at 540 ft/min face velocity than at 360 ft/min face velocity. The change in pressure drop caused by increasing the face velocity from 360 ft/min to 540 ft/min was 0.065 in. W.G. for the 1-in. thick filter and 0.135 in. W.G. for the 2-in. thick filter with the media clean in each case.

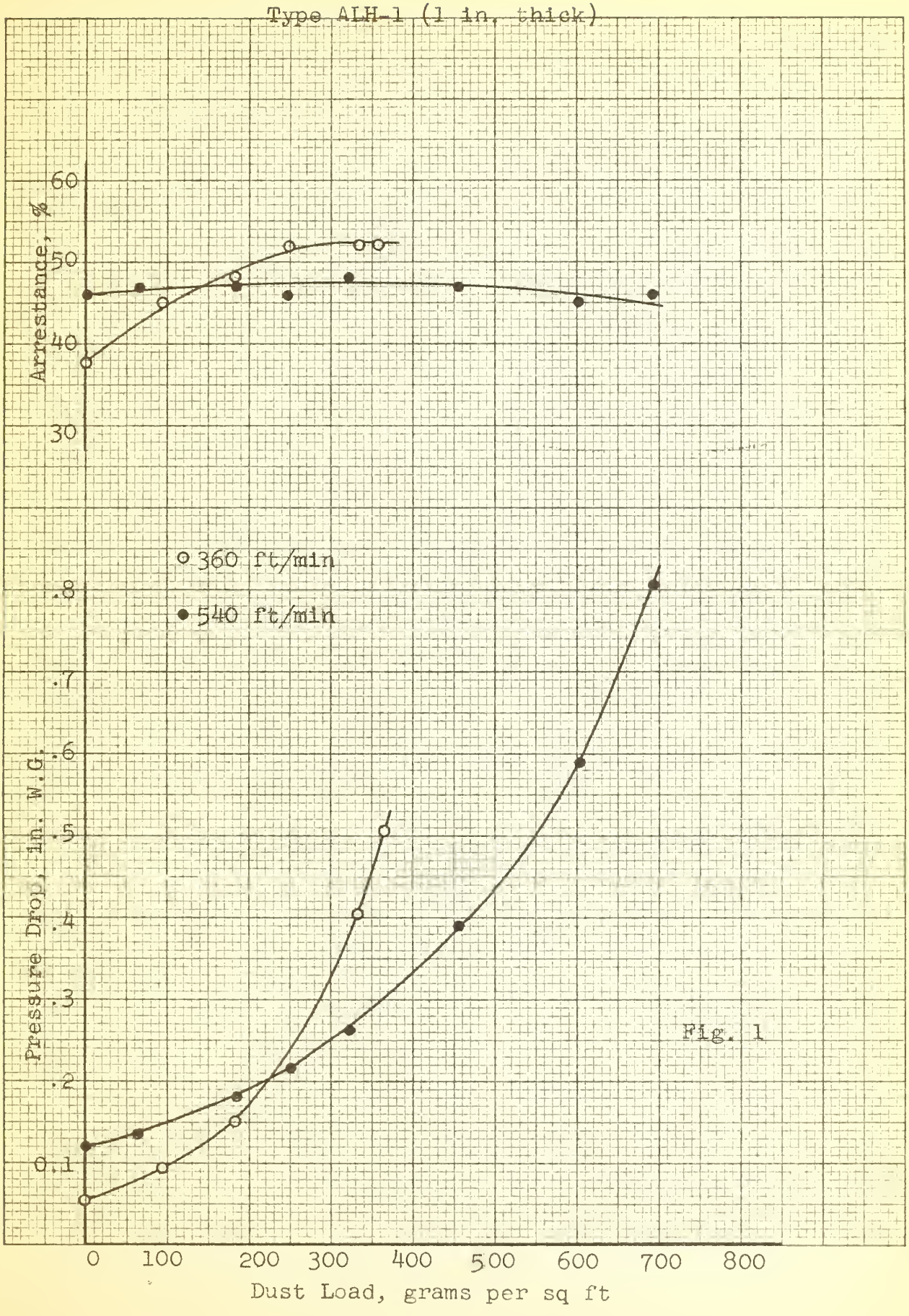
Type ALH-1 (1 in. thick)
Arrestance, %
60
50
40
30
Pressure Drop, in. W.G.
.8
.7
.6
.5
.4
.3
.2
0.1
360 ft/min
540 ft/min
0
100
200
300
400
500
600
700
800
Dust Load, grams per sq ft

