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Environmental Protection Technology Series

EPA FABRIC FILTRATION STUDIES:
2. Performance of Non-woven Polyester Filter Bags

Industrial Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

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EPA FABRIC FILTRATION STUDIES: 2. PERFORMANCE OF NON-WOVEN POLYESTER FILTER BAGS

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PREFACE

This report is the second in a series of reports, entitled EPA Fabric Filtration Studies, which summarize the results of EPA laboratory testing of new baghouse fabric materials and present the conclusions of specialized research studies in fabric filtration. These tests have been carried out over the past four years by the Industrial Environmental Research Laboratory, Research Triangle Park, North Carolina, and previously by predecessor agencies. The purpose of these investigations was to evaluate the potential of various new fabrics as baghouse filters and to obtain data for use by the fabric filtration community. The testing consisted of simulating a baghouse operation in a carefully controlled laboratory setting that allowed measurement and comparison of bag performance and endurance. The simulation discussed in this paper covered only a very narrow range of operating conditions:

1) Redispersed, classified flyash (mass median diameter between 5 and 6 μm) entrained in air was the only dust used.
2) All filtering was done at room temperature.
3) Humidity was varied from about 30 to 70 percent.
4) The air to cloth ratio was held at 4 to 1.
5) The dust loading was held in the vicinity of 3 grains/ft^3 (6.9 g/m^3).*
6) The test cycle consisted of a constant 20 minute feed, 1 minute delay, 2 minute shake cleaning, and 1 minute delay, regardless of the pressure drop across the bag.

Extreme caution should be used in extrapolating the results reported here to the substantially different conditions that occur in all field applications. The usefulness of the present results is primarily as an initial screen of candidate fabrics for baghouse applications.

*EPA policy is to use SI units only or to list both the common British unit and its metric equivalent. For convenience and clarity, non-metric units are used in this report. Readers more familiar with metric terms may use the factors in the appendix to convert to that system.

The projected *EPA Fabric Filtration Studies* series will contain:

1) Performance of Non-Woven Nylon Filter Bags.
2) Performance of Non-Woven Polyester Filter Bags (this report).
3) Performance of Expanded PTFE Laminate Filter Bags.
4) Aging Effects.
5) Bag Cleaning Technology.
6) Analysis of Particle Size Efficiency.

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LIST OF ABBREVIATIONS AND SYMBOLS

A = filtration area of fabric, sq ft

C_o = mass outlet concentration, grains/1000 cu ft

E = mass collection efficiency, percent

F = fallout fraction (dust which goes directly to baghouse hopper without contacting bag)

K_2 = true value of specific cake resistance, (in. H_2O/fpm)/(lb/sq ft)

K_2' = measured value of specific cake resistance, (in. H_2O/fpm)/(lb/sq ft)

ΔP_E = pressure drop across bag at time zero of filtration cycle (in. H_2O)

ΔP_T = pressure drop across bag at end of filtration cycle (in. H_2O)

Q = flow rate through filter, cfm

q_s = flow rate through sampling system, cfm

R = average dust feed rate, grams/min

S_E = effective drag, in. H_2O/fpm

S_T = terminal drag, in. H_2O/fpm

T = filtration time, min

V = filtration rate, fpm (air/cloth ratio)

W_D = mass of dust collected in sampling system, grams

ACKNOWLEDGMENTS

E.I. DuPont de Nemours and Co., Wilmington, Del. donated all the spunbonded polyester bags used in this study. They manufactured the fabric and assumed all costs of sewing and preparing the bags to fit the EPA test facility. In addition, Messrs. Paul Langston and Harry Sandstedt of DuPont's Textile Fiber Department provided advice and encouragement throughout the evaluation.

SECTION I
CONCLUSIONS

Laboratory comparisons of various spunbonded polyester bags used to filter redispersed flyash at room temperature show that:

1) Based only on measurements of efficiency, drag, and specific cake resistance, the 6 oz/yd^2 nominal weight crimped polyester fiber offers the best overall performance/cost tradeoff; this bag performed slightly better than the spunbonded nylon bags previously tested,[1] substantially better than the lighter weight crimped polyester fibers tested, and somewhat better than the straight fiber polyester bags tested (neglecting the endurance data).

2) In the endurance tests, the 3 oz/yd^2 acrylic coated bag withstood 3.5 million shakes and the 6 oz/yd^2 crimped filter bag, 22 million shakes, both significantly less than the woven polyester bag which withstood about 54 million shakes.

3) For both the crimped and the straight fiber spunbonded polyesters, increasing the fabric weight increased the filtration efficiency.

4) For comparable fabric weights (3 oz/yd^2 spunbonded polyster vs. 3.9 oz/yd^2 woven polyester) the spunbonded polyester fabrics have higher efficiencies, lower outlet concentrations, lower specific cake resistances, and much lower effective drags than the woven polyesters.

5) For comparable fabric weights (the 2.2 oz/yd^2 straight fabric versus the 2.4 oz/yd^2 crimped fiber), bags made from straight polyester fibers showed higher efficiencies and drags, and lower outlet concentrations and specific cake resistances than bags made from crimped polyester fibers.

6) No significant performance differences existed between the acrylic coated and the uncoated spunbonded polyester bags tested.

Other general conclusions of these experiments are the following:

1) The smallest sized particles measured (0.3 to 0.5 μm optical diameter) are less effectively filtered than the larger sized particles.

2) As is true for typical woven and felted fabrics, the filter efficiency is generally lowest immediately following a cleaning cycle and highest at the end of the filtration cycle.

3) Following cleaning, high humidity (70 percent) reduces the time required for the bag to reestablish high filtration efficiency.

4) Filtration efficiency is higher at high humidity (70 percent) than at low humidity (30 percent), while specific cake resistance has only a small humidity dependence and both effective drag and terminal drag increase slightly over this humidity range.

The best performing spunbonded polyester bags significantly outperformed the woven polyester bags; they displayed higher efficiencies, and lower cake resistances and effective drags. Their initial costs are lower but they may have to be replaced more often.

The 6 oz/yd^2 crimped fiber bag was clearly the all around superior performer, based on both performance and endurance tests. The 3 oz/yd^2 bag performed nearly as well but proved much less rugged in the endurance tests.

These conclusions are based on room temperature filtering of redispersed flyash. No conclusions regarding operation at higher temperature, in corrosive environments, with different dusts or other typical field conditions are explicitly stated.

SECTION II
INTRODUCTION

Non-woven fabrics are receiving increased attention as filtering mediums. One type of non-woven fabric, referred to as "spunbonded," is made by forming webs of continuous filaments which are then bonded into an integral fabric structure. This type of fabric can be produced from any polymer; commercial materials include polyamides, polyesters, and olefins. This report summarizes tests carried out with bags made of spunbonded polyester fibers manufactured by DuPont under the tradename of "Reemay." Reemay bags are made of polyester filaments containing a small amount of a lower melting point copolyester to effect bonding. Typical physical properties of Reemay spunbonded polyester are given in Table 1. Both the manufacturer's nominal values and the values measured by the Fabric Research Laboratory (FRL) on fabric samples furnished by EPA are listed in Table 1. The measured and nominal sample weights agree reasonably well and correlate well with other fabric properties. Thickness, on the other hand, varies widely and does not correlate with weight or other properties. It appears to be a marginally meaningful value as measured on these samples.

Fabric filtration is a proven method for the removal of particulates from gas streams. The performance of a bag is often measured by its efficiency, E, of dust removal or by the concentration of dust in the effluent, C_O, (the outlet concentration). The experiments to be reported here were carried out at constant dust feed rates and dust loadings so that the outlet concentration is the preferred parameter of comparison because of its direct dependence on W_D, T, and q_s (see the List of Abbreviations and Symbols for all definitions of terms):

$$E = 100 \left[1 - \frac{(W_D)(Q)}{(R\text{-}FR)(T)(q_s)} \right] \qquad (1)$$

Table 1. PROPERTIES OF REEMAY SPUNBONDED POLYESTER FABRICS[a]

Sample No. / Characteristic	Straight Fiber				Crimped Fiber		
	1	2	3	4 (acrylic coated)	5	6	7
Weight (oz/yd^2)	1.27	2.19 (2.2)[b]	3.04 (3.0)	2.95	(1.9)	2.49 (2.4)	5.96 (6.0)
Thickness (mil)	10.7	18.9 (12.0)	13.9 (16.2)	16.0	(13.4)	15.9 (17.5)	14.8 (34.7)
Grab Tensile (lbs)							
Machine Direction	35.4	35.2 (58.3)	89.6 (89.9)	69.8	(30.4)	54.7 (47)	123 (136)
Cross Direction	50.3	45.0 (47.0)	53.0 (75.9)	39.4	(28.3)	73.5 (41)	97 (114)
Grab Elongation (%)							
Machine Direction	25.0	45.2 (43)	72.2 (52)	54.7	(41)	44.3 (69)	112 (83)
Cross Direction	48.5	57.2 (49)	61.6 (68)	41.1	(57)	90.5 (82)	114 (108)
Tongue Tear (lbs)							
Machine Direction	3.10	2.67 (3.91)	3.53 (6.44)	2.70	(3.34)	4.83 (5.5)	12.16 (14.1)
Cross Direction	2.71	1.96 (3.99)	2.53 (6.27)	2.80	(3.40)	3.93 (6.0)	12.30 (15.7)
Mullen Burst (psi)	51	72 (65)	111 (99)	97	(28)	59 (40)	107 (105)
Frazier Permeability	(measured at 0.5 in. H_2O pressure differential)						
$(ft^3/min)/ft^2$	525	307 (288)	175 (246)	253	(392)	312 (298)	160 (94)

[a]Measurements made by FRL, An Albany International Company, Rt. 128 at Rt. 1, Dedham, Mass. 02026. ASTM test methods used.

