DEEP BED ACTIVATED CARBON FOR LIQUID, SOLID, AEROSOL AND GASEOUS FILTERS

J. L. Kovach   North American Carbon, Inc.
P. O. Box 19737
Columbus, Ohio 43219
USA

R. G. Newton   MSA Research Corporation
Evans City, Pennsylvania 16033
USA

INTRODUCTION

A combined particulate and gaseous radioactive contaminant removal system was proposed for radioactive gaseous waste filtration. (1)

The proposed design is shown on Figure No. 1.

The deep bed adsorber system has several significant advantages over conventional design in reducing decay caused ignition, flooding, gasket leakage etc.

The proper sizing of such a packed bed filtration unit required the evaluation of both the particulate and gaseous filtration efficiency.

There is no data in the literature relating to particulate filtration efficiency of carbon beds, due to the fact that conventional shallow beds of carbon did not remove any measurable quantity of particulate matter.

The only available data was based primarily on sand bed filter design. (2)(3)(4)

Thus additional particulate aerosol and gaseous efficiency tests were required to evaluate the feasability of the design.

EQUIPMENT AND PROCEDURES

The equipment used for the particulate filtration evaluation is shown on Figure No. 2.

The standard NBS dust filtration procedure was used to generate both the NBS and the SiO_2 dust. The NBS dust was 0.8 - 12μ particle size range with an average diameter of 5μ.

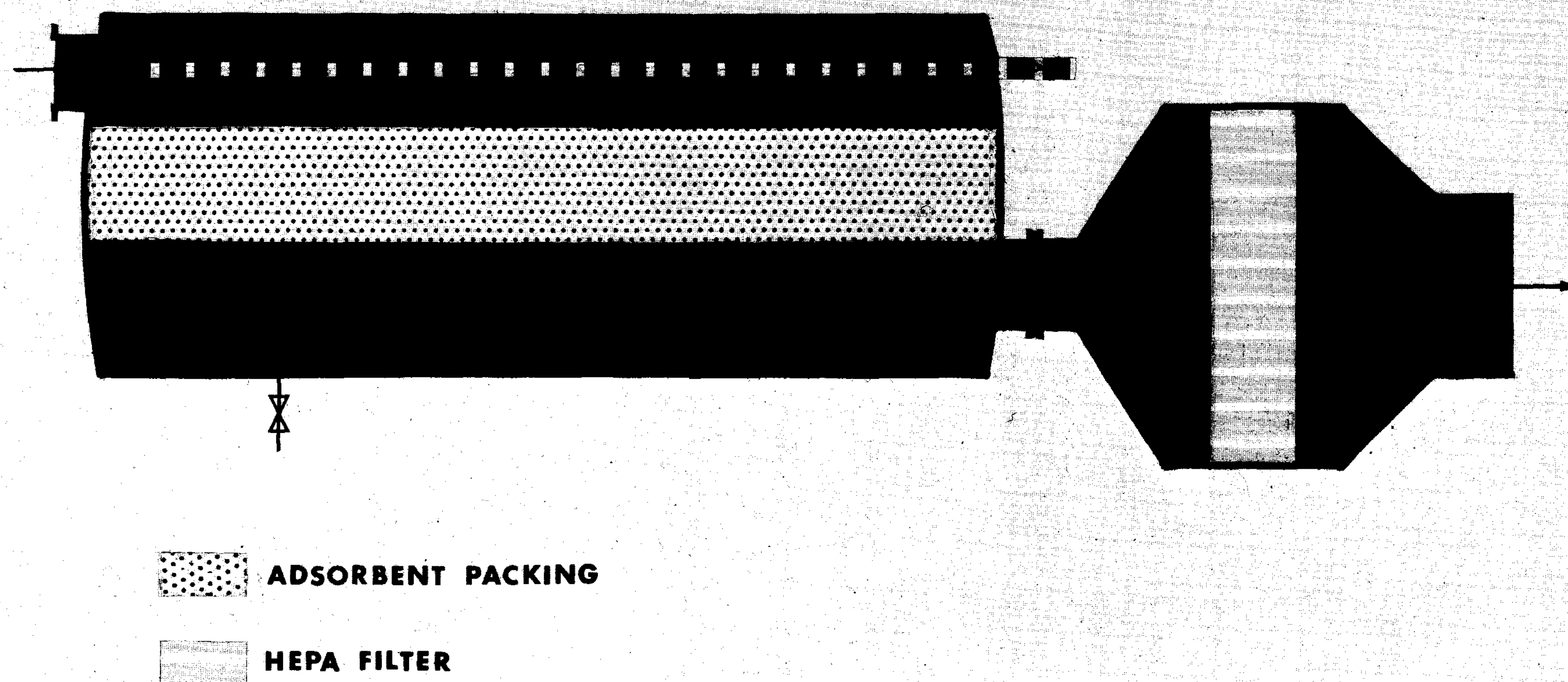
To generate the cold DOP, the TDA 4A generator was used.

The polystyrene microsphere aerosol was generated by a Laskin atomizer from an 0.1% solids water emulsion. The vaporization rate was 2 mls/minute. The carrier water droplets were evaporated in a heated section of the feed line.

A forward light scattering photometer was used to measure upstream and downstream aerosol concentrations.

For the NBS dust removal efficiency, both isokinetic and gravimetric determinations were made.

FIGURE 1

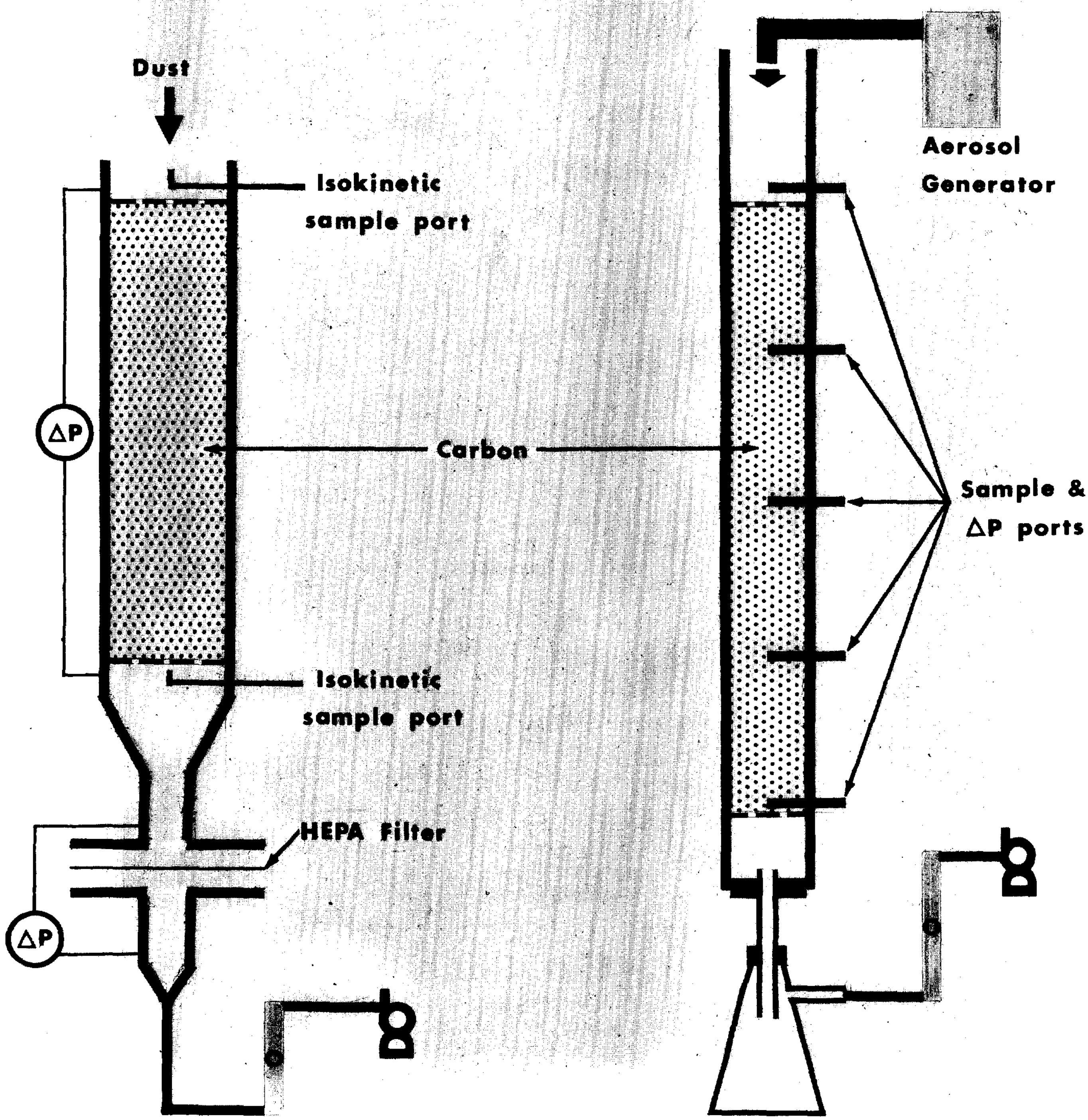


TYPICAL DEEP BED - HEPA FILTER SYSTEM

Figure 2

Experimental Apparatus for Dust Removal Study

Experimental Apparatus for DOP and Polystyrene Aerosol Removal Study



The vapor phase iodine removal efficiency determination was made using $^{131}I_2$ tagged $^{127}I_2$.

All filter tubes were sized to have an internal diameter at least 10 times the maximum particle diameter.

The water flooding attempts were performed utilizing the trap at the bottom of the aerosol filter rig.