Fig. 1

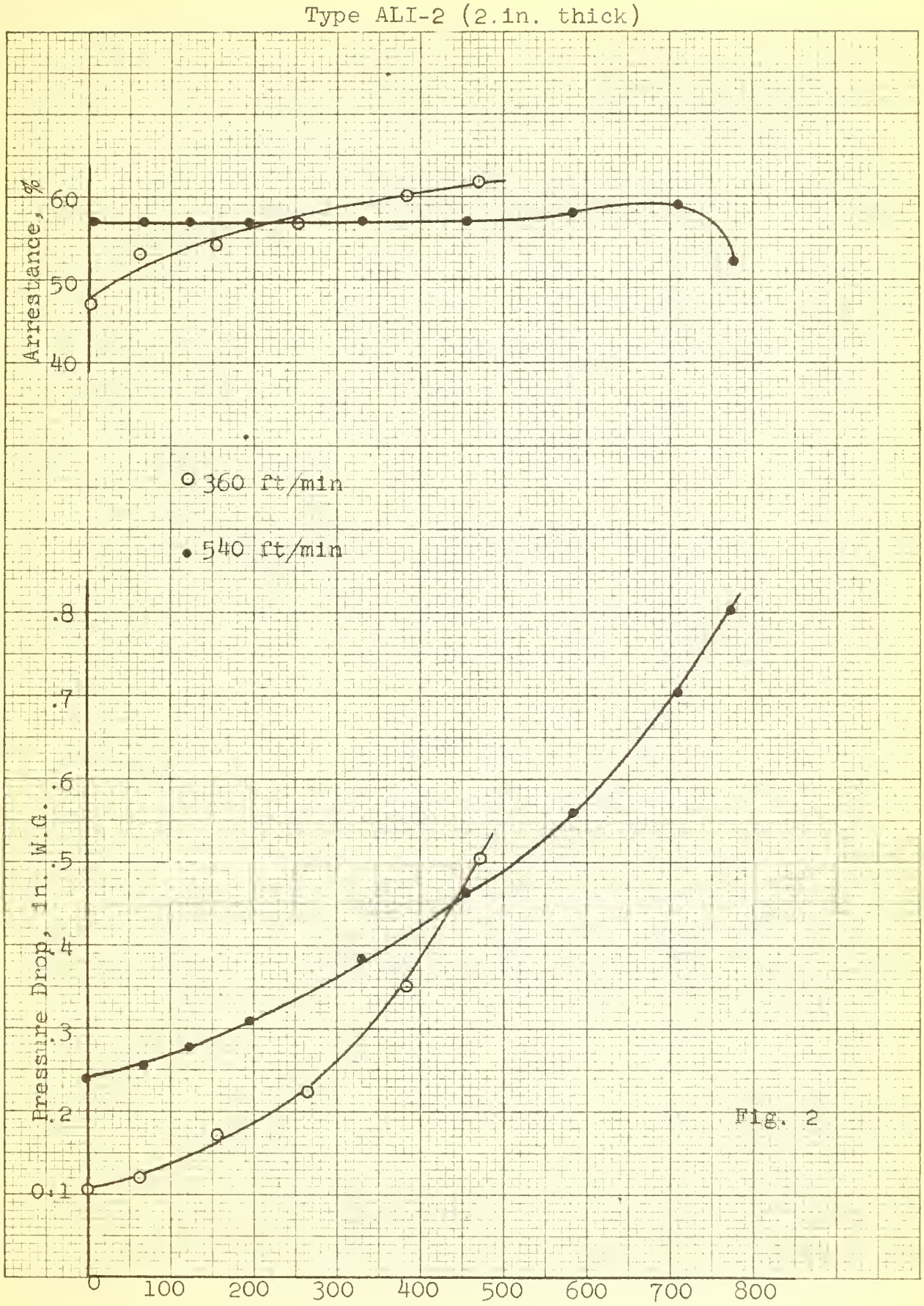

Fig. 2

K&E CO., N.Y. 01659

But the specific dust loads at 0.5 in. W.G. pressure drop, as indicated by the graphs, was 362 g at the lower face velocity and 550 g at the higher face velocity for the ALH-1 type and 468 g and 518 g for the ALI-2 type. This seems to indicate that the accumulation of dust and lint at the face of the filter was considerably heavier at the lower air flow rate and that at the higher air flow rate a better dust loading throughout the thickness of the filter media occurred.

The arrestance of both types increased with the loading of the filters during the 360 ft/min face velocity tests, but it remained practically constant at the 540 ft/min face velocity tests. The 1-in. thick filter showed an overall slight decrease of the arrestance at the higher flow rate whereas the 2-in. thick type showed a constant arrestance during the first 60 percent of its loading, then increased slightly and dropped off. This drop of the arrestance was probably caused by dust being forced through the medium which had been fully loaded over its entire depth.

The dust loads for both types as shown in Fig. 1 and 2 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 have been tabulated in Table 5 as "Dust Holding Capacity". Also shown in this table are the mean arrestance values for each filter at both air flow rates during the period in which the capacity dust load was being deposited.

Table 5

Dust Holding Capacity and Mean Arrestance
(Determined from Fig. 1 and 2)

Type of Filter	ALH-1		ALI-2	
Thickness of Filter Media, 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	362	690	468	775
Mean Arrestance, percent	47	47	56	57

This table shows that the change of face velocity did not affect the mean arrestance value of the 1-in. thick filter and increased by only one percent that of the 2-in. thick filter. The dust holding capacity increased at the higher face velocity from 362 g to 690 g (91 percent) for the 1-in. type and from 468 g to 775 g (56 percent) for the 2-in. type.

The useful life of a filter of this type depends on its structural stability as well as on its ability to be satisfactorily cleaned after each loading. The cleanability of each of the test specimens was indicated by a comparison of the weights and pressure drops of the oiled and drained filters when new and after each of two loading and cleaning cycles.

Table 6

Cleanability of Filters

Condition of Filter	Weight of Filter grams	Pressure Drop, in. W.G. 360 ft/min	540 ft/min
1-in. Thick Medium, Type ALH-1			
New	902	0.055	0.128
After 1 loading and cleaning	892	0.050	0.120
After 2 loadings and cleanings	890	0.055	0.125
2-in. Thick Medium, Type ALI-2			
New	2330	0.105	0.245
After 1 loading and cleaning	2318	0.105	0.240
After 2 loadings and cleanings	2330	0.105	0.240

Table 6 shows that neither the weight nor the pressure drop of the filters increased after two loading and cleaning cycles. The deviations shown in the weights and pressure drop may be caused by differences in the thickness of the oil coating on the filter media.

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