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TESTS OF FABRIC FILTRATION MATERIALS

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TESTS OF FABRIC FILTRATION MATERIALS

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ABSTRACT

This report describes laboratory and pilot scale testing of filter fabrics. Tests were made on flat specimens and on bags. Fifteen styles of fabrics made from cotton, polyester, aramid or glass were tested using cement, coal or talc dusts. Collection efficiencies and pressure drop data are presented for inlet dust concentrations of 10 - 11 g/m^3, filtration velocities of 60 and 80 m^3/m^2-hr, temperatures of 20 to 30°C and relative humidities of 55 to 60 percent.

Conclusions reached were: 1) fabrics which performed well on bench scale apparatus also performed well on large scale apparatus, 2) free area calculations for characterizing fabrics are useful for staple fiber fabrics, but not for continuous filament fabrics, 3) smooth fiber fabrics with low coefficients of friction may have poor collection efficiency at high filtration velocities, 4) cleaning properties of fabrics depend on the fabric composition and structure, and on dust properties, but not on filtration velocity.

Collateral tests are described.

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1.0 INTRODUCTION

Filtration has been defined as a process for removal of solid particles from an aerosol by a porous medium. Widest industrial application has been found for textile media, which can be subdivided into two groups: non-woven (fibers, mattes, felts) and woven (filter fabrics). These two groups have differences in surface and spatial structure which, depending upon filtration and process parameters, determine the choice between the two.

There are many publications in engineering and scientific journals about textile filtration media, in which different authors chose different testing conditions to confirm empirical dependences. The conclusions from these experiments have not proven to be very useful under alternate conditions, particularly with different aerosols and filtration media.

Classical filtration theory was born in the First and Second World Wars with efforts to establish a theoretical base for removal of toxic substances and solid pollutants from the air. The special requirements of the nuclear power industry and the space program have influenced the development of the theory, and it is still being refined. Increasing pressures on the legislatures concerning dust emission into the air during the last twenty years has stressed the need for theoretical studies of the dust collectors used for industrial filtration.

Although the description of the filtration process on a macroscopic level for given aerosol and filter parameters has been relatively easy, its generalization to the microscopic level in terms of particulate properties and structural parameters is still the subject of investigation. Many authors have tried to base the description of filtration processes on classical filtration theory and have derived general mathematical relations. But these seem inadequate in light of the differences between atmospheric filtration, for which the theory was derived, and industrial filtration; for example, the possibility of filter structure regeneration in a dust collector.

From previously published studies, three main types of filtration processes can be delineated:

1) High efficiency filtration with initial particle concentrations below 1 mg/m^3 (or 0.5 mg/m^3),
2) Air filtration at initial concentrations between 1 mg/m^3 and 50 mg/m^3, and
3) Dust filtration at initial concentrations above 50 mg/m^3.

Each of these processes requires special conditions to insure that separate filtration mechanisms predominate. The initial concentration, according to which the three groups are divided, is the decisive factor for selecting parameters for the filtration process and determining its efficiency. It also determines the focus of the investigation with regard to particle interactions and the effects of filter structure.

Industrial dust collectors fall into Group 3 because the initial concentrations are far in excess of 50 mg/m^3. The major operating characteristic of this group is the formation of a dust cake on the filter structure, followed by a cyclic regeneration. At present, there is no mathematical description of the dust filtration process which could make possible prediction of filter characteristics in industrial applications, optimization of filter media structures and filtration parameters, and projection of the optimized filtration structure for defined filtration conditions.

In this situation, there is wide application of empirical methods in selection of the filter medium in filtration conditions. A selection of filter media is usually done prior to testing, with consideration of aerosol temperature, aerosol humidity, aerosol corrodibility, and method of filter regeneration. As a result of the selection, we obtain a group of filter media which are satisfactory from the point of view of thermal, chemical, and mechanical resistance.

Economic factors also have weight in the selection process, using qualitative filter medium parameters (efficiency, flow resistance), which may be obtained from permeability data, results of brief tests, or prior experience. Finally, pilot tests of certain filter media of differing structures should be run to select the best medium for specific applications, with the type and degree of testing dependent upon the importance of the problem.

Apart from such applications testing of filter materials, testing methods are also the scientific foundation for the investigation of the peculiarities of dust filtration. Of course, they are different in scope, and the criteria of choice are based upon the scientific premises connected with the problem.