PRESENTATION OF THE RESULTS

The coarse fly ash removal efficiencies and the dry carbon bed high humidity iodine filtration results were reported in the previous paper, based on this data.

The design parameters relating to carbon particle size, pressure drop and filtration efficiency indicated the preferred use of a coarse particle size carbon, the filtering efficiency of which is evaluated here in detail. (NACAR G352 carbon)

The NBS and SiO_2 filtration efficiency is shown on Table No. 1. The column I. D. was 3.0 inches for these tests.

A typical time versus efficiency and ΔP change for SiO_2 dust filtration is shown on Figure No. 3.

The DOP removal efficiency of various carbon diameters versus bed depth is shown on Figure No. 4.

The polystyrene latex removal efficiencies are shown on Figure No. 5.

The elemental iodine removal efficiency previously reported is reproduced for reference on Figure No. 6.

EVALUATION OF THE RESULTS

The combined particulate removal efficiency of the 15 inch deep filter shows a typical packed bed filtration property in its test aerosol particle size - efficiency dependence.

The carbon bed exhibits a satisfactory protective action pre-filtering even submicron aerosols and preventing overloading of the downstream HEPA filter. This property was shown both by the removal efficiency of the carbon bed and in the slight pressure drop increase through the HEPA filter even at very high dust loadings.

While no significant increase in efficiency or change in pressure drop was observed when using the 5.0μ average diameter test dust, an increased efficiency was observed with increasing loading of the carbon by the 0.6μ SiO_2 dust.

Table 1

DUST REMOVAL by G 352

TEST DUST	NBS	NBS	NBS	NBS	SiO_2	SiO_2
Avg. Diam.	5	5	5	5	0.6	0.6
Inlet Conc. mg/m^3	39.8	56.3	136.5	110.5	270.3	200.5
Velocity fpm	145	145	145	100	100	145
Bed Depth Inch	15	15	15	15	15	15
Outlet Conc. mg/m^3 Start	2.2	7.2	7.5	2.2	33.2	21.9
Outlet Conc. mg/m^3 Avg.	4.2	7.3	6.6	3.1	11.0	10.8
Outlet Conc. mg/m^3 Final	8.6	8.4	8.0	3.3	12.2	6.6
Length of test minutes	70	91	137	135	135	135
Efficiency % Start	94.5	87.2	93.2	95.9	89.6	88.4
Efficiency % Avg.	89.5	86.7	95.0	97.1	93.9	94.5
Efficiency % Final	83.4	85.1	94.9	97.6	95.3	97.0
ΔP mm Hg Carbon Bed	26	22	22	13	13 $\rightarrow$ 16	19 $\rightarrow$ 23
ΔP mm Hg HEPA	--	19	19	13	13 $\rightarrow$ 15	23 $\rightarrow$ 28

