PERFORMANCE TEST OF A HIGH-VELOCITY ELECTROSTATIC AIR CLEANER, MODEL HV-1

Manufactured by
Dollinger Corporation
Rochester, New York

by
C. W. Coblentz and P. R. Achenbach

Report to
General Services Administration
Public Buildings Service
Washington 25, D. C.
The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers. These papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($1.50), available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.
PERFORMANCE TEST OF A HIGH-VELOCITY ELECTROSTATIC AIR CLEANER, MODEL HV-1

Manufactured by
Dollinger Corporation
Rochester, New York

by
C. W. Coblentz and P. R. Achenbach
Mechanical Systems Section
Building Research Division

to
General Services Administration
Public Buildings Service
Washington 25, D. C.

IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS REPORTS are usually preliminary or progress accounting documents intended for use within the Government. Before material in the reports is formally published it is subjected to additional evaluation and review. For this reason, the publication, reprinting, reproduction, or open-literature listing of this Report, either in whole or in part, is not authorized unless permission is obtained in writing from the Office of the Director, National Bureau of Standards, Washington 25, D. C. Such permission is not needed, however, by the Government agency for which the Report has been specifically prepared if that agency wishes to reproduce additional copies for its own use.
PERFORMANCE TEST OF A HIGH-VELOCITY
ELECTROSTATIC AIR CLEANER, MODEL HV-1

Manufactured by
Dollinger Corporation
Rochester, New York

by

C. W. Coblentz and P. R. Achenbach

1. INTRODUCTION

At the request of the Public Buildings Service, General
Services Administration, the performance characteristics of a
high-velocity electrostatic precipitator, Model HV-1, manu-
factured by the Dollinger Corporation of Rochester, New York,
were determined. The scope of this examination included the
determination of the arrestance of the particulate matter in
the laboratory air and of Cottrell precipitate, the pressure
drop, and the dust-holding capacity of the specimen.

2. DESCRIPTION OF TEST SPECIMEN

The device was manufactured and supplied for test purposes
by the Dollinger Corporation of Rochester, New York. The test
specimen was described as a "high-velocity cell."

The outside dimensions of the collector cell were 20 in.
high by 23 in. wide, and 22 3/4 in. deep; the inside air passage
measured 18 1/4 in. by 21 3/4 in. corresponding to a gross face
area of 3.20 sq ft and a net face area of 2.76 sq ft for the
cell. The collector plates were made of aluminum sheet 0.0343
in. thick and measured 18 1/2 in. by 16 in. with eleven 18 1/2
by 18 1/2 plates extended to furnish the struds between the ten
ionizer wires. The plates were spaced 5/16 in. center-to-center.

The 100-watt power pack had two high voltage terminals of
equal but opposite polarity. The positive terminal was con-
ected to the ionizer wires and the negative terminal to the
group of collector plates which included the struds between
the ionizer wires. The alternate collector plates were grounded.
The cell was equipped with a cleanable viscous impingement type
after-filter, Air-Maze Corporation Type P-5, measuring 23 in.
by 19 3/4 in. by 1 7/8 in. outside and having a net face area
of 21 3/4 in. by 18 1/8 in., or 2.69 sq ft.
3. TEST METHOD AND PROCEDURE

The arrestance 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 collector cell 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.

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 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 excessive differences in the dust spots when determining Cottrell precipitate arrestance values above 95 percent. The arrestance, A (in percent), was then calculated by the formula:

$$A = \left(1 - \frac{SD}{SU} \cdot \frac{\Delta D}{\Delta U_1 + \Delta U_2}\right) \times 100$$

where SU and SD are the upstream and downstream sampling areas and ΔU1, ΔU2, and ΔD the observed changes in the opacity of the two upstream and one downstream sampling papers, respectively.

For determining the arrestance of the particulate matter in the laboratory air, 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 a solenoid valve in the upstream sampling line and using another one to by-pass the upstream 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.

After installing the device, the power pack was connected to the laboratory electric supply line and the static potentials at 115 volts input measured with an electrostatic kilovoltmeter were then 6,500 volts. By means of a variable voltage transformer, the line voltage was adjusted during subsequent readings of the static voltage to 115 volts \( \pm \) 1/4 volt but was allowed to drift between readings.

Several arrestance determinations, made under this condition, using the particulate matter in the laboratory air as the aerosol, indicated that the air flow rate at which 90% arrestance was obtained had to be reduced below the design air flow rate of 1800 cfm. After consulting with the manufacturer, the static potential was raised to \( \pm \) 6,850 volts, and the arrestance with atmospheric air was again determined.

Following the initial arrestance determinations with the particulate matter in the laboratory air as the aerosol, the arrestance of the device was determined with laboratory air into which Cottrell precipitate was dispersed at a rate of one gram per thousand cubic feet of air. The loading of the filter was then commenced with 4 parts lint by weight added to every 96 parts of Cottrell precipitate. The Cottrell precipitate had been previously sifted through a 100-mesh screen and the lint was prepared from No. 7 cotton linters which were ground in a Wiley mill with a 4 mm screen. Each aerosol was dispersed separately into the air stream. As the loading progressed, arrestance determinations were made at selected intervals using either the laboratory air alone or laboratory air with Cottrell
precipitate. No lint was introduced into the test apparatus during the arrestance determinations with Cottrell precipitate, but an appropriate amount of lint was added to maintain the overall ratio of 4 to 96. The pressure drop across the test specimen, the ionizer and plate voltages, and the frequency of noticeable electrostatic discharges were recorded at each arrestance determination and also after each increment of 20 grams of Cottrell precipitate had been introduced into the test apparatus.