[b]Numbers in parentheses are the nominal values published by the manufacturer (DuPont).

$$C_o = \frac{(15.43\ \frac{\text{grains}}{\text{gram}})\ (W_D)\ (1000)}{(T)\ (q_s)} \qquad (2)$$

In addition to the obvious requirement of high efficiency, other important properties which are indicators of performance are pressure drop through the bag, endurance, and cake buildup.

Pressure drop through a bag filter is an important cost consideration, since the pressure drop is a measure of the energy consumption of the system. This parameter is measured by the filter effective drag,

$$S_E = \Delta P_E/V; \qquad (3)$$

and the terminal drag,

$$S_T = \Delta P_T/V. \qquad (4)$$

During the filter cycle, pressure drop increases as the dust cake builds up and the efficiency of the bag improves. However, the increase in pressure drop implies an increase in the energy consumption of the system. The most important parameter of the cake buildup is the specific cake resistance, K_2 or K_2', which is the rate of increase of drag with cloth loading during the filter cycle, and can be a useful design parameter. The value of K_2 reflects how fast the bag recovers after a cleaning cycle and is believed to be a function of both fabric and dust characteristics. For more information consult the Handbook of Fabric Filter Technology.[2]

Fabric endurance is important for cost estimation. The bag life, together with the initial bag cost and bag installation costs, determines one portion of the baghouse operating costs. The primary factors which influence bag life are the filtering environment (gas stream, temperature, and chemistry), the bag cleaning technique, and the abrasiveness of the dust. More information concerning endurance can be found in Fabric Filter Cleaning Studies.[3]

The final factor considered in this report is the effect of humidity upon bag performance. Humidity affects the collection efficiency by altering both fabric and dust characteristics. Various types of woven fabrics have been shown to respond differently to humidity changes, but the humidity effects on spunbonded fabrics have not yet been studied in great detail.[4]

SECTION III
EXPERIMENTAL METHODS

The tests on the spunbonded polyester bags were conducted in an experimental, single compartment baghouse as shown schematically in Figure 1. The area of each bag was 8.5 sq ft and the air to cloth ratio was held fixed at 4/1. The test dust used for the evaluation was powerplant flyash which was classified to remove over-sized particles. The size distribution, as determined by Coulter Counter analysis, showed that 10 percent was less than 3.5 μm, 90 percent was less than 20 μm, and the mass median diameter was between 5 and 6 μm.

Inlet air was fed to the system from the top to the inside of the bag, passed through the bag, through a sampling area, and out of the system. The dust loading, temperature, humidity, and quantity of air were controlled. Pressure drop across the baghouse and the flow rate were measured continuously with a differential pressure cell and a venturi. Humidity and dust loading were checked periodically. Humidity was measured with wet bulb/dry bulb thermometers and the dust feed was measured by periodically sampling the output of the feeder. The grain loading of the outlet air stream was determined by sampling the stream isokinetically and collecting the dust on a 0.45 μm Millipore filter. The weight gain acquired by the filter element during the sampling period became the W_D term in equations 1 and 2.

The first set of tests was designed to evaluate bag performance as a function of fabric weight. For each sample, tests began with a 24 hour operating period as a "break in" cycle. Standard operating conditions were 20 minutes of filtration, 1 minute delay, 2 minutes of shake cleaning, and 1 minute delay for each filtration cycle. Shake action applied to the bottom of the bag consisted of periodic displacements at a frequency of 240 cycles per minute and an amplitude of 0.81 inches. Measurements began after 24 hours.

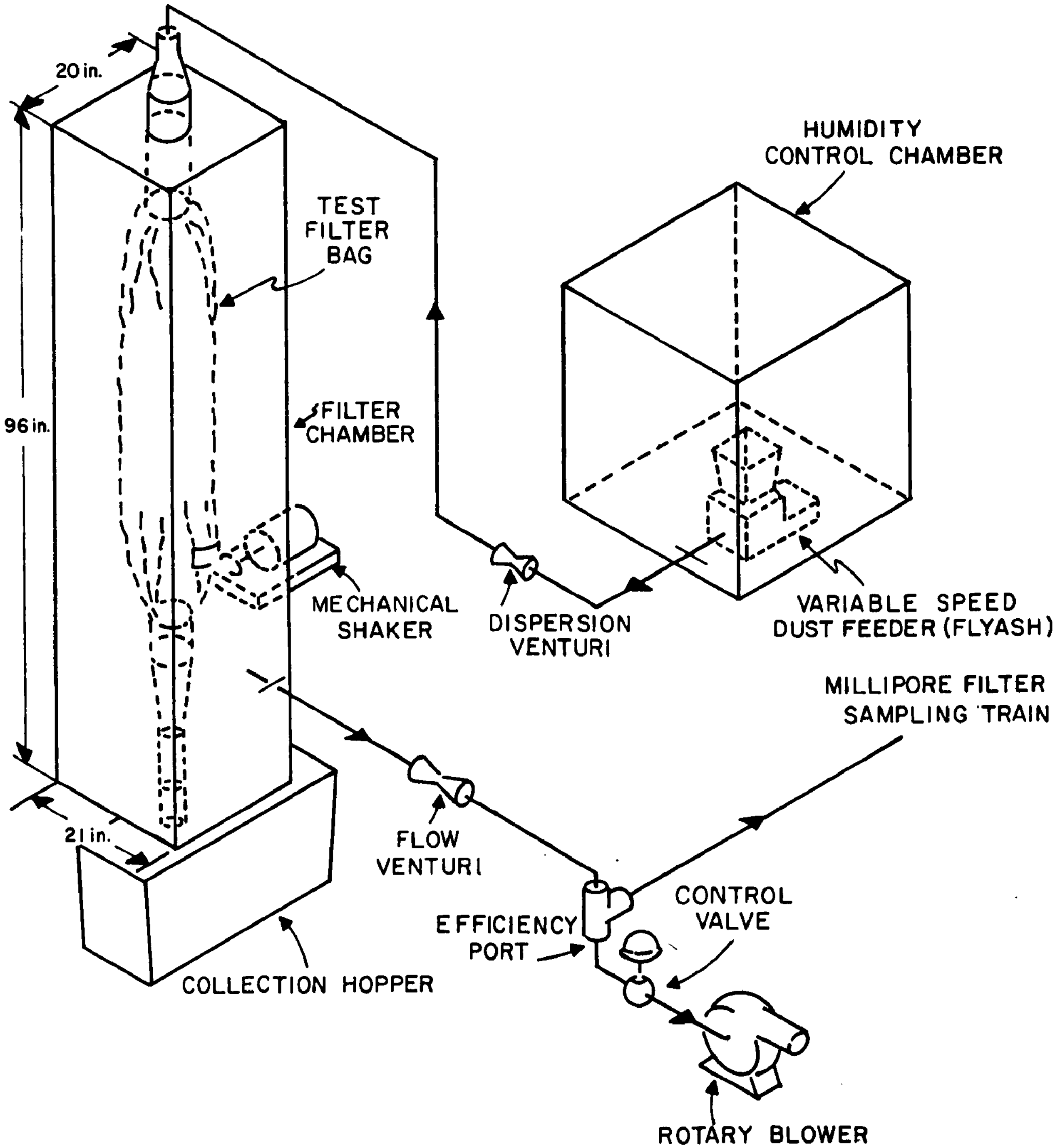

Figure 1. Apparatus used for testing spunbonded polyester bags.

Three types of Reemay bags were tested at a constant humidity of 40 percent:

1) Three straight fiber bags of nominal weights, 1.35, 2.2, and 3.0 oz/yd^2 (Samples 1, 2, and 3, Table 1).

2) Three crimped fiber bags of the following nominal weights: 1.9, 2.4, and 6.0 oz/yd^2 (Samples 5, 6, and 7).

3) A 3.0 oz/yd^2 acrylic coated straight fiber bag (Sample 4).

The acrylic coat is a fiber variation designed to increase abrasion resistance.

Humidity tests were conducted on two of the bags--the 6 oz/yd^2 crimped fiber bag (Sample 7) and the 3 oz/yd^2 acrylic coated bag (Sample 4). To establish equilibrium prior to testing, these bags were operated for 96 hours before taking any humidity-dependent data. Following this equilibrium period, the relative humidity was varied in a random fashion between 30 and 70 percent. After each humidity change, the bag was operated for 48 hours before recording new data. The standard operating cycle was used for these tests.

Endurance tests were also run on Sample 7 (6 oz/yd^2) and Sample 4 (3 oz/yd^2). For this test, the filtration cycle was changed to consist of 2 minute feed, 1 minute delay, 15 minute shake cleaning, and 1 minute delay. The bags were operated until failure occurred, failure being defined by a tear or large hole in the bag as detected by a high outlet concentration. No attempts were made to seal pin holes or thin spots during the run.