Figure 3

Carbon: G 352

Test Dust: SiO_2

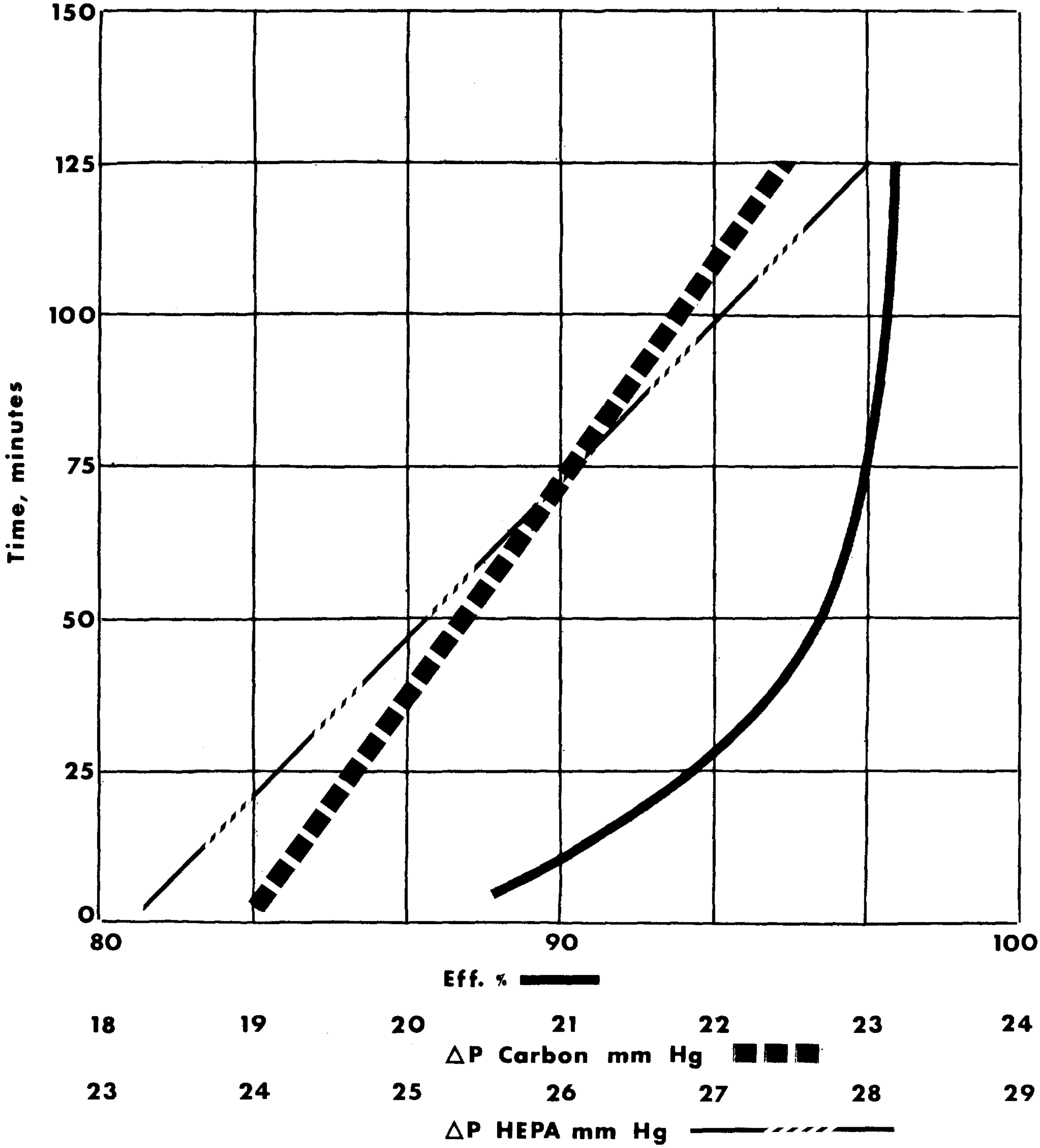


Figure 4

DOP Removal Efficiency of Granular Carbon

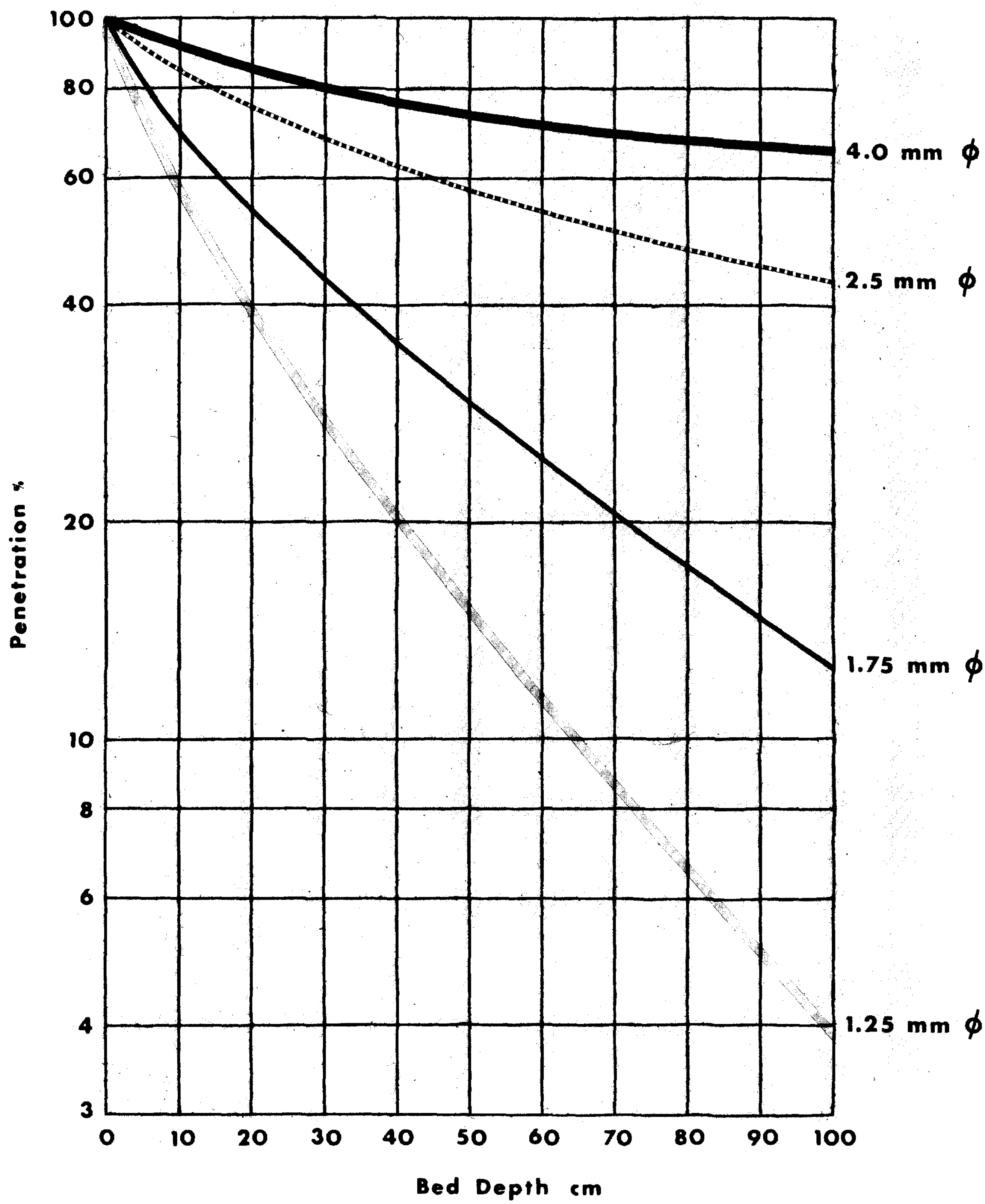


Figure 5

0.1 μ Polystrene Removal Efficiency of Granular Carbon

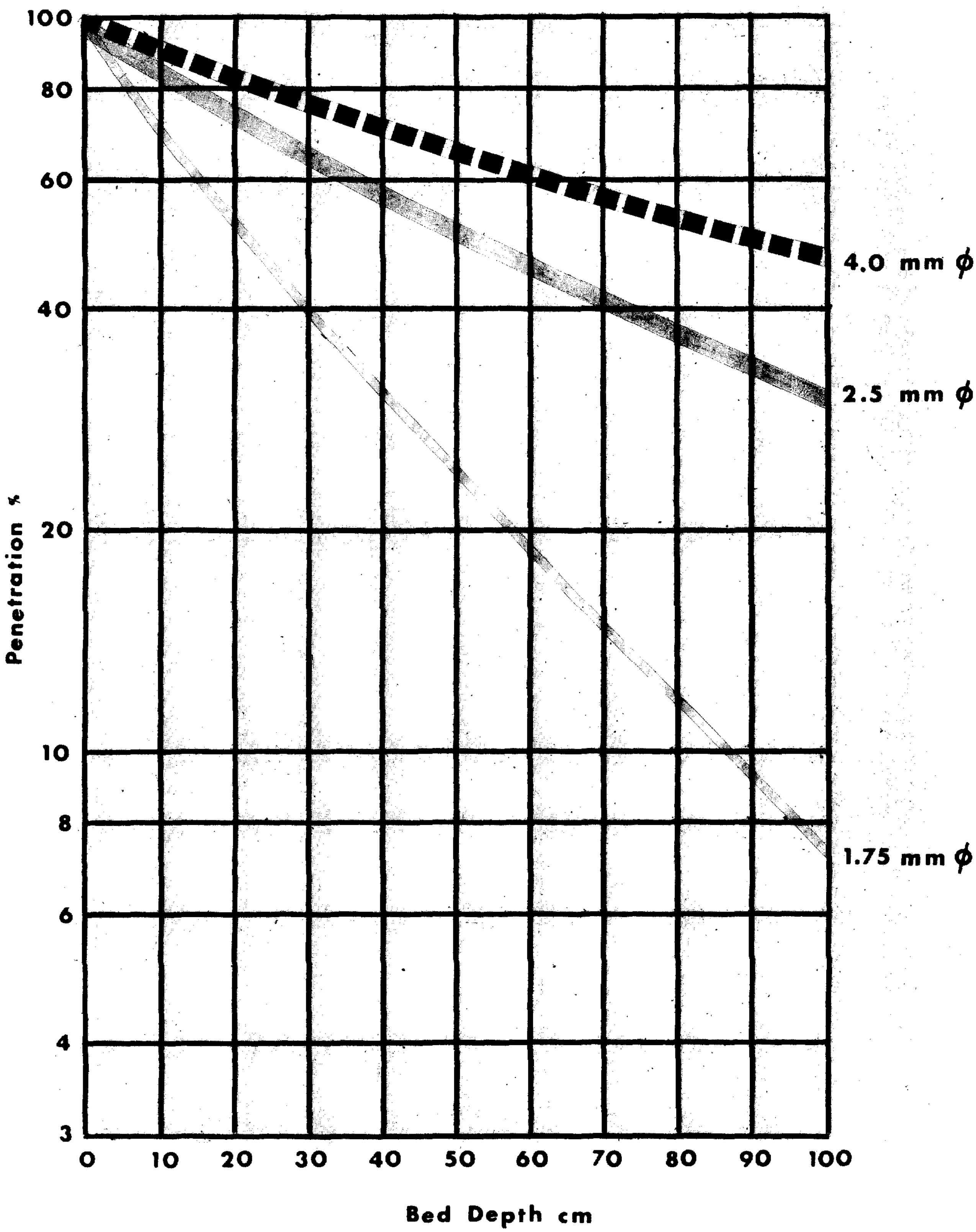
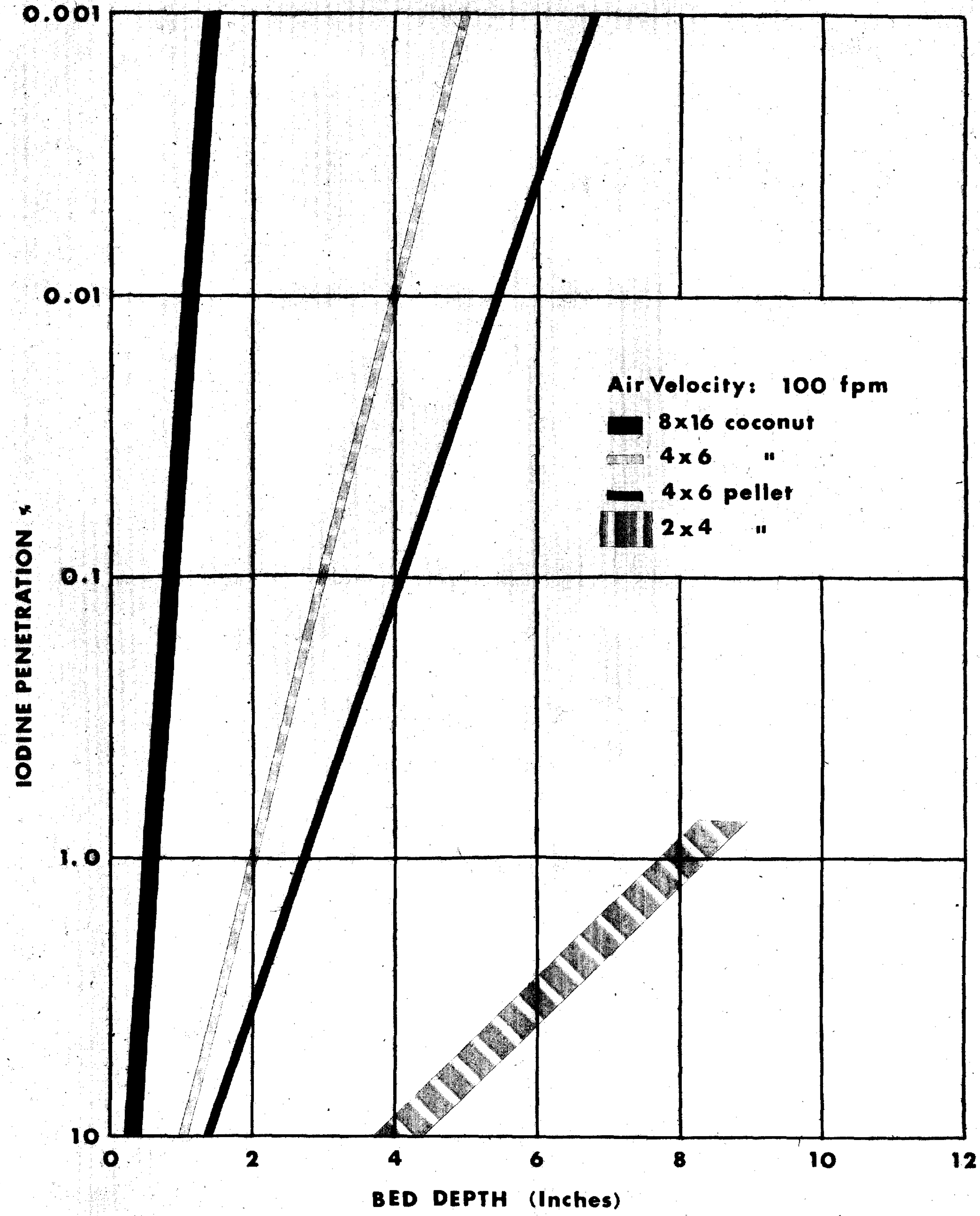


FIGURE 6


0.001
0.01
0.1
1.0
10
0
2
4
6
8
10
12
IODINE PENETRATION %
BED DEPTH (Inches)
Air Velocity: 100 fpm
8x16 coconut
4x6 "
4x6 pellet
2x4 "

The loading by DOP and the polystyrene latex was not high enough to show significant change with increased loading.

The vapor phase iodine adsorption shows the expected dependence on particle size.

At the high air velocities used, flooding of the G 352 carbon bed could not be sustained.

Based on the currently available results, the design utilizing a horizontally placed 15 inch deep carbon bed consisting of coarse particle size carbon followed by HEPA filters shows the following advantages.

The deep bed filter system at the high operating velocities has a lower iodine adsorption efficiency per inch of bed depth causing a wider distribution of the iodine forms adsorbed, thus preventing narrow band overheating caused by decay heat. The larger particle size and high velocity down-flow only operation prevents flooding and/or percolating in the carbon bed which occurs in currently used shallow bed filters.