Thirteen arrestance determinations were made during the loading period with air flow rates ranging from 1,400 to 2,200 cfm using either Cottrell precipitate or the particulate matter of the laboratory air as the aerosol. A total of 1,214 grams of Cottrell precipitate and lint were introduced into the test apparatus during the loading in conformance with the regular practice of terminating the test of such filters with a dust load of 2/3 grams for each cfm rated air flow.

4. TEST RESULTS

The test specimen had a rated air flow rate of 1,800 cfm with a gross face area of 3.20 sq ft. This corresponded to a face velocity of 563 ft/min.

A summary of the test results is presented in Table 1 and shows the air flow rates, dust load, pressure drop, and arrestance values observed with the particulate matter in the laboratory air as well as with Cottrell precipitate as the aerosol. The effect of the dust load on the pressure drop and on the arrestance of the particulate matter in the laboratory air is plotted in Figure 1 and smooth curves were fitted to the plotted points.
Table 1

Performance of the
Dollinger Corporation Electrostatic Precipitator
(at ± 6850 volts potential)

<table>
<thead>
<tr>
<th>Air Flow Rate cfm</th>
<th>Dust Load grams</th>
<th>Pressure Drop in. W. G.</th>
<th>Arrestance %</th>
<th>Aerosol **</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400</td>
<td>0</td>
<td>0.116</td>
<td>95.1*</td>
<td>A</td>
</tr>
<tr>
<td>1800</td>
<td>0</td>
<td>0.183</td>
<td>91.1*</td>
<td>A</td>
</tr>
<tr>
<td>2200</td>
<td>0</td>
<td>0.257</td>
<td>87.8*</td>
<td>A</td>
</tr>
<tr>
<td>1800</td>
<td>12</td>
<td>0.183</td>
<td>97.8</td>
<td>C</td>
</tr>
<tr>
<td>1800</td>
<td>323</td>
<td>0.229</td>
<td>97.9</td>
<td>C</td>
</tr>
<tr>
<td>1800</td>
<td>323</td>
<td>0.229</td>
<td>90.9</td>
<td>A</td>
</tr>
<tr>
<td>1800</td>
<td>601</td>
<td>0.296</td>
<td>90.5</td>
<td>A</td>
</tr>
<tr>
<td>1800</td>
<td>974</td>
<td>0.399</td>
<td>90.5</td>
<td>A</td>
</tr>
<tr>
<td>1800</td>
<td>1202</td>
<td>0.508</td>
<td>89.0</td>
<td>A</td>
</tr>
<tr>
<td>1800</td>
<td>1214</td>
<td>0.513</td>
<td>95.4</td>
<td>C</td>
</tr>
</tbody>
</table>

* Average of two tests.

** A = Particulate matter in laboratory air.
  C = Cottrell precipitate in laboratory air.

It will be noted that the arrestance of atmospheric dust at the rated air flow rate was 91.1 percent with a clean filter and 89.0 percent with a dust load of 1,202 grams. The pressure drop increased during loading from an initial value of 0.116 in. W.G. to 0.508 in. W.G. Reducing the air flow rate to 1,400 cfm increased the initial arrestance to 95.1 percent while an increase to 2,200 cfm reduced it to 87.8 percent. The average arrestance of Cottrell precipitate was 97 percent.

Table 2 shows the arrestance of the test specimen at two different static potentials giving a comparison between the initial tests at 6,500 volts and the later tests at 6,850 volts. The values are plotted in Figure 2. The arrestance at 6,500 volts was extrapolated above 1,800 cfm as a dashed line. The difference in the arrestance at the two static potentials was 1.9 percent at 1,400 cfm air flow rate; it increased to 2.2 percent at 1,800 cfm, and to approximately 2.5 percent at 2,200 cfm.
Table 2
Arrestance at Reduced Static Potential

<table>
<thead>
<tr>
<th>Air Flow Rate, cfm</th>
<th>1400</th>
<th>1800</th>
<th>2200</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,500 volts</td>
<td>93.2</td>
<td>88.9</td>
<td>85.2*</td>
</tr>
<tr>
<td>6,850 volts</td>
<td>95.1</td>
<td>91.1</td>
<td>87.8</td>
</tr>
</tbody>
</table>

* extrapolated from Figure 2.

An examination of the collector cell at the conclusion of the test showed that all plates were about evenly covered with a light layer of dust. The after-filter and the collector cell were washed with water and no difficulty was encountered in cleaning out the dust that had accumulated during the test.

The number of electrical discharges between plates observed during the tests reached, at one time, 19 per minute but it was considerably less during most of the test and no discharges at all were noticed during about half of the operating time.
DOLLINGER CORPORATION ELECTROSTATIC PRECIPITATOR
MODEL HV-1
Arrestance and Pressure Drop v/s Dust Load
at 1800 cfm Air Flow Rate and ± 5850 Volts Potential

Figure 1
MODEL HV-1
DOLLINGER CORPORATION ELECTROSTATIC PRECIPITATOR

Arrestance of Clean Filter v/s Air Flow Rate
For Two Values of Applied Voltage

Air Flow Rate, cfm

Figure 2
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, Colo., 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.

WASHINGTON, D.C.


Office of Weights and Measures.

BOULDER, COLO.