For comparison, a 3/1 twill woven bag made from continuous filament polyester was also tested for endurance. The weight of this woven polyester bag was 3.9 oz/yd^2.

For certain of the tests, mostly the humidity tests, the outlet dust was classified according to size with a Climet Counter. This counter measures the concentration of particulates in the following size ranges:

1) 0.3 - 0.5 μm.
2) 0.5 - 1 μm.
3) 1 - 2 μm.
4) 2 - 4 μm.
5) 4 - 8 μm.
6) >8 μm.

This measurement is in real time and allows the size distribution to be determined at various times during the 20 minute filtering cycle. Typically the size distribution was determined at the beginning of the filtration cycle and every 2 minutes thereafter throughout the 20 minutes.

The Climet data provided a comparison of populations in different optical size ranges as a function of time rather than an absolute determination of outlet concentration. The Climet data were not used to measure any performance parameter but only to furnish additional qualitative insight into the dust/fabric interaction. (The Millipore filter sample furnished the measures of total dust, W_D, from which filtration efficiency was calculated.)

Only a limited number of bags were used in the test program. In general, one bag of each sample type was used for gathering performance data which could be completed in about 2 days. For the two bags tested for humidity dependence (Samples 4 and 7), a second fresh bag was used in each humidity test series. Because of their superior performance, these same two sample types were also those chosen for endurance tests. The initial plan was to use the same bag on which the humidity series had been run for the endurance tests. This plan was carried out for Sample 7 but, because of an early failure on the Sample 4 bag, the endurance tests for that type bag were completed (and essentially entirely carried out) on the bag that had been used previously to measure the performance parameters. Conceivably, some bias could have been introduced into the results because of this difference in bag conditioning.

SECTION IV
RESULTS

PERFORMANCE

The effect of fabric weight on the efficiency and outlet concentration is shown in Figures 2 and 3. Comparisons are made with 3.9 oz/sq yd woven polyester fabric and with spunbonded nylons as tested and reported previously.[1,4] Both the coated and uncoated straight fiber 3 oz/yd^2 spunbonded polyester bags exhibited a lower outlet concentration (higher efficiency) than the 3.9 oz/yd^2 woven polyester bag. An increase in fabric weight resulted in a higher efficiency for both the crimped and straight spunbonded fibers.

Fabric weight versus specific cake resistance is shown in Figure 4. The specific cake resistance for the spunbonded nylons increased with fabric weight[1] but this pattern was not observed with the spunbonded polyester bags: the single bag made from crimped 6 oz/yd^2 polyester consistently operated at lower K_2' values than bags made from 1.9 or 2.4 oz/yd^2 crimped fibers. The 3 oz/yd^2 bag had a specific cake resistance of about 70 percent of the 3.9 oz/yd^2 woven polyester. The low weight, crimped spunbonded polyester fibers had significantly higher specific cake resistances than comparably low weight spunbonded nylons, but the 6 oz/yd^2 spunbonded polyester bag had a specific cake resistance about 40 percent lower than both the 5.9 oz/yd^2 spunbonded nylon and the 3.9 oz/yd^2 woven polyester reference bag.

The spunbonded polyester bags contain trilobal cross-sectional yarn as shown in Figure 5 while the woven polyester and the spunbonded nylon bags are made of yarn with round cross-sections. The crimped fiber and the trilobal cross-sectional yarn probably influences the manner in which dust builds up on the filter as has been found by Miller, Lamb and Costanza.[5]

The effective drag of the spunbonded polyester increased with fabric weight as shown in Figure 6. The woven polyester had an effective drag about three times as high as that of the 3 oz/yd^2 spunbonded polyester bags and slightly less than three times as high as that of the 6 oz/yd^2 spunbonded polyester bags. The effective drag of the spunbonded polyester bags was generally lower that of the spunbonded nylon bags.

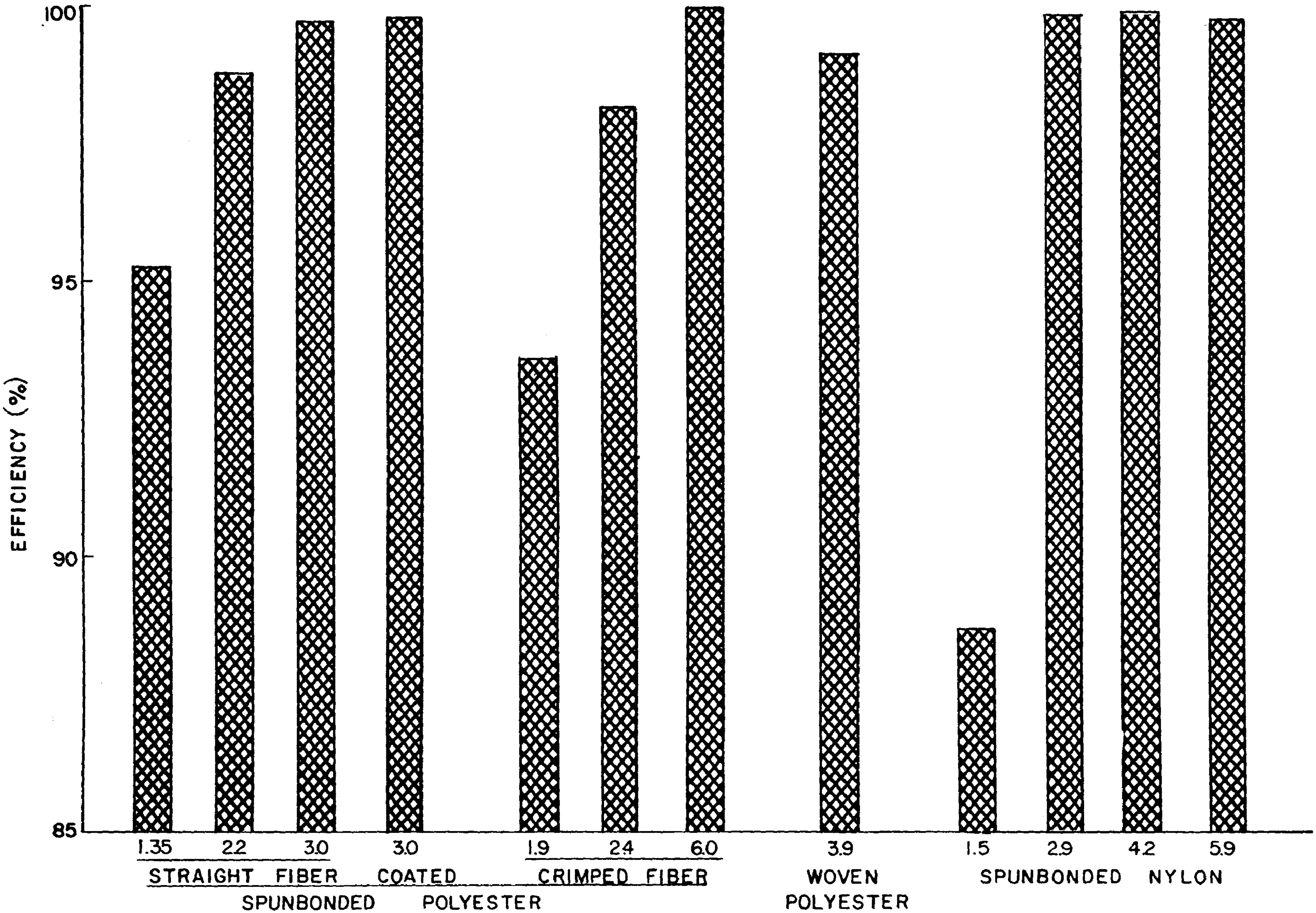

Figure 2. Mass collection efficiency of spunbonded bags (weight in oz/yd^2).

