PERFORMANCE TEST OF A "DUSTFOE" DISPOSABLE AIR FILTER

manufactured by
Mine Safety Appliances Company
Pittsburgh, Pennsylvania

by

Carl W. Coblentz and Paul R. Achenbach

Report to
General Services Administration
Public Buildings Service
Washington 25, D. C.
THE NATIONAL BUREAU OF STANDARDS

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A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (Includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
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Mechanical Systems Section
Building Research Division

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IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
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1. **Introduction**

At the request of the Federal Supply Service, General Services Administration, the performance characteristics of a Dustfoe disposable air filter manufactured by the Mine Safety Appliances Company of Pittsburgh, Pennsylvania, were determined. The scope of this examination included the determination of the arrantace of the particulate matter in the laboratory air, the pressure drop and the dust holding capacity of the test specimen at the rated air flow rate of 1,000 cfm.

2. **Description of Test Specimen**

The test specimen was manufactured and supplied for test purposes by the Mine Safety Appliances Company of Pittsburgh, Pennsylvania. The outside dimensions of the filter unit were 23 1/4 in. square by 5 7/8 in. deep, its weight was 5,355 g (about 11 1/2 lbs.). Four pieces of hard fiber board, each about 23 in. long, 5 7/8 in. wide, and 1/4 in. thick formed a rigid box frame with sheet metal angles as corners. The filter media was arranged in 46 pleats that were supported by a wire framework. The media was cemented to the inside of the box frame. The total area of the filter media was approximately 75 sq ft and it consisted of a loose glass fiber paper that was supported on both sides by a 10-mesh webbing of a stiff organic fiber thread which did not sustain combustion.

The test specimen was operated at its rated air flow rate of 1,000 cfm. Based on a gross face area of 3.75 sq ft, this air flow rate corresponded to a face velocity of 267 ft/min, or with reference to the 75 sq ft of filter media installed in the filter to an average media face velocity of approximately 13.3 ft/min.

3. **Test Method and Procedure**

The arrantance measurements were made in accordance with the "NBS Dust Spot Method" described in a paper by R. S. Dill and entitled "A Test Method for Air Filters" (ASHVE Transactions, Vol. 44, p. 379, 1938).
For test purposes, the filter element was installed in the test apparatus and carefully sealed to prevent inward leakage of air except through the measuring orifice. The desired rate of air flow through the filter was established and samples of air were drawn from the center points of the test duct two feet upstream and eight feet downstream of the test specimen at equal rates and passed through known areas of Whatman No. 41 filter paper. The change of the opacity of these areas was determined with a sensitive photometer which measured the light transmission of the same spot 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.

All but one of the arrestance determinations were made using the particulate matter in the laboratory air as the aerosol. For these tests equal sampling areas were used for the upstream and downstream samplers. A similar increase of the opacity of the upstream and downstream filter papers was obtained by passing the sampling air through the upstream paper only part of the time while operating the downstream sampler continuously. This was accomplished by installing one solenoid valve in the upstream sampling line and another one as a by-pass for the sampler and first solenoid valve. The valves were operated by an electric timer and a relay so that one was open while the other one was closed during any desired percentage of the 5-minute timer cycle, reversing the position of the two valves during the remainder of the cycle. The arrestance, A (in percent), was then determined with the following formula:

\[ A = 100 - T \times \frac{\Delta D}{\Delta U} \]

where \(T\) is the percentage of time during which air was drawn through the upstream sampler, \(\Delta U\) and \(\Delta D\) being the changes of opacity of the sampling papers, as previously indicated.

For determining the arrestance of the filter, with Cottrell precipitate as the test dust, different size areas of sampling papers were used upstream and downstream of the filter in order to obtain a similar increase of opacity on both sampling papers.