The overall iodine adsorption efficiency of the full bed depth is higher than the conventional adsorber efficiency.

The single container design eliminates extensive gasketing which in turn eliminates potential leak paths. Any possible pressure shock is attenuated before it reaches the HEPA filter bank.

The deep bed filter system permits in situ regeneration of a weathered carbon bed by the introduction of hot inert gas.

The hazard of disposal of the contaminated bed is considerably reduced.

The deep bed filter design permits easy continous monitoring of decontamination efficiency, even during accident conditions. by monitoring activity in the adsorber at various levels.

CONCLUSIONS

A simplified high reliability combined filtration design is proposed by using deep carbon beds consisting of coarse activated carbon followed by HEPA filters.

The design permits the use of several adsorbents in layers and eliminates numerous hazards of the conventional filtration systems.

BIBLIOGRAPHY

(1) Kovack, J. L. & Hannan, D. G.; NACAR 010006 (1970)
(2) Thomas, J. W. & Yoder, R. E.; AMA Arch. Ind. Health 13, 545, (1956)
(3) Thomas, J. W. & Yoder, R. E.; AMA Arch. Ind. Health 13, 550, (1956)
(4) Cheever, C. L. et al; USAEC, CONF. 660904 Vol. 2, (1967)

DISCUSSION

WEHMANN: I have two questions. Did you have any break up of this large carbon?

KOVACH: No, the hardness property of the carbon is about 96 in the conventional definition of hardness. We didn't notice breakdown even after the flooding and the high velocity. If the carbon started breaking down it would show up in the tests for example in the HEPA filter downstream. We see only a slight continuing increase in P during the run. And as soon as we stopped loading the aerosols we had constant pressure drop in the filter downstream. So we didn't see any migration through the system. Now I'm sure that if we could load sufficient aerosol on the bed that we would get at some point some migration through. But in up to six hours we haven't reached that point.

WEHMANN: You indicated to help with decayed heat problem that you might go to and I would like to quote "some non-combustible absorbant." Do you want to reveal what that is?

KOVACH: Well, we were talking about using some silver salt or lead or aluminum in the first two three-inch layers, and followed by activated carbon. Or in some cases, if somebody still desires, you can put just one absorbent alone. But for BWR applications we are looking at carbon by itself.

WEHMANN: Now, would this be in front of the thick bed?

KOVACH: No, it would be a part of the thick bed. The thick bed would be a layered bed with a metal separator in between.

SCHWENDIMAN: Since you have had quite a bit of experience with these sand bed filters, have you considered layering charcoal in zeolite at your front end?

KOVACH: Right. As a matter of fact, first we started to look at even the possible replacements of some of the sand in the layers in the conventional filters to assure that they get some gas phase removal efficiency. But as I mentioned, the problem with the conventional standard design is at least all of the ones that I'm aware of, that they have up flow. But the use of an inert media that is not even supposed to remove any gaseous material can be incorporated into the bed.

ATMOSPHERIC PARTICLE PENETRATION THROUGH HIGH EFFICIENCY FILTERS

A. Lieberman, Director of Research
Royco Instruments, Inc., Menlo Park, Cal.

R.D. Scott, Vice-President,
HEPA Corporation, South El Monte, Cal.

ABSTRACT

Penetration of atmospheric particles through filters with rated DOP removal efficiencies ranging from 90% to 99.97% is studied. Exact data on DOP removal are obtained with a Q76 penetrometer. Atmospheric particle number concentrations were determined in the size ranges 0.3 - 0.5 µm; 0.5 - 0.7 µm; 0.7 - 1.0 µm and 1.0 - 3.0 µm, up and downstream of the filters. Relationships between DOP penetration and atmospheric particle penetration are discussed. The effect of variations in filter face velocities are included.

Introduction

Many facilities require air cleaning systems that will operate with high collection efficiencies.

Some facilities generate airborne toxic or hazardous material; these require air filtration systems that will contain the materials that are produced. Other facilities involve operations or devices that may be damaged by exposure to particles suspended in cooling or process gas streams. These require filtration systems to ensure that the gas streams are clean. In both cases, the particles that must be removed from the exhaust or inlet air flows are generated by a variety of allied mechanisms. Abrasion, fracture, wear, vapor condensation, gas phase reactions are some of the processes which generate the aerosol particles that must be handled by the air cleaning system. The resultant aerosol contains a mixture of solid crystalline materials, flocs, liquid droplets and combinations thereof, modified by agglomeration and other time-related processes.

Depending on the air cleanliness requirements, air filters are used. These range in performance from the High Efficiency Particulate Aerosol (HEPA) filter with 99.97% filter efficiency, to lower efficiency filters of 50%, and less, filter efficiency. For filters of greater than 90% efficiency, most are quality-control tested[1], using a 0.3 μm monodisperse, thermally generated, dioctyl phthalate (DOP) aerosol. A forward light-scattering photometer is used to sample upstream and downstream of the filter being tested. Since the aerosol is monodisperse and spherical, the filter efficiency recorded can be that on the basis of count, mass or volume. Since the aerosol in use is neither monodisperse nor spherical, it is not clear as to the relationship between the DOP efficiency and the count or mass efficiency for a typical atmospheric aerosol. For this reason some comparisons are described between DOP efficiency and count efficiencies for two different atmospheric aerosols.

Experimental Procedure

A series of 4" x 4" x 5" deep filters were fabricated for this test. The fabrication procedures were identical to those used for standard production. Ten 99.97% filters, six 99% filters, three 95% filters and six 90% filters were used.

DOP efficiency was determined for each filter at a face velocity of 2.8 cm/sec, using a Q76 penetrometer.[2]

Atmospheric particle penetration was determined for each filter by measuring the number of particles in four size ranges from 0.3 μm to 3 μm (diameter) with a Royco Model 220 Airborne Particle Counter.[3] These measurements were made in Los Angeles, and repeated in the San Francisco Bay Area, at Menlo Park. In this way two slightly different urban aerosols were used. The differences are not great between the two sites. The mass median diameters reported by Ludwig and Robinson[4], vary more with relative humidity than with location. The particle size distributions are generally log probability with geometric standard deviations nearly 7 in both localities. Upstream number concentrations were usually in the range from 200,000 to 1,000,000 particles/cu. ft. of air.

In Los Angeles, each filter was placed on the Q76 penetrometer, the atmospheric particle penetration was determined by measuring number concentrations upstream and downstream; then the DOP penetration determined. In Menlo Park, the same filters were used, but only the

the atmospheric particle penetration measured. In each filter class one was selected to determine the effects of variation in face velocity. Atmospheric particle penetration was determined at 0.2, 1.3, 2.8, 5.6 and 8.4 cm/sec.

A great deal of care was used in operating the Q76 penetrometer, especially with the high efficiency filters. In particular, the boiler and reheater temperature stability was carefully controlled and the DOP droplet size measured as carefully as possible with the built-in Owl. Even so, some variability is expected[5]: ". . . a deviation of only one degree (0.003 micron change in radius) was equivalent to a change of approximately 0.015% penetration". Similarly, care was used in making the atmospheric particle penetration measurements. Each measurement reported is an average of several replications, none of which varied by more than ± 10%. Each replicated measurement represents a 0.1 cubic foot sample, taken over a one minute interval. For this reason, concentrations of less than 50 particles per cubic foot may include variability up to 50%.

Experimental Results

Data showing the variation in penetration for both DOP and atmospheric aerosol are shown in Table 1 and Table 2. Table 1 represents atmospheric particle penetration for Los Angeles and Menlo Park. The table shows percentage penetration for the four size ranges monitored with the Royco 220, the DOP penetration, and the pressure drop. Table 2 summarizes the average penetrations for the four filter types used in the two locations. Figures 1 and 2 show penetration as a function of particle size for both locations. It was assumed that the log-normal particle size distribution is maintained in the intervals shown in Tables 1 and 2. Table 3 shows the penetration of atmospheric aerosol as a function of face velocity for specific filters, one from each type class, as do figures 3-6.

Discussion and Conclusions

Examination of the data in Tables 1 and 2 indicates that there is a degree of variation from one filter to another within any class. This can be expected, since the manufacturing process allows some variation. In most cases, however, the DOP penetration is below the stated penetration, e.g., filters 1-10 are classified as 99.97%. No DOP penetration reaches 0.03%. Filters 11-16 are classified as 99% filters. No DOP penetration