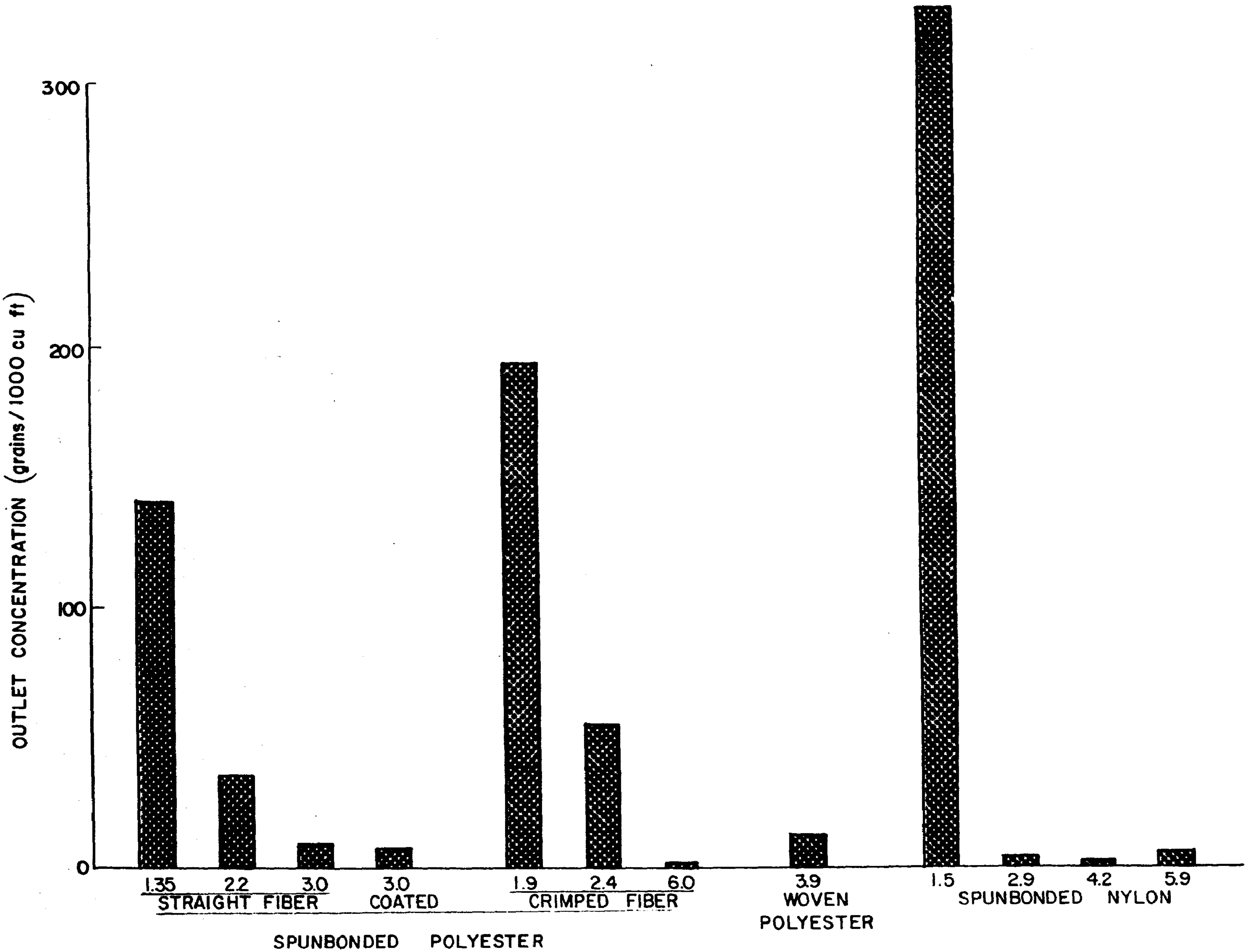

Figure 3. Outlet concentration of spunbonded bags (weight in oz/yd^2).

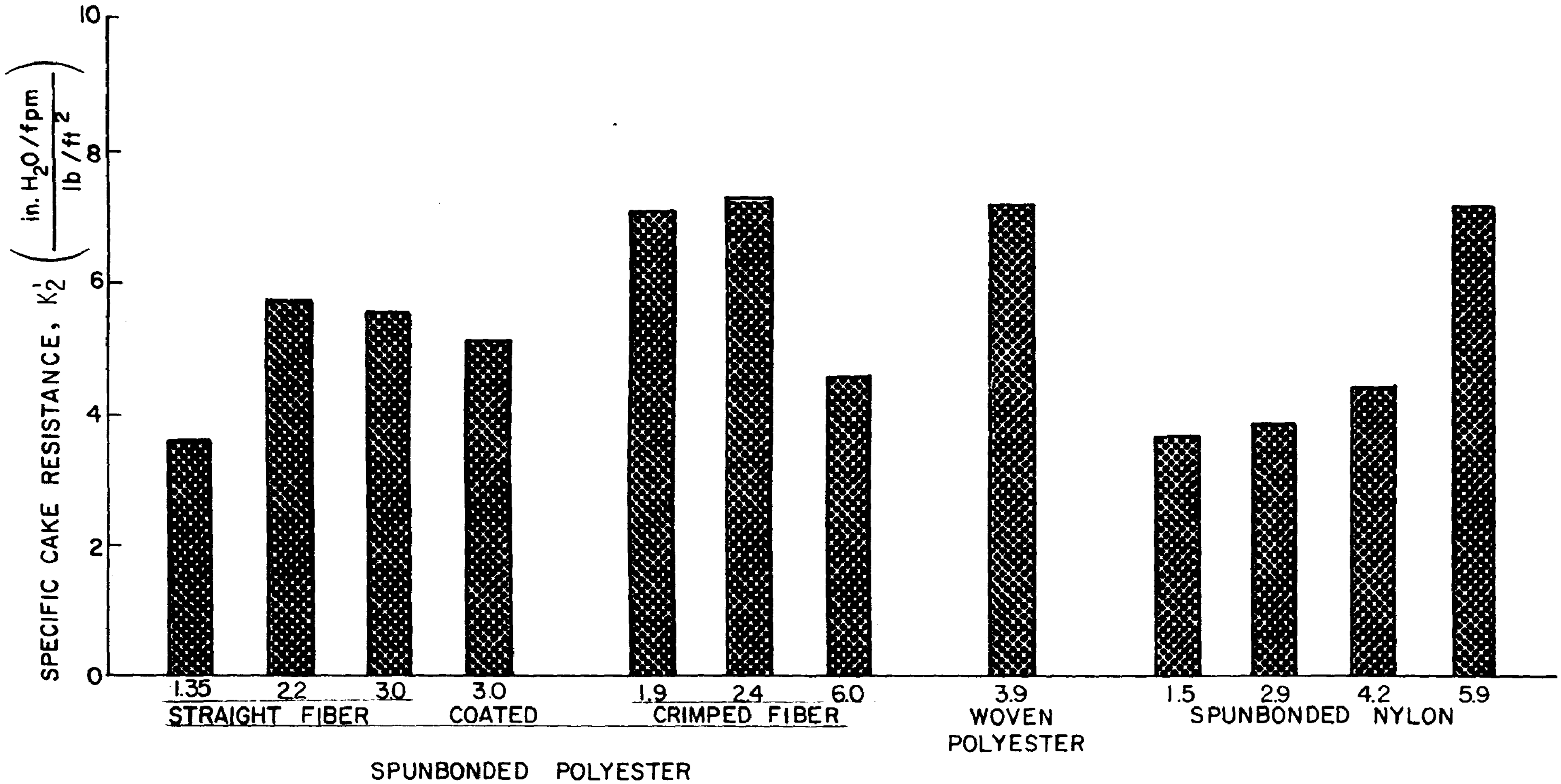

Figure 4. Specific cake resistance of flyash on spunbonded bags (weight in oz/yd^2).

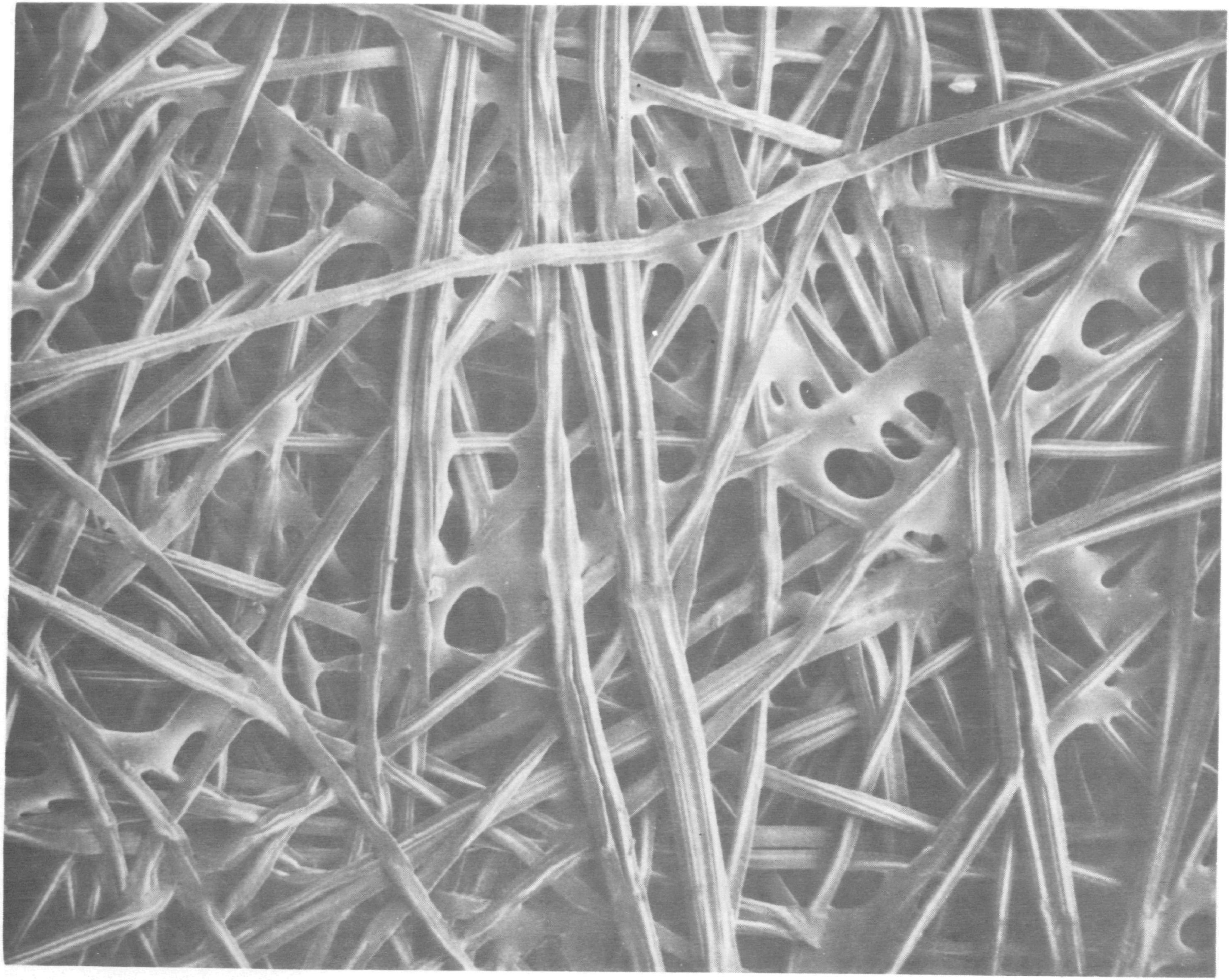

Figure 5. Reemay fabric photomicrograph (Sample 3, 108X).