For each arrestance determination with Cottrell precipitate, the upstream sample of the aerosol was collected on one filter paper for about half of the test period and on a second filter paper during the remainder of the test period. The downstream sampling paper collected the dust for the entire test. This method was used to avoid too large differences in the dust spots when determining Cottrell precipitate arrestance values
### Table 1

**PERFORMANCE OF A MINE SAFETY APPLIANCES COMPANY**  
"DUSTFOE" DISPOSABLE AIR FILTER  
**AT AN AIR FLOW RATE OF 1000 CFM**

<table>
<thead>
<tr>
<th>Dust Load (g)</th>
<th>Pressure Drop (in. W.G.)</th>
<th>Arrestance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.415</td>
<td>85.0</td>
</tr>
<tr>
<td>0</td>
<td>0.417</td>
<td>84.6</td>
</tr>
<tr>
<td>15</td>
<td>0.437</td>
<td>98.9*</td>
</tr>
<tr>
<td>99</td>
<td>0.587</td>
<td>88.8</td>
</tr>
<tr>
<td>158</td>
<td>0.700</td>
<td>89.4</td>
</tr>
<tr>
<td>238</td>
<td>0.901</td>
<td>--</td>
</tr>
<tr>
<td>257</td>
<td>0.989</td>
<td>92.2</td>
</tr>
<tr>
<td>257</td>
<td>1.20</td>
<td>94.1</td>
</tr>
</tbody>
</table>

*Cottrell precipitate was used as the aerosol in this test, all other arrestance determinations were made using the particulate matter in the laboratory air as the aerosol.*
on the order of 99 percent. The arrestance, A (in percent), was then calculated by the formula:

\[
A = \left(1 - \frac{S_D}{S_U} \times \frac{\Delta D}{\Delta U_1 + \Delta U_2}\right) \times 100
\]

where \(S_U\) and \(S_D\) are the upstream and downstream sampling areas and \(\Delta U_1\), \(\Delta U_2\), and \(\Delta D\) the observed changes in the opacity of the two upstream and one downstream sampling papers, respectively.

After making two arrestance determinations with the particulate matter in the laboratory air as the aerosol, one arrestance determination was made with Cottrell precipitate. The specimen was then loaded with Cottrell precipitate and lint at a rate of 1 gram of dust per 1,000 cu ft of air. Cotton lint was added during the loading process in a ratio of 4 parts to every 96 parts by weight of Cottrell precipitate, including the amount used for the one arrestance measurement. The Cottrell precipitate was previously sifted through a 100-mesh screen and the lint was prepared by grinding No. 7 cotton linters in a Wiley mill with a 4-millimeter screen.

Four more arrestance determinations were made at selected intervals with the particulate matter in the laboratory air as the aerosol. The pressure drop across the filter was recorded at the beginning and at the end of each arrestance determination and also after introducing each increment of 20 grams dust into the test apparatus. The test was terminated when the pressure drop exceeded 1 in. W.G.

4. Test Results

The test results are summarized in Table 1 which shows the pressure drop across the filter and the arrestance values determined at several dust load conditions.

The "Dust Load" shown in this table is the weight of Cottrell precipitate and lint received by the filter. It is the total aerosols introduced into the test apparatus diminished by the percentage of fallout upstream of the filter. This dust fallout was determined at the conclusion of the test by sweeping out the test duct on the approach side of the test specimen. The fallout amounted to 13 grams, or 4.8 percent of the total 270 g of Cottrell precipitate and lint introduced into the test apparatus during the test.

It will be noted that the arrestance of the particulate matter in the laboratory air increased from about 85 percent to 94 percent while the filter received a dust load of 257
grams. Only one arrestance determination was made with Cottrell precipitate as the aerosol indicating almost 99 percent with a clean filter. The pressure drop of the clean filter was 0.415 in. W.G.

Figure 1 presents a graph of the values shown in Table 1 with the pressure drop and the arrestance values plotted against the dust load. Smooth curves were drawn through the plotted points representing the observed data. This graph shows that the pressure drop increased in almost direct proportion to the dust load until more than 200 grams had been introduced and then rose very sharply. This rise in pressure drop coincides with a sudden rise of approximately 3 percent in the observed arrestance. This sudden rise in pressure drop and increase in arrestance occurred during a period of about 2 hours in which an atmospheric arrestance determination was being made and no additional Cottrell precipitate was added.

According to these graphs, the dust load at 1.00 in. W.G. pressure drop was 255 grams and the average arrestance approximately 89 percent.
MINE SAFETY APPLIANCES COMPANY "DUSTFOE" FILTER

PERFORMANCE CURVES FOR AIRBORNE DUST
AIR FLOW RATE, 1000 C.F.M.

FIGURE 1
THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

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