TABLE 1: FILTER PENETRATION

Filter	ΔP_1 In, H_2O	DOP	Penetration % Los Angeles 0.3-0.5	0.5-0.7	0.7-1.0	1.0-3.0	Menlo Park 0.3-0.5	0.5-0.7	0.7-1.0	1.0-3.0
1	0.91	0.006	0.009	0.002	0.007	0.041	0.035	0.030	0	0
2	0.93	0.02	0.22	0.008	0.009	0	0.033	0.020	0	0
3	0.95	0.008	0.003	0	0	0	0.027	0	0	0
4	0.95	0.007	0.057	0.015	0.015	0	0.025	0.018	0.055	0
5	0.97	0.006	0.002	0	0	0	0.010	0	0	0
6	0.90	0.009	0.004	0.001	0	0	0.033	0.028	0.021	0
7	0.89	0.009	0.004	0.001	0	0	0.032	0	0	0
8	0.89	0.008	0.004	0	0	0	0.024	0.010	0	0
9	0.90	0.006	0.003	0	0	0	0.038	0.013	0	0
10	0.91	0.024	0.021	0.005	0.003	0	0.038	0.013	0	0
Average		0.016	0.013	0.003	0.003	0	0.031	0.014	0.007	0
11	0.40	0.8	0.278	0.050	0.037	0.024	0.404	0.050	0	0
12	0.40	0.8	0.278	0.050	0.037	0.024	0.404	0.050	0	0
13	0.43	0.7	0.306	0.022	0.001	0	0.403	0.055	0	0
14	0.43	0.8	0.277	0.025	0.001	0	0.402	0.046	0	0
15	0.42	1.2	0.234	0.026	0.007	0	0.462	0.059	0.025	0
16	0.41	1.2	0.278	0.031	0.010	0.005	0.339	0.042	0.019	0
Average		0.95	0.279	0.033	0.013	0.006	0.418	0.053	0.007	0
17	0.4	5.2	-	-	-	-	4.85	1.37	0.770	0.196
18	0.4	7.0	-	-	-	-	6.44	1.75	0.827	0.303
19	0.4	5.0	-	-	-	-	6.05	1.50	0.761	0.302
Average		5.7	-	-	-	-	5.78	1.54	0.786	0.267
20	0.23	10	9.07	1.99	0.734	0.318	5.40	2.28	1.47	0.477
21	0.23	10	10.4	2.21	0.859	0.342	5.23	2.08	1.16	0.476
22	0.24	14	11.4	2.54	0.964	0.465	3.75	1.50	0.820	0.224
23	0.24	9	8.52	1.87	0.615	0.228	4.60	1.98	0.740	0.405
24	0.23	9	8.79	1.95	0.710	0.179	3.88	1.42	0.809	0.332
25	0.24	10	8.15	1.96	0.744	0.171	3.97	1.50	1.25	0.358
Average		10.3	9.39	2.09	0.771	0.284	4.47	1.79	1.04	0.379

TABLE 2: AVERAGE PENETRATION PERCENTAGES

		Penetration %							
Filter	DOP	Los Angeles				Menlo Park			
Class		0.3-0.5	0.5-0.7	0.7-1.0	1.0-3.0	0.3-0.5	0.5=0.7	0.7-1.0	1.0-3.0
99.97	0.016	0.013	0.003	0.003	0	0.031	0.014	0.007	0
99	0.95	0.278	0.033	0.013	0.006	0.418	0.053	0.007	0
95	5.7	-	-	-	-	5.78	1.54	0.786	0.267
90	10.3	9.39	2.09	0.771	0.284	4.47	1.79	1.04	0.379

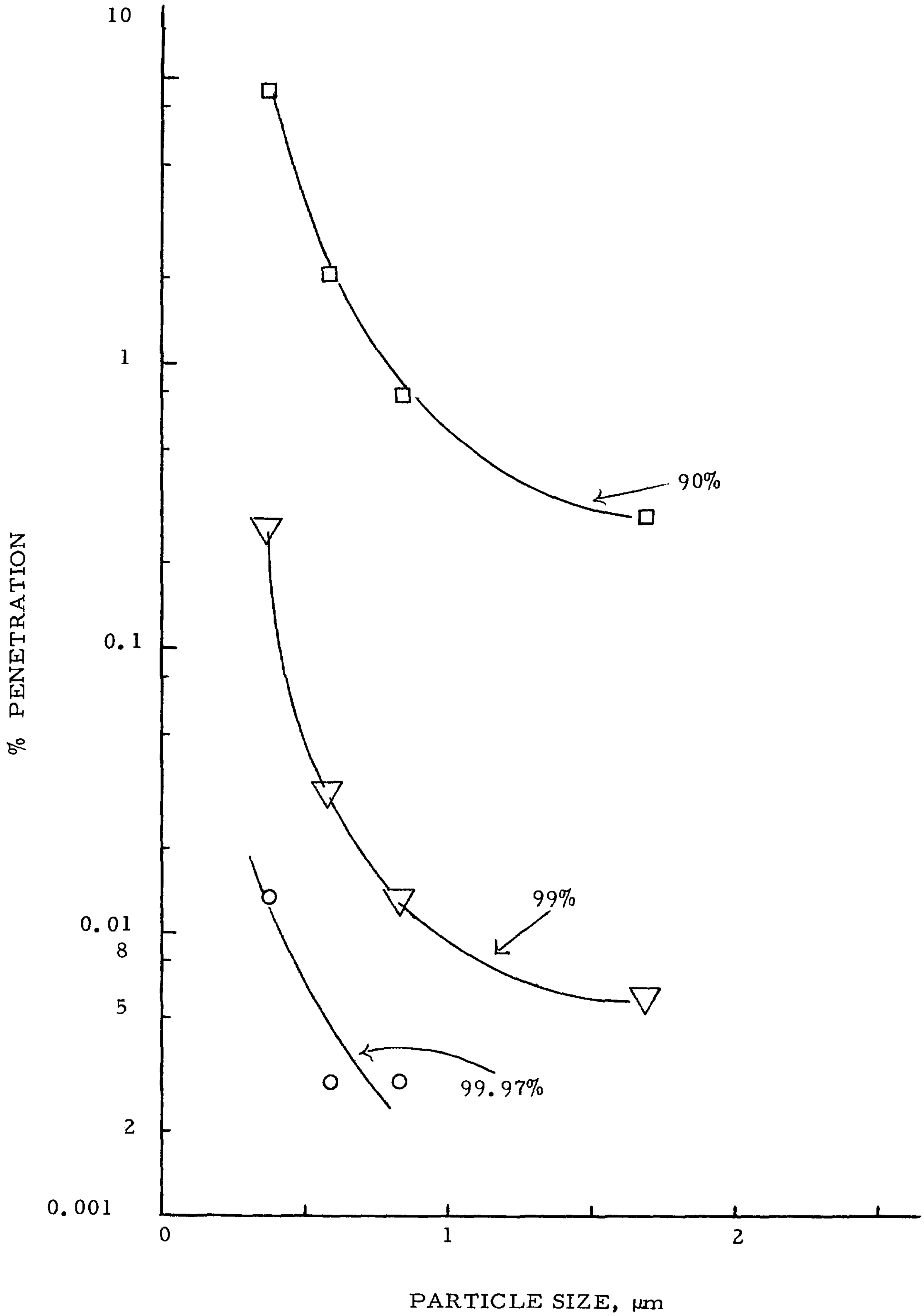
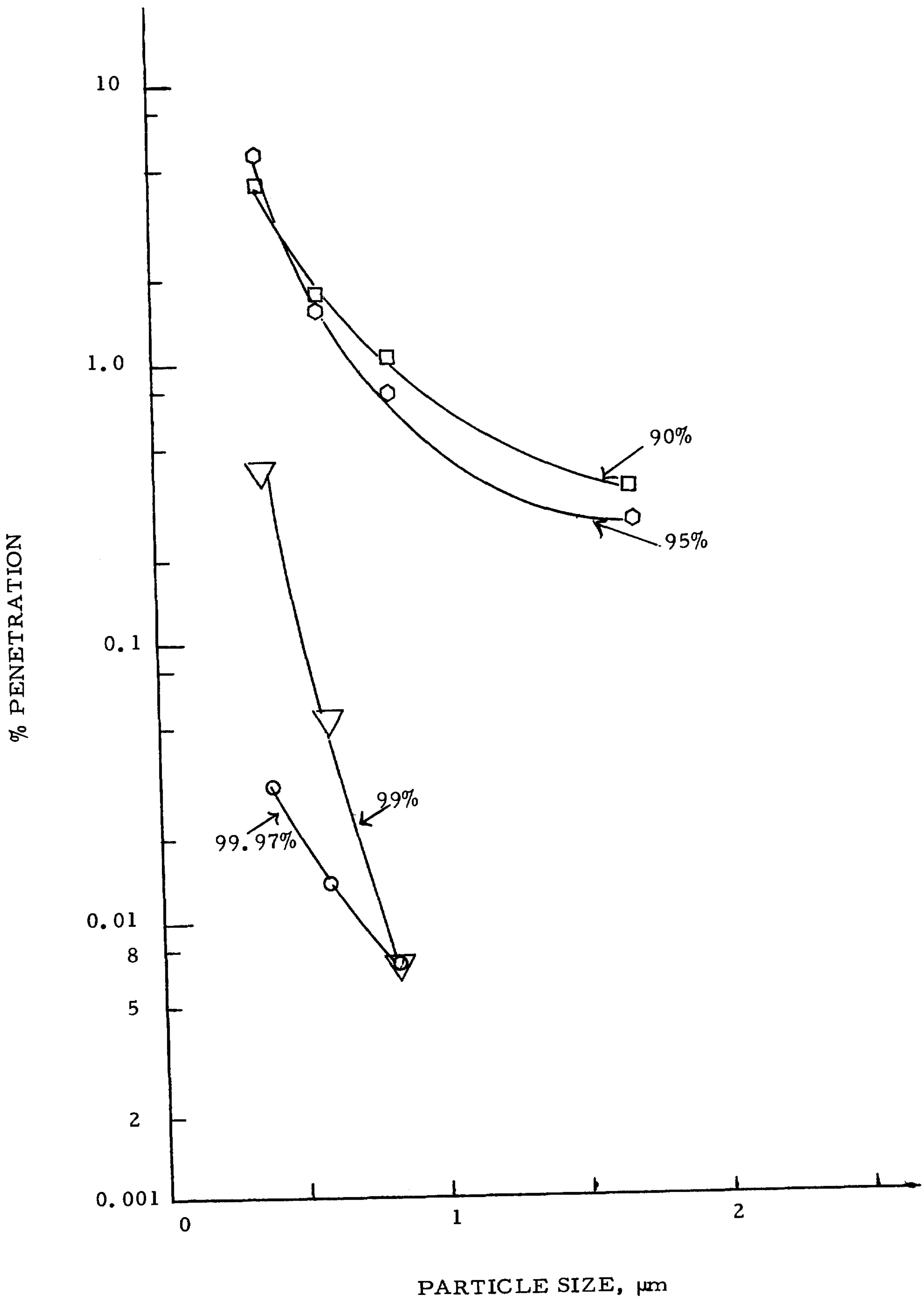