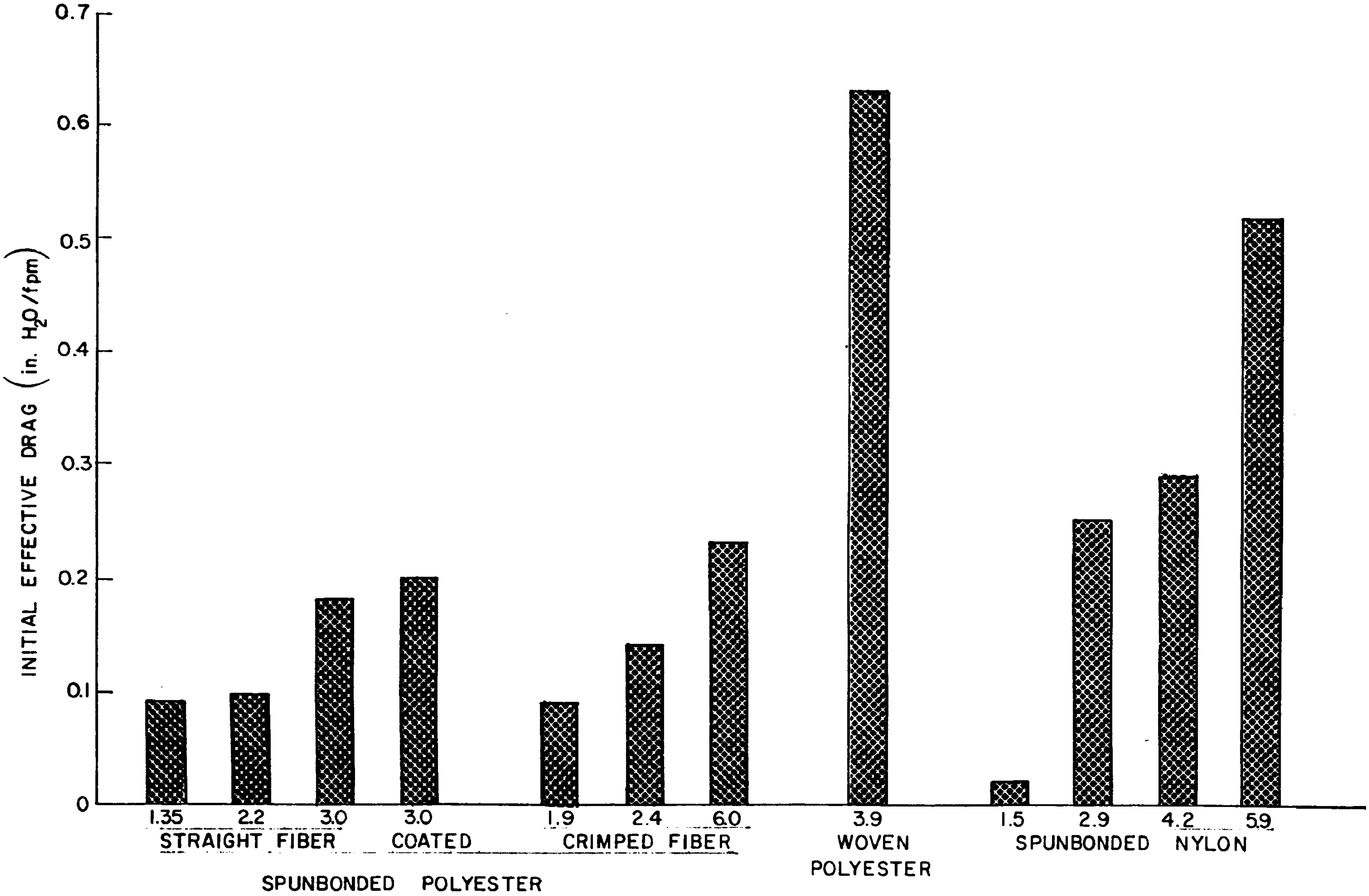

Figure 6. Effective drag of spunbonded bags (weight in oz/yd^2).

ENDURANCE

The endurance testing was interrupted periodically in order to measure bag performance. For these measurements, the cycle was changed from the endurance cycle (2 minute filtration, 1 minute delay, 15 minute shake) to the standard operating cycle (20 minute filtration, 1 minute delay, 2 minute shake). As usual, the average of three cycles was used to measure the performance.

6 oz/yd^2 Spunbonded Fabric (Sample 7)

The first signs of fabric deterioration for the 6 oz/yd^2 bag occurred after 12.5 million shakes when a small tear about 1/2 inch long and numerous weak spots were discovered (outlet concentration of 14 grains/1000 ft^3). After 20 million more shakes, the outlet concentration was approximately 34 grains/1000 ft^3. The bag was inspected again and rotated 180 degrees during remounting so as to place the tear directly above the baghouse outlet. This reorientation of the tear caused the outlet concentration to increase immediately to 88 grains/1000 ft^3. The bag was considered to have failed after 22 million shakes and the test was concluded. Various bag performance parameters versus number of shakes are plotted in Figures 7-9. Although the bag was declared a failure after 22 million shakes, the failure was not catastrophic and the bag remained functional even after 32 million shakes.

3 oz/yd^2 Spunbonded (Sample 4)

The outlet concentration and efficiency versus number of shakes for the 3 oz/yd^2 acrylic coated spunbonded bag are shown in Table 2. A bag was installed initially which failed after 370,000 shakes. Failure was due to a 3 inch tear located at the bottom of the bag where the cuff was sewn.

An identical bag was installed with approximately 370,000 shakes from a previous run. The second bag performed satisfactorily for 3.5 million shakes at which time the outlet concentration rose to over 46 grains/1000 ft^3. Visual inspection revealed a number of breaks in the bag over the entire length. The bag was considered failed at this point.

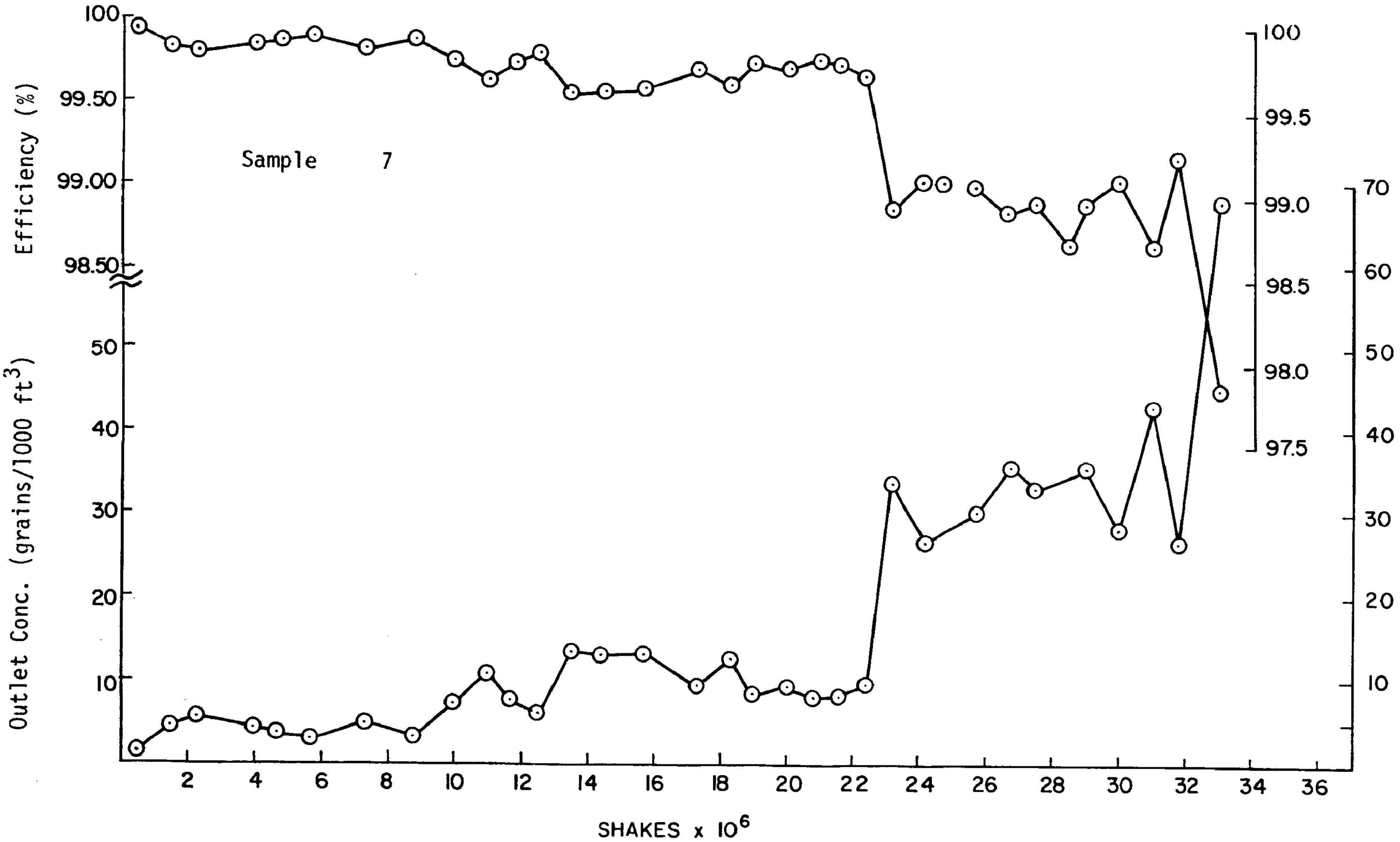

Figure 7. Outlet concentration and efficiency versus number of shakes for the 6 oz/yd^2 spunbonded polyester bag.