1.1 Methods of Filter Fabric Testing

Tests of textile media are conducted in four levels of experiments: laboratory scale, large scale, pilot scale and industrial scale.

Laboratory testing is conducted with samples of selected filtration fabrics with a surface area of 100-300 cm^2. Dusty air can flow through the fabric in an upward or downward direction, and the dust collection efficiency is evaluated by weighing. The pressure drop as a function of time is also recorded. Laboratory testing measures Type I dust filtration, the initial filtering action of a virgin filtration medium. The dust used for testing can be separated or unseparated, according to the requirements of the testing program. Laboratory testing allows easy variation of the experimental conditions to identify and define their effects on filtration.

Large scale testing is conducted on full-size filtration equipment, usually one to four bags installed in a special casing. It simulates the industrial experimental conditions with respect to regeneration and the thermodynamic parameters of the dispersion medium. The generation of the aerosol is performed by injecting dust into the gas or air stream with the help of a dust feeder. Large scale testing operates with Type III dust filtration, where multiple loading and regeneration of the fully filled fabric occurs. The degree of filling depends upon the strength of the regeneration system. Industrial dusts are used in large scale testing, just as well-characterized dusts are used in laboratory scale testing. The test stands allow for performing the same kinds of experiments as in laboratory testing, but the time involved is much longer because a larger area must be filled.

Pilot Scale testing is conducted on miniaturized fabric filters which collect some of the gases from the pilot system. These tests are capable of giving very precise information on those aspects of filter media relating to the aerosols. They are primarily empirical tests, facilitating the choice of filtration and regeneration times for the filter material. Such testing also helps to estimate the bag life. Because of the variability of the initial aerosol parameters, the results of pilot testing are not significant for theoretical research, but can be used to verify the tendencies of the process.

Industrial testing includes the whole filter device or dust control system. It is conducted only in special cases or for very important technologies because of very high costs and the relatively small amount of theoretical information obtained. Industrial scale tests do provide the best actual confirmation of the filter selection process and the performance of the filters.

1.2 Interpretation of Results of Experiments

The fact that there is no sound theoretical basis for interpreting the dust filtration process means that interpretation is limited to the specific conditions of the experiments. Interpretation is based on a comparative analysis of qualitative fabric filtration performance for special aerosols and types of dust. The performance factors to be compared are the average dust removal efficiency and the time variation dust-fabric resistance of the system for specific initial concentrations.

The regeneration properties of filter fabrics are also estimated by comparison of values of the coefficient for regeneration susceptibility, a coefficient which is directly connected with the structure of the filter medium surface and fiber and dust properties. It can be defined in terms of certain static pressure gradients.

A comparative analysis is conducted for each particular scale of experiment. For instance, laboratory scale experiments measure different types of filtration from large scale experiments. The degree of evaluation depends on the number of parameters used to characterize the process. The comparative analysis can be conducted on a few chosen parameters or, in a larger experimental program, on the functional form of the parameters.

The results obtained in laboratory scale testing usually give lower values for dust removal efficiency and filtration resistance than those obtained in large-scale tests. This is illustrated in Figure 1. At present, it is very difficult to define the character of the correlation between Type I and Type III dust filtration. This problem is still the subject of investigation, and although laboratory scale testing does not absolutely determine the qualitative parameters encountered on the industrial scale, it still is a very important element of investigations.

According to our experience, filtration fabrics which had unsatisfactory values for the parameters in laboratory tests were also regarded as fabrics of low effectiveness in industrial conditions. It is important to note that at present laboratory tests are necessary for development of new fabric configurations and for evaluation of filtration mechanisms on dust removal efficiency. It is possible that in the future the theoretical foundation of dust filtration processes will allow the use of laboratory tests for qualitative testing of manufactured textile media, substituting efficiency and filtration resistance for the currently used permeability magnitude.