10
1
0.1
0.01
8
5
2
0.001
% PENETRATION
90%
99%
99.97%
0
1
2
PARTICLE SIZE, μm

FIGURE 2

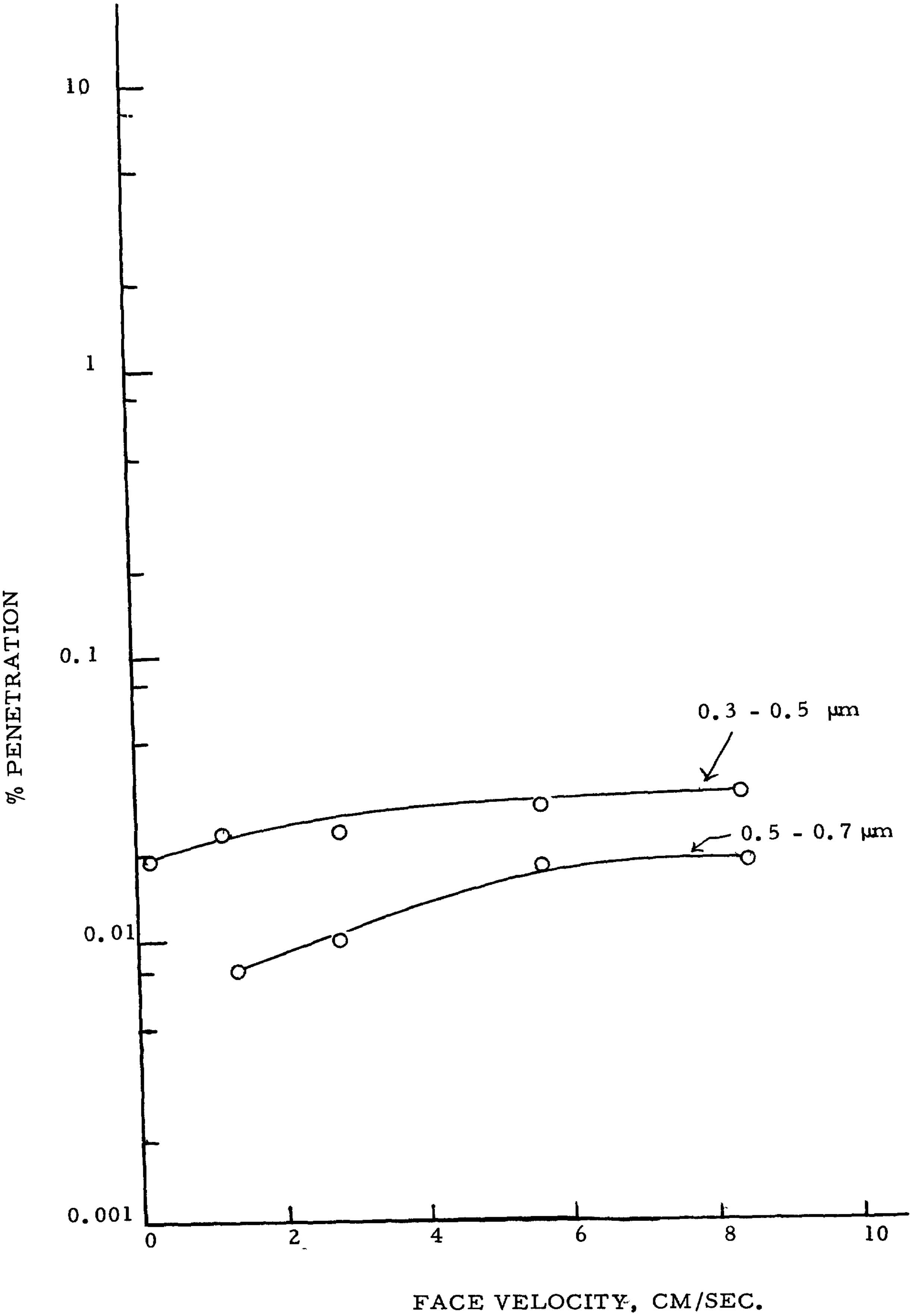


10
1.0
0.1
0.01
8
5
2
0.001
0
1
2
% PENETRATION
PARTICLE SIZE, μm
90%
95%
99%
99.97%

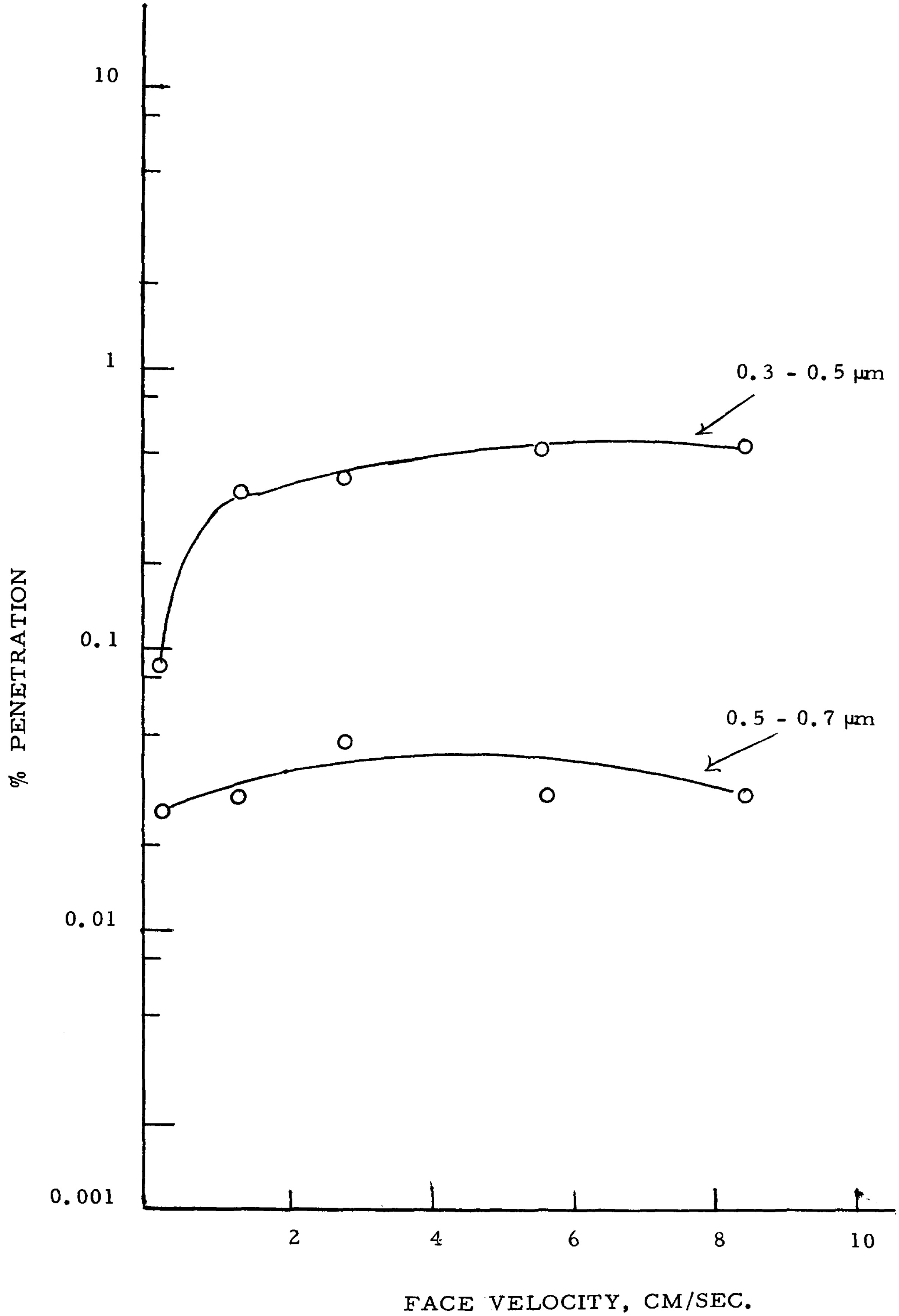
TABLE 3: FILTER PENETRATION VS. FACE VELOCITY

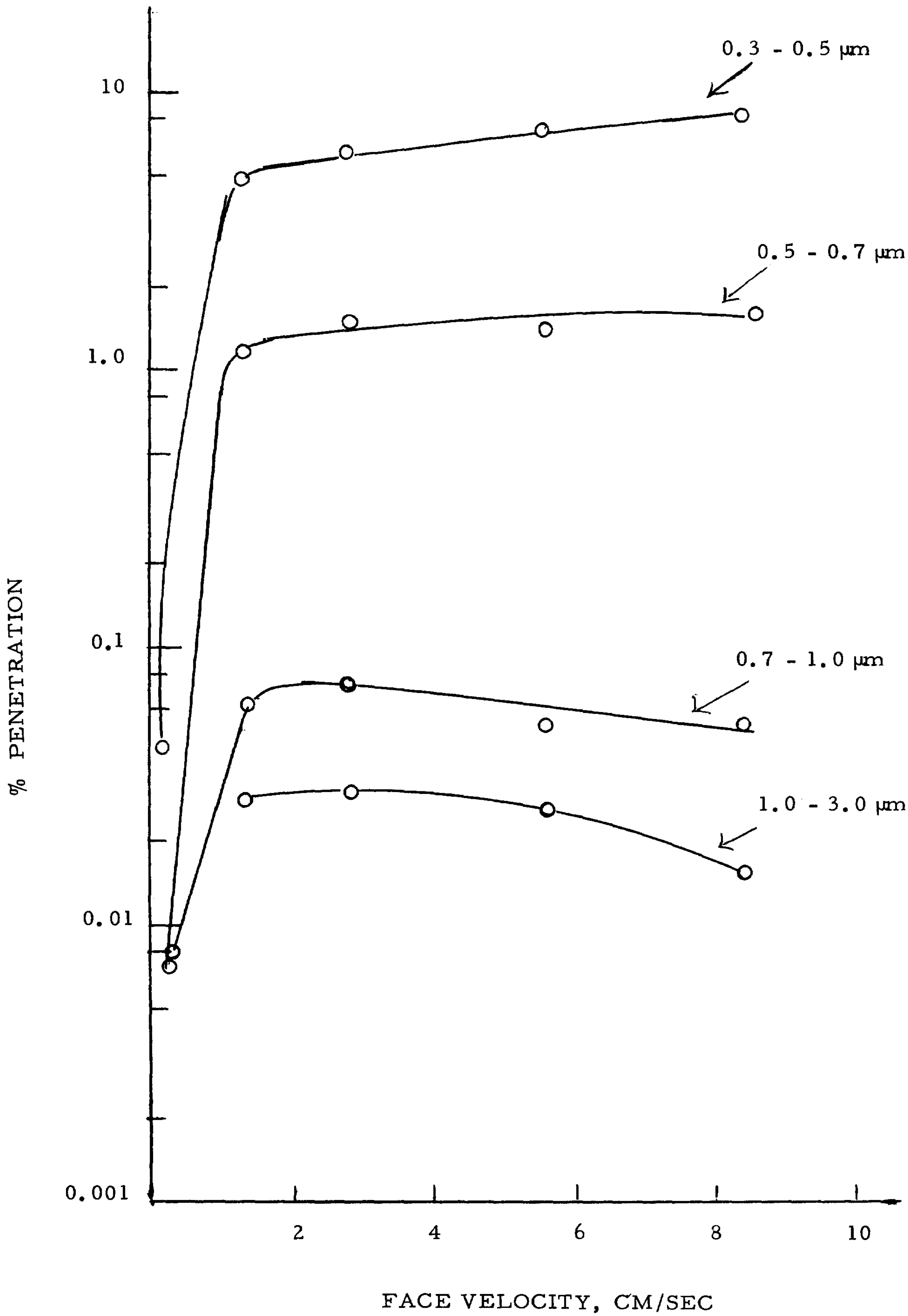
	Face Velocity	Penetration, %			
Filter	cm/sec	0.3-0.5	0.5-0.7	0.7-1.0	1.0-3.0
#8	0.2	0.019	0	0	0
	1.3	0.024	0.008	0	0
	2.8	0.024	0.010	0	0
	5.6	0.029	0.018	0	0
	8.4	0.033	0.018	0	0
#14	0.2	0.090	0.027	0	0
	1.3	0.360	0.030	0	0
	2.8	0.402	0.046	0	0
	5.6	0.502	0.030	0	0
	8.4	0.513	0.029	0	0
#19	0.2	0.044	0.007	0.008	0
	1.3	4.93	1.15	0.655	0.297
	2.8	6.05	1.50	0.761	0.302
	5.6	7.31	1.40	0.521	0.206
	8.4	8.37	1.54	0.535	0.156
#25	0.2	0.042	0.009	0.004	0
	1.3	6.55	1.36	0.518	0.185
	2.8	8.15	1.96	0.744	0.171
	5.6	10.0	2.58	0.901	0.367
	8.4	13.5	3.17	1.15	0.685

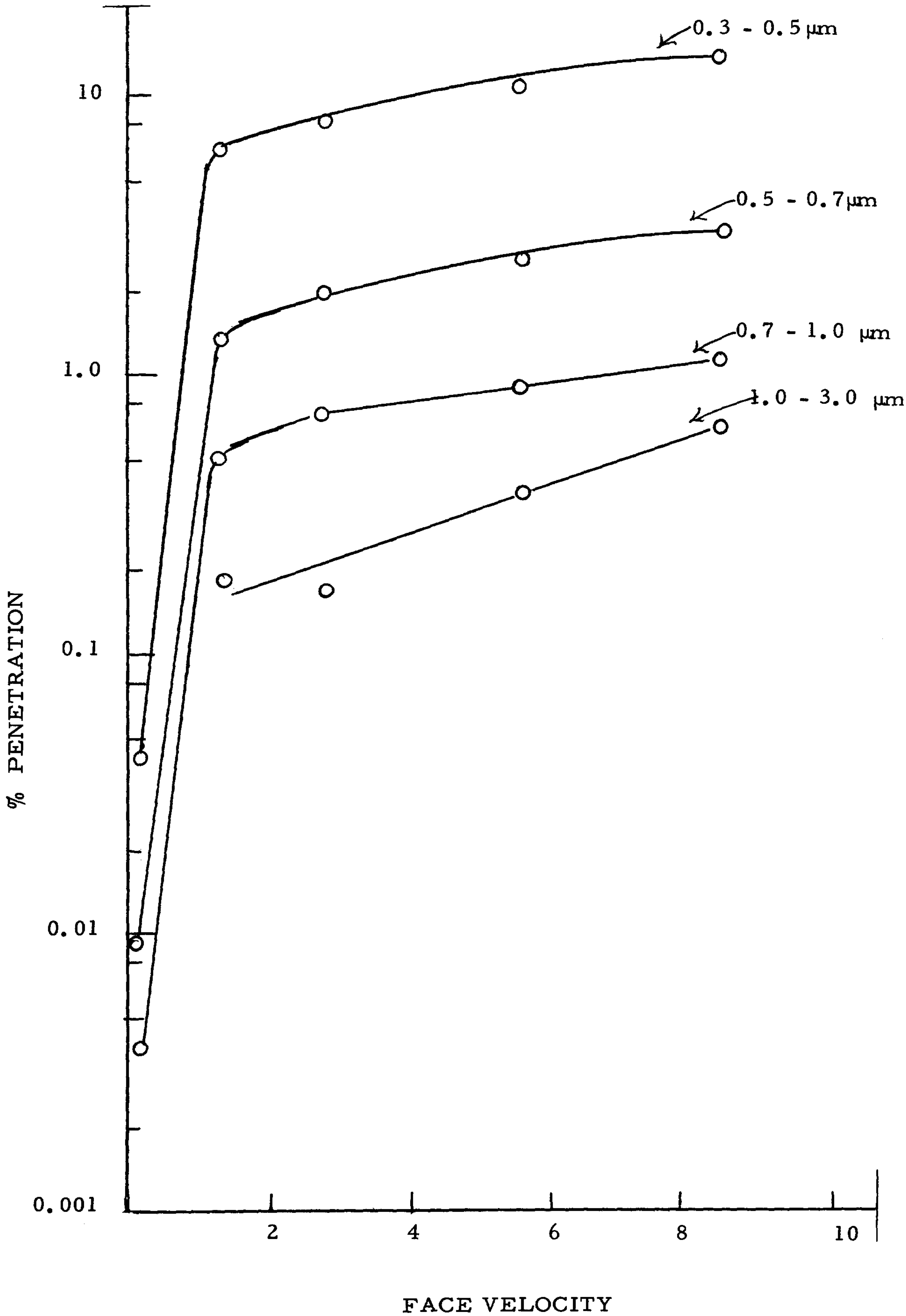
FIGURE 3



10
1
0.1
0.01
0.001
% PENETRATION
0.3 - 0.5 µm
0.5 - 0.7 µm
0
2
4
6
8
10
FACE VELOCITY, CM/SEC.


10
1
0.1
0.01
0.001
% PENETRATION
0.3 - 0.5 μm
0.5 - 0.7 μm
2
4
6
8
10
FACE VELOCITY, CM/SEC.


0.3 - 0.5 µm
0.5 - 0.7 µm
0.7 - 1.0 µm
1.0 - 3.0 µm
10
1.0
0.1
0.01
0.001
% PENETRATION
2
4
6
8
10
FACE VELOCITY, CM/SEC


0.3 - 0.5 µm
0.5 - 0.7µm
0.7 - 1.0 µm
1.0 - 3.0 µm
10
1.0
0.1
0.01
0.001
% PENETRATION
2
4
6
8
10
FACE VELOCITY

reaches 1%. Filters 17-19 are classified as 95%; here the DOP penetration value does equal or exceed the classification. Similarly, filters 20-25, classified as 90% filters include one that is out of specification.

Atmospheric particle penetration in Los Angeles averaged below the classification in all cases. Some filters showed penetrations above the average. In general, it appears that the variability for atmospheric particle penetration is greater than that for DOP penetration. This may be expected since the atmospheric aerosol varies both in composition and in particle size distribution over any time period. It is of interest to note that some penetration occurs for particles larger than 0.7 µm even for filters which are better than 99.97% efficient for 0.3 µm DOP. As anticipated, however, penetration decreases with increasing particle size for all of the filters, as shown in Figures 1 and 2.