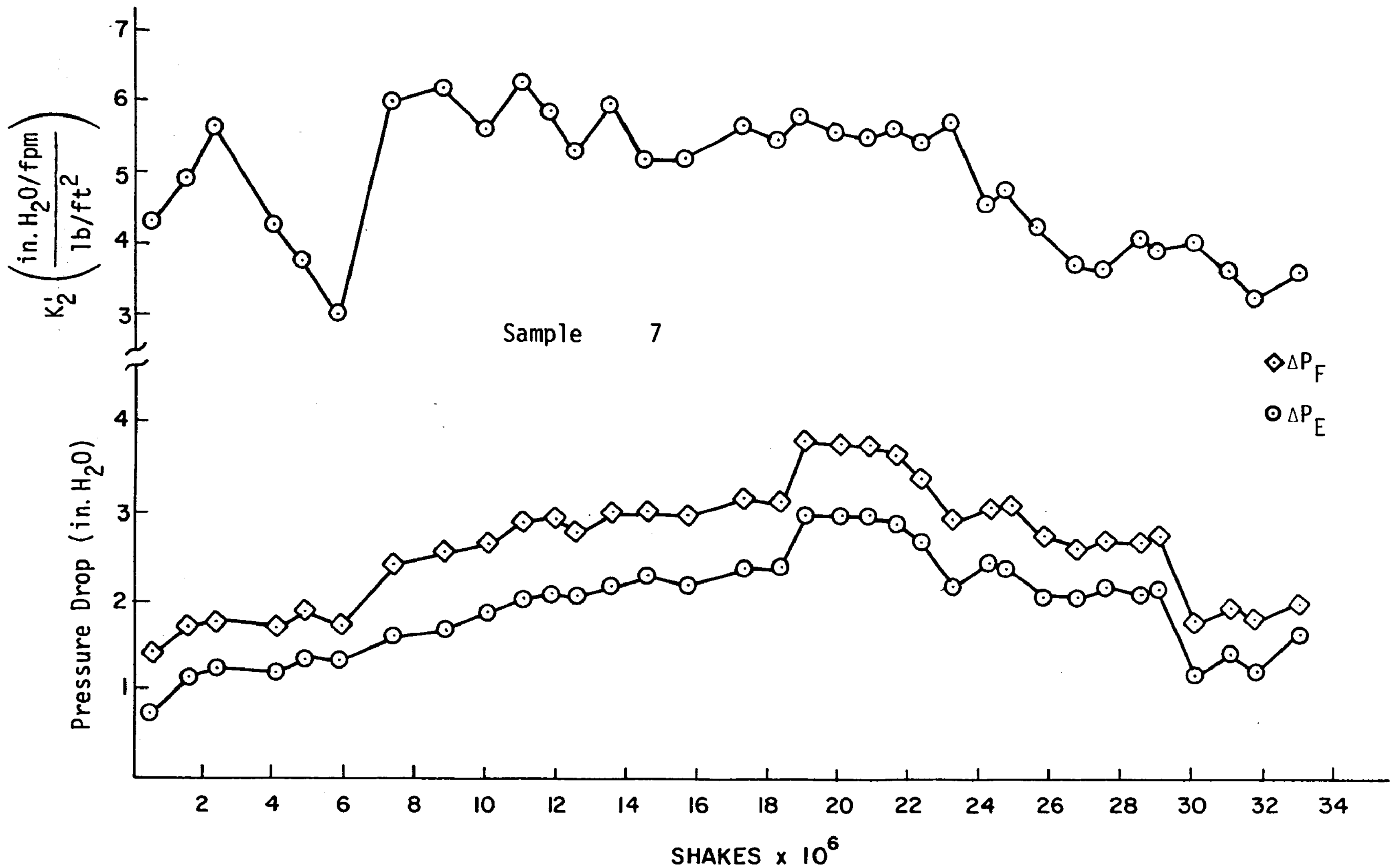

Figure 8. Specific cake resistance and pressure drops during endurance testing of the 6 oz/yd^2 spunbonded polyester bag.

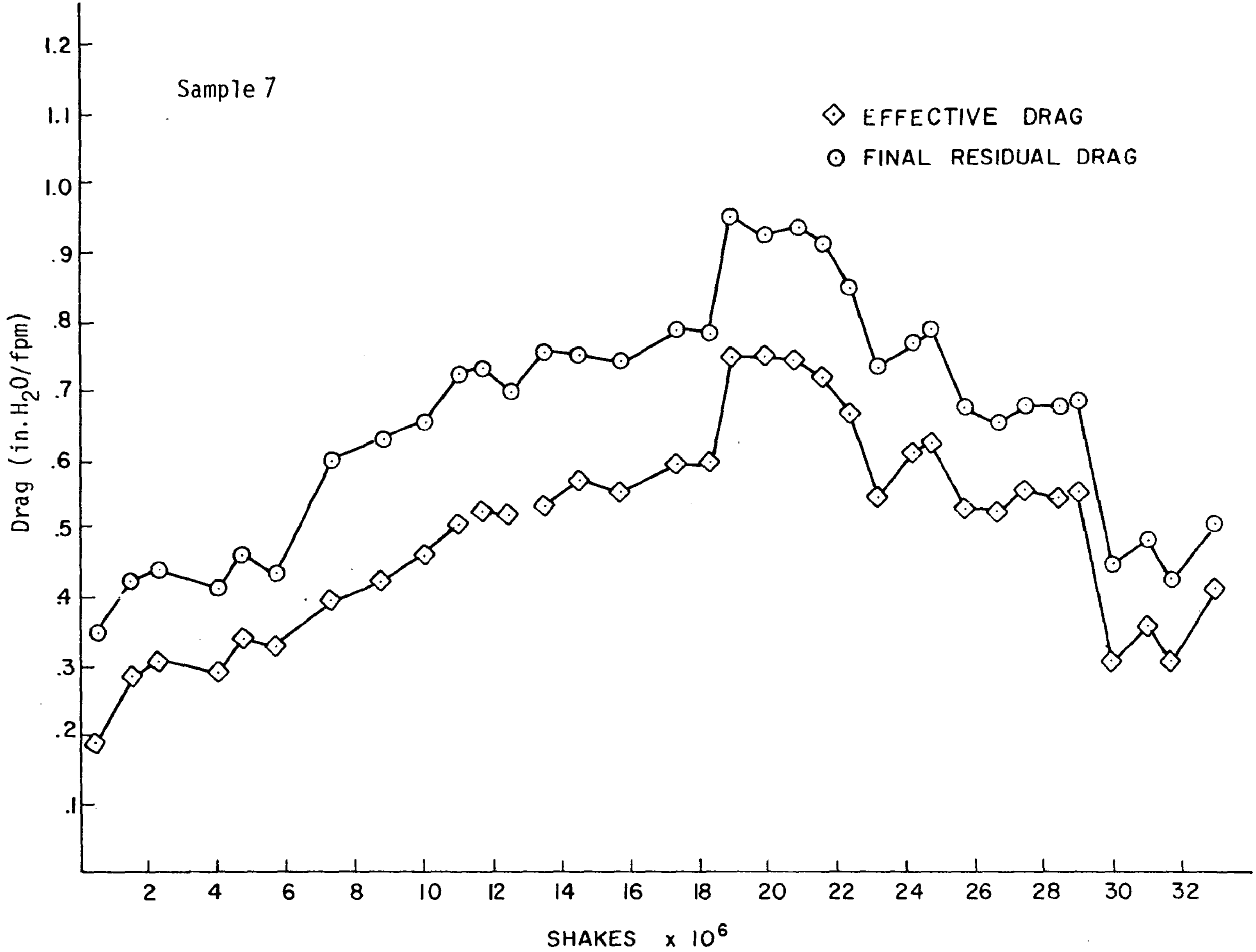

Figure 9. Effective and terminal drags during endurance testing of the 6 oz/yd^2 spunbonded polyester bag.