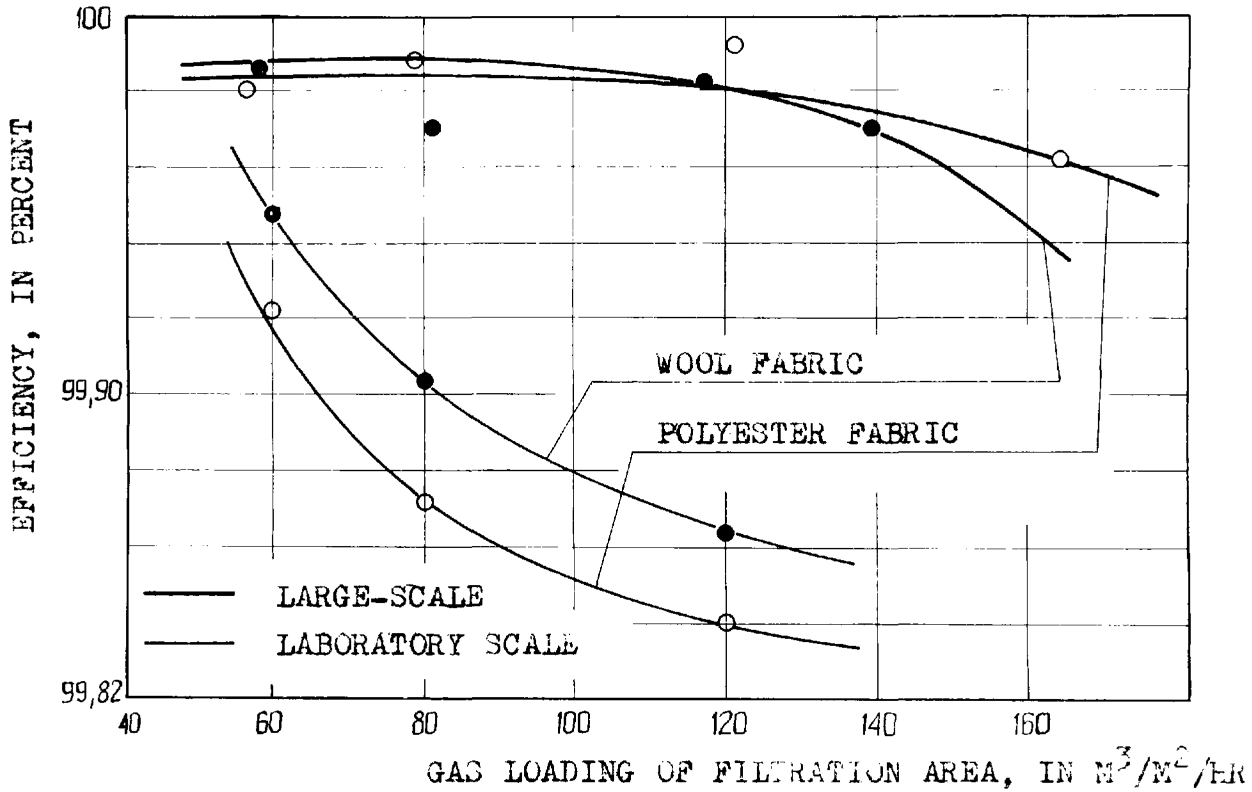


Figure 1. Comparison of Efficiency in Laboratory and Large-Scale.

2.0 RESEARCH OBJECTIVES

The basic objectives of this research program, supported by the EPA and conducted by the Institute of Cement Building Materials in Opole, were: determination of the dust removal efficiency of fabrics manufactured in the USA (supplied by EPA); determination of the flow characteristics of fabrics, both clean and during filtration; compilation and comparative analysis of the results in order to determine the qualitative parameters of the tested fabrics; and evaluation of the regeneration properties of the fabrics. The total program included laboratory testing, large-scale testing, and auxiliary studies.

2.1 General Program

Laboratory testing was performed on fifteen kinds of filtration fabrics and four types of dust, under the following conditions:

1) Dust concentration at the inlet of the test chamber was 10-11 g/m^3.
2) Dust loading on the filtration areas was 400 g/m^2 with $\Delta P < 250$ mm water.
3) Gas loading on the filtration areas was 60 and 80 m^3/m^2-hr.
4) The relative humidity of the dispersion medium (not adjustable) was 55 to 60 percent.
5) The temperature of the dispersion medium was 20 to 30°C.
6) The dispersion medium was atmospheric air at atmospheric pressure.

Large-scale tests were performed using filtration bags with operating lengths of 3300 mm, with the same dusts used in the laboratory testing. All other test conditions were identical with those in the laboratory scale testing except for the relative humidity, which was 65 to 72 percent.

According to the results obtained in the laboratory testing and large-scale tests, a comparative analysis will be conducted for the purpose of determining the qualitative properties of the fabrics for filtration of aerosols containing four types of dust. The results obtained will be used for further investigations of the mathematical model for the dust filtration process (Project P-5-533-3).

2.2 Detailed Program for the First Phase

The tasks for the laboratory tests were