Atmospheric particle penetration in Menlo Park is also shown on Tables 1 and 2. It is immediately obvious that the penetration of atmospheric particles in Menlo Park differs from that in Los Angeles for the same filters. Filters 1-10, show about 3 times the penetration; filters 11-16 show about twice the penetration and filters 20-25 show about half the penetration. These differences suggest that the atmospheric aerosol differs even more than Ludwig-Robinson indicate. It is suggested that the aerosols vary in terms of their electrical characteristics, as well as in their mean size. Very early in the experimental work in Menlo Park the increased penetration became apparent. Therefore, extreme care was taken to insure that no leakage or bypassing of the filter mounting took place. The difference in penetration is real and is not an artifact of the Menlo Park test procedure. The characteristics of the atmospheric aerosols in Los Angeles and in Menlo Park became apparent as an important factor in filter penetration, especially in noting the averaged data for the 90% class filter in Table 2.

Table 3 shows the atmospheric aerosol penetration for the several filter examples with varying face velocity. Figure 3 shows penetration for the 99.97 class. No penetration is noted for particles larger than 0.7 µm. For the two size ranges plotted, the small increase in penetration with velocity is not considered significant. Even though the effects are as anticipated from the work of Ramskill and Anderson [6], these are considered coincidental. Figures 4, 5 and 6, however, do show the effects of varying filtration mechanisms with particle size change.

One may conclude that a relationship between DOP penetration and atmospheric aerosol penetration does exist for high efficiency filters, but it is qualitative only. A variation in atmospheric aerosols appears to exist so that penetration varies from place to place. The DOP penetrometer then characterizes a filter, but the performance of the filtration system must also take into consideration the nature of the challenge aerosol.

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1 U.S. Army Chemical Corps and U.S. Navy Bur. Ships: Filter Units, Protective Clothing, Gas Mask Components and Related Products: Performance-Test Methods, Report MIL-STD-282 (May 1956).

2 U.S. Army Edgewood Arsenal Instruction Manual for the Installation, Operation and Maintenance of Penetrometer, Filter Testing, DOP, Q76.

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DISCUSSION

BURCHSTED: The efficiency of the 90 to 95% filter was established by DOP testing, is that correct?

LIEBERMAN: Yes, that is right.

BURCHSTED: So these filters do not compare directly with the 90 to 95% filters that you buy on the open market which were tested by the NBS dust-spot method. I think that we should point that out because I don't think that the efficiency of a commercially available 90 to 95% dust-spot efficiency filter can even approach this degree of performance.

LIEBERMAN: You are quite right. A filter which shows 90-95% efficiency when tested with coarse dust would probably show something in the order of 20 to 30% -- or less -- when tested with DOP.

GOVERNMENT-INDUSTRY MEETING ON FILTERS, MEDIA AND MEDIA TESTING

by

W. L. Anderson
Naval Research Laboratory

Many of the accomplishments of the AEC air filtration program achieved thus far have been due to the efforts of an informed working group concerned with high efficiency filters. This group had its origin several conferences ago, when a few interested people met in an evening session in a hotel room and informally discussed the operational problems current at that time. It is unknown whether the continuous growth of the original group at subsequent conferences was due to the dedicated interest of the attendees or the liquid refreshments available. Each successive session became larger until at the 10th Conference in New York, it was necessary to obtain a special meeting room and establish a prepared agenda.

At this, the 11th Conference, 42 persons comprised the so-called committee; 23 from industry, 7 from government, 9 contract investigators, and 3 international guests. Other individuals had expressed a desire to participate but the limited facilities of the meeting room prevented their attendance. With this rate of expansion, we expect that at the 12th Conference our committee members may exceed the total conference registration. With such numbers of interested people, we recommend that we reclassify the assembly as a working group rather than a committee.

The most recent session of the group was held this past Monday morning and was devoted to a series of discussions of current interest. This session, following the precedent of earlier meetings, utilized the collected talents of the assembled body in a unified effort toward the problems of the particulate filter, its components and methods of test. Representatives of all of the facets of the industrial complex were present, from the basic fiber suppliers, through the media producers, and finally to the filter unit fabricators. Research organizations from R and D government laboratories and academic institutions contributed status reports on work currently underway. Users at various levels expressed their problems and actively participated in the discussions.

The following review of the proceedings may seem to be an agglomeration of information and at times show no continuity of thought. It is our intent to review for you, in abstract form, the total content of the committee deliberations. We will address the items in the order of their discussion; it should be noted that the total agenda for this session was by far the largest attempted. However, under the capable direction of our chairman and behind the smoke screen that be generated, we were able to cover all items with dispatch and complete the entire agenda in the alloted time.

A total of 8 separate subjects were discussed.

1. Military Specifications - The Chemical Corps has recently issued a specification (MIL-F-51068C) for high efficiencey filter units. Since a number of changes requested by AEC were not incorporated the specification is not considered to be acceptable. An addendum has been prepared by Edgewood and will be issued shortly. This addition will modify the original specification in accordance with the AEC requests. A new specification (MIL-F-51079A) for filter media is under preparation and will be issued in the near future. Hopefully the AEC requirements will be incorporated in the original draft.

2. Substitution of Code 753 Glass Fibers for Code 475 - Johns Manville (JM) had reported that some Data in their laboratories indicated that Code 753 glass fibers exhibited greater acid resistivity that the presently utilized Code 475 fibers. C. W. Weber (ORGDP) presented a series of data on comparative tests on handsheets made from the two competitive fibers. In general, the 475 material has the better corrosion and moisture resistance in dynamic exposures, and exhibits less weight loss on exposure to acids. Since no economic advantage is to be gained by converting to the 753 fibers, it was decided that 475 fibers would be the material of choice. JM has agreed to continue to supply this grade of material.

3. Irradiation Tests on HEPA Materials - A materials-radiation effects study has been initiated to determine the extent and mechanism of material degradation from high energy irradiation. L. R. Jones (SRL) described the radiation facility and the conditions under which the exposures were conducted. The total source strength has been estimated as about 75,000 curies from a cobalt material; integrated doses to the materials average about 5×10^7 rads received over a 3-hour period. W. L. Anderson (NRL) reported on some of the materials effects noted thus far. It should be pointed out that the results are only preliminary since the exposures and evaluations are still in progress. Some qualitative results are already apparent. Framing materials showed little effect of the irradiation; the ply wood and particle-board showed

no change in strength, only slight discoloration and surface powdering. The filter media exhibited deterioration in tensile strength, particularly those materials with the latex binders. The sealants all deteriorated, but elastomeric sealants retained sufficient strength to indicate they would be adequate under operational conditions. The foamed urethane sealant failed, the foam solidifying into a rigid non-adhesive surface at the frame interface. Only neoprene gasket material has been evaluated thus far and this material showed evidence of deterioration. No separator materials have been tested to date. Additional exposures and tests will be conducted and a final summary report prepared.

4. HF Resistant Media - W. L. Belvin (HERTY FOUNDATION) reported on the current progress of the program to develop a HEPA media that is resistant to hydrogen fluoride. L-134, a JM prototype fiber, combined with crocidolite asbestos appears to be the most promising candidate material. Handsheets of 66% L-134 and 34% asbestos have been successfully prepared. However a major obstacle appears to be in the quality of the L-134 fiber as received from JM. Fibers received to date have contained a high percentage of "shot" which seems to be inherent in the production process itself. Efforts to clean the fiber have not been successful without degradation of the fiber itself. Samples of the filter media have been forwarded to Oak Ridge for corrosion testing. It appears that a trade-off analyses between operational need, performance and cost effectiveness must be accomplished before a final production decision can be reached.

5. Moisture Resistance Test - Special moisture resistance requirements by Savannah River have necessitated a re-examination of the water repellancy tests for HEPA media. H. C. Schwable (Herty Foundation) reported on a refinement of the original 10-hour repellancy test developed by Savannah River. Through equipment improvements and substitution of the sonic modulus test for tensile strength, the time of test has been reduced to 2 hours. The modified test characterizes competitive media and correlates well with known media performance. Further work is required to establish minimum standards for the test that can be adapted to production procedures. A comprehensive report will be forthcoming soon.

6. Filter Media Caliper - Continued surveillance of HEPA filter materials by the Naval Research Laboratory indicates that some of the media does not meet specification requirements, particularly with respect to paper caliper. Even though a uniform test method (TAPPI T-411) has been specified, sufficient deviations in test equipment and or personnel technique have resulted in erronious measurements and sub-specification material. Media manufacturers recommended the use of a motorized tester to eliminate the human factors and to provide an

acceptable industry-wide standard. The Naval Research Laboratory will procure the specified tester and attempt to correlate with existing procedures.

7. Penetrometer Calibration - AEC has established a program with the National Bureau of Standards whereby calibrated reference plates are supplied to filter testing groups for proper adjustment of test air flows. Rolie (Hanford Environmental Health Foundation) described a modification to his equipment which materially improves the reproducibility of calibrated flow rates. Sketches and test descriptions will be prepared and distributed to all organizations participating in the calibration plate program.

8. Miscellaneous - Mr. A. R. Allan (Flanders) stressed the need for uniformity in specification requirements for HEPA filters among varied Government agencies and contractors to Government Agencies. The importance of such a standard was stressed, particularly since uninformed personnel are continuously being utilized in the areas of filter specification writing and procurement. An additional requirement for uniform packaging for HEPA units was also made. Comments related to an association composed of manufacturers and buyers of HEPA units whereby information on credit, performance, etc. could be exchanged was ruled to be beyond the scope of the working group and referred to any intersted parties on an individual basis.

In conclusion, it should be reemphasized that this informed working group, with its diversified representation, provides a means for a comprehensive and expedient solution to the problems of the filtration industry. The total effort has proven invaluable because it permits the surfacing and exposure of problems that might otherwise be lost in the quagmire of bureaucracy and management. The meetings are intended to be and actually are a working level distribution of data and expertise as well as a progress report of ongoing projects in the particle filtration areas. To this end, we feel that we have been successful and further sessions are contemplated.