Table 2. PERFORMANCE OF SPUNBONDED POLYESTER[a] FILTER BAG WITH NUMBER OF SHAKES

Characteristic \ Number of Shakes x 10^6	0.845	1.10	1.34	2.10	2.88	3.56
Efficiency (%)	99.54	99.24	99.43	99.56	99.49	98.46
Outlet Concentration (C_o), grains/1000 ft^3	13.91	22.95	17.66	13.25	15.33	46.42
Specific Resistance (K_2') (in.H_2O/fpm)/(lb/sq ft)	3.88	4.35	4.47	4.26	4.59	4.23
Effective Drag (S_E) in.H_2O/fpm	0.16	0.15	0.16	0.16	0.19	0.20
Terminal Drag (S_T) in.H_2O/fpm	0.29	0.30	0.32	0.31	0.34	0.35
Terminal Pressure Drop (ΔP_T), in.H_2O	1.18	1.21	1.27	1.24	1.38	1.38

[a]Fabric weight = 3 oz/sq yd (endurance data for the 6 oz/yd^2 bag is plotted in Figures 7-9).

Both of these spunbonded polyester bags failed significantly sooner than woven polyester bags. In a similar endurance test a bag made of woven polyester (with properties plotted in Figures 2, 3, 5, and 6) showed signs of wear after 18 million shakes, but was not considered failed until about 54 million shakes.

The number of shakes to failure measured here does not directly correspond to bag life in field use, since most shaker baghouses in the field operate on a pressure-drop-controlled cycle; that is, the filtration cycle continues until the pressure drop across the bag reaches a predetermined maximum value, following which the shake cleaning cycle commences and continues until the pressure drop falls to a predetermined low value. Because of the lower drags and lower specific cake resistances associated with the spunbonded polyester bags, a given number of shakes in the fixed cycle test reported here implies a longer field life for the spunbonded bags than the same number of shakes would for the woven polyester bags.

HUMIDITY

The effect of relative humidity on the outlet concentration of the 3 oz/yd^2 acrylic coated bag is given in Figure 10. Outlet concentration decreases with increasing humidity but the data show large scatter and poor reproducibility. Similar testing of the 6 oz/yd^2 bag produced the same general trend but with even greater scatter. The outlet concentration of the 6 oz/yd^2 bag was 3 grains/1000 ft^3 for all filtering done at 70 percent relative humidity. At 40 percent relative humidity, the outlet concentration varied between 2.5 and 11 grains/1000 ft^3.

Cake resistance was insensitive to relative humidity, while the effective drag and terminal drag both reflected a small dependence on humidity, being lower at the lower values of relative humidity. Since the effective drag increases with time, plots of S_E and S_T versus relative humidity (Figure 11) depend on the order in which the data are taken. All data in Figure 11 were taken with a single acrylic coated bag (Sample No. 4) over a 3 week period. The number next to each of the data points refers to the order in which that specific point occurred in the sequence of test runs. Time alone causes an increase in both the drags, S_E and S_T (compare points 1, 2, and 3; 4 and 5; 7, 8, and 9). The humidity dependence is superimposed upon this time dependence of the drags.

The Sample 7 bag (6 oz/yd^2) showed similar behavior.

For both these spunbonded polyester bags, then, the effect of humidity upon performance is not very large when filtering redispersed flyash.

SIZE DISTRIBUTION

The size distribution of dust at the bag outlet was determined every 2 minutes during the humidity tests. The analysis showed that immediately after cleaning--at the beginning of the next filtration cycle--the concentration of the larger sized particles was greatest and decreased rapidly with time. The smallest sized fraction (0.3 to 0.5 μm), however, increased in concentration initially, peaked anywhere from 4 to

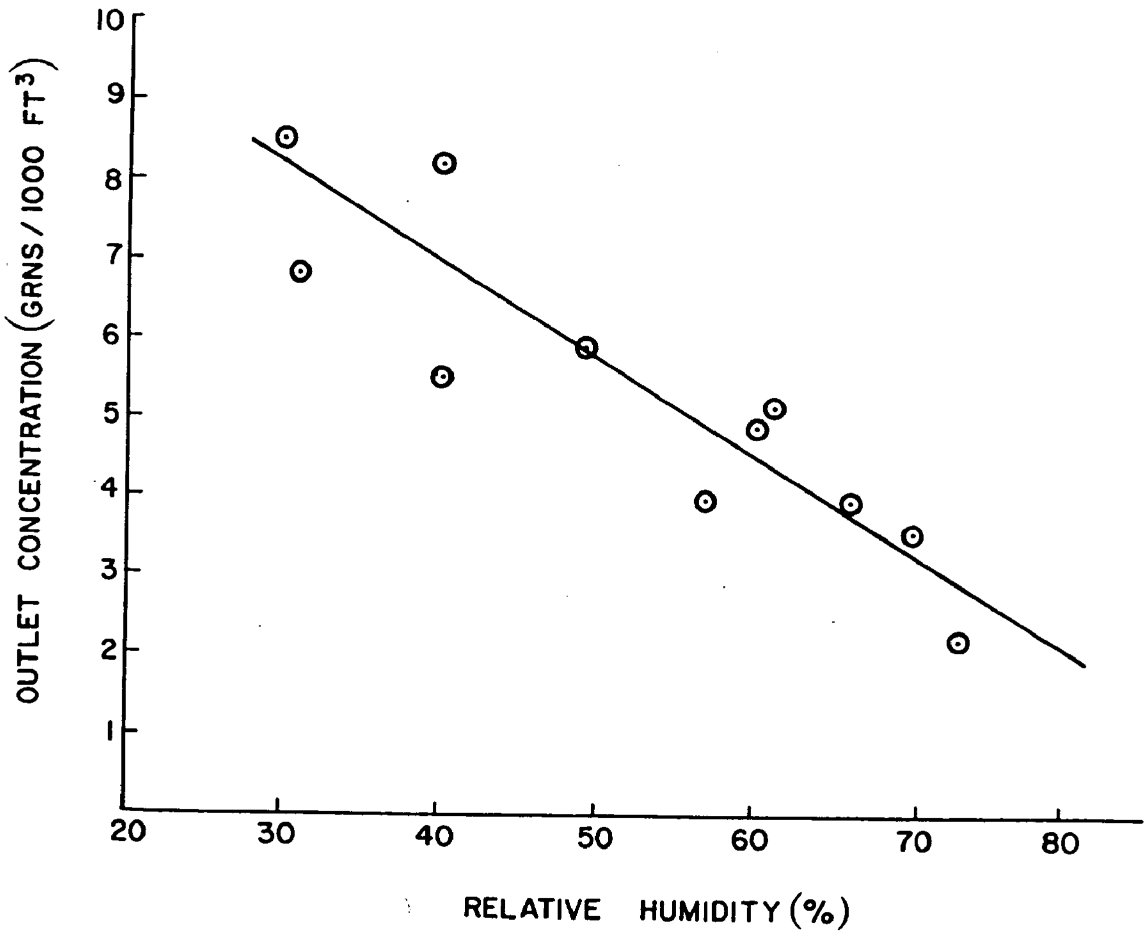

Figure 10. Outlet concentration versus relative humidity for the 3 oz/yd^2 acrylic coated polyester bag.

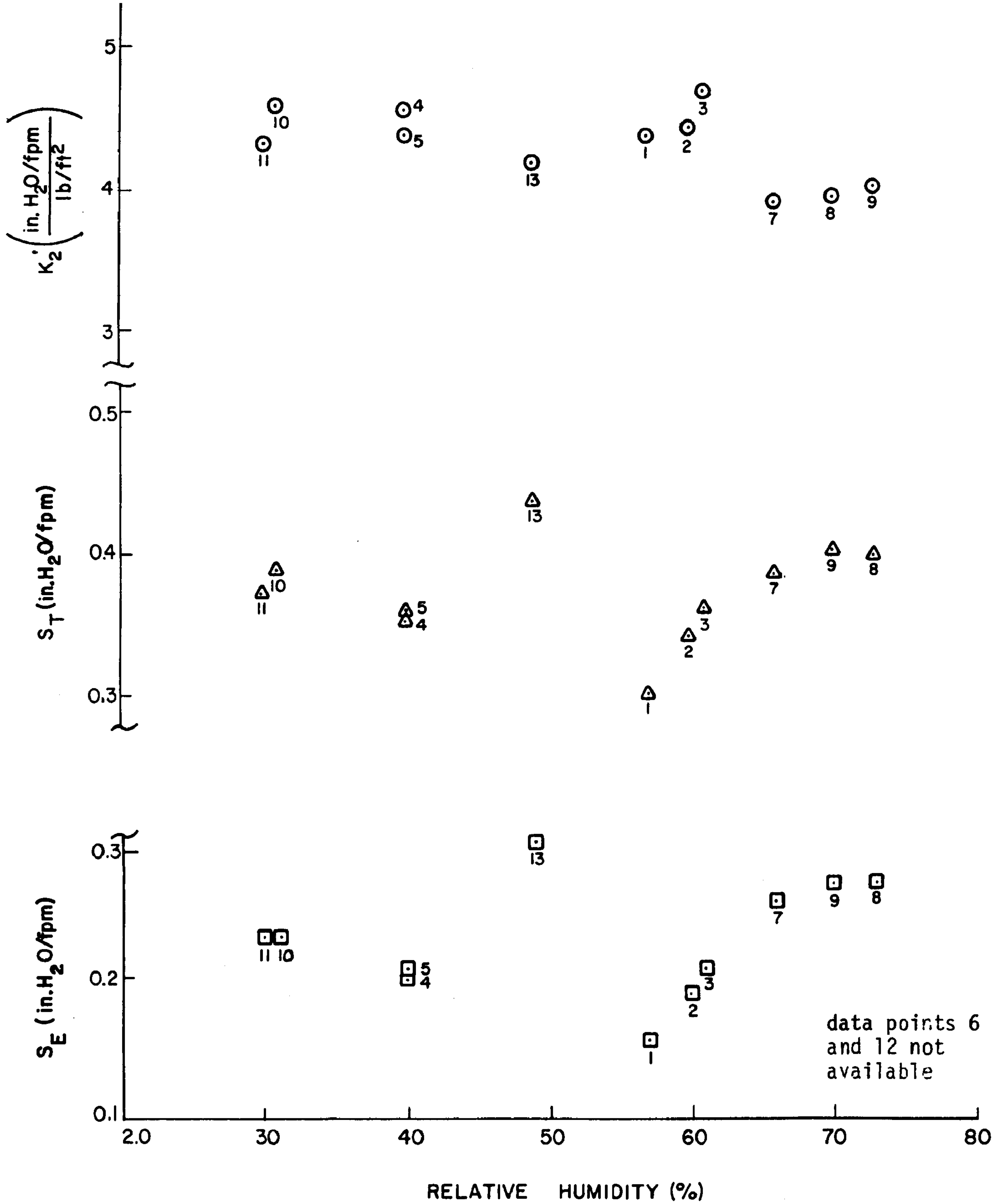

Figure 11. Specific cake resistance, effective and terminal drags as a function of relative humidity (3 oz/yd^2 acrylic coated polyester bag).

10 minutes after the filtration cycle began, and then decreased (Figure 12).

In nearly all the samples evaluated, the 0.3 - 0.5 μm sized particulates were the dominant size at the end of the 20 minute filtration cycle but never at the beginning. At the start of the filtration cycle either the 0.5 to 1 μm group or the 1 to 2 μm group was the largest. The concentrations of these two groups both fell more rapidly than that of the smallest group so that by the end of the filtration cycle, the smallest sized particles dominated. Fall-off was according to size range, the largest sized particles falling off in concentration most rapidly. As is shown in Figure 12, humidity affects the time dependence of the size distribution of particles in the outlet. The concentration curves measured at 59 percent relative humidity decay more rapidly than those measured at 28 percent.

Cake resistance (K_2'), and the effective (S_E) and terminal (S_T) drags were higher at 59 percent than at 28 percent relative humidity but some of this increase was probably a time effect (the 28 percent humidity data were taken several weeks before the 59 percent data), as illustrated in Figure 11 for bag Sample 4. The humidity dependence of K_2', S_E, and S_T is probably small.

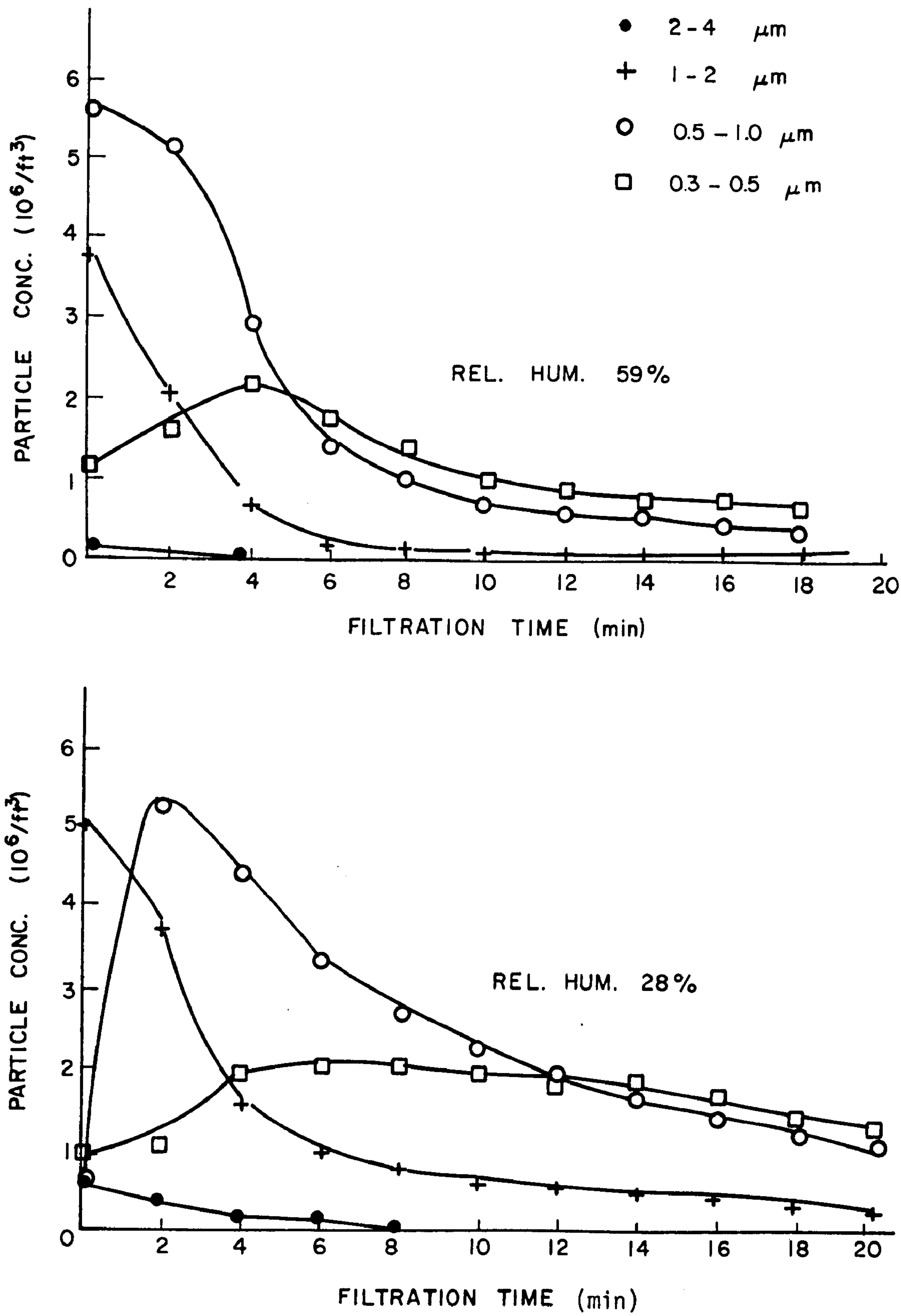

Figure 12. Size analysis of outlet dust (Sample 7).

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APPENDIX

Conversion Factors

To Convert From:	To:	Multiply By:
foot	meter	3.05×10^{-1}
$foot^2$	$meter^2$	9.29×10^{-2}
$foot^3$	$meter^3$	2.83×10^{-2}
foot/min (fpm)	meter/sec	5.08×10^{-3}
grain	kilogram	6.48×10^{-5}
grains/1000 ft^3	g/m^3	2.29×10^{-3}
inch	meter	2.54×10^{-2}
$inch^2$	$meter^2$	6.45×10^{-4}
$inch^3$	$meter^3$	1.64×10^{-5}
inch of water (60°F)	$newton/meter^2$	2.49×10^{-2}
lb (force)	newton	4.49
lb (mass)	kilogram	4.54×10^{-1}
$lb/foot^2$	$newton/meter^2$	4.79×10^{-1}
$lb/inch^2$ (psi)	$newton/meter^2$	6.89×10^{-3}
mil	meter	2.54×10^{-5}
oz/yd^2	kg/m^2	3.39×10^{-2}
yard	meter	9.14×10^{-1}
$yard^2$	$meter^2$	8.36×10^{-1}
$yard^3$	$meter^3$	7.65×10^{-1}

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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16. ABSTRACT The report gives results of an evaluation of fabric filter bags made of non-woven, spunbonded polyester in a laboratory simulation of a baghouse operating at room temperature. Using only redispersed power plant flyash, the collection efficiency, specific cake resistance, and pressure drops (effective and terminal drags) were measured for seven bags each of which was made from one of seven different spunbonded polyester fabrics. The two best-performing bags were further evaluated in humidity and endurance tests. Overall, the bag made from crimped polyester fiber of 6 oz/sq yd (0.20 kg/sq m) nominal weight provided the best performance/operating cost tradeoff. It significantly outperformed a woven polyester bag (included in the tests as a reference) but lasted less than half as long in the endurance tests. Classification of the outlet dust according to size during the humidity tests showed that: filtration efficiency is higher at 70 than at 30 % relative humidity; although filtration efficiency is always lowest immediately after a cleaning cycle, high relative humidity (70 %) reduces the time required to re-establish operation at high filtration efficiency; and the smallest particles measured (0.3 to 0.5 micrometer optical diameter) are less efficiently filtered than larger particles.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Air Pollution	Polyester Fibers	Air Pollution Control	13B	
Dust	Fly Ash	Stationary Sources	11G	21B
Filtration		Particulate	11D	
Dust Filters		Fabric Filters	13K	
Fabrics		Baghouses	11E	
Nonwoven Fabrics		Collection Efficiency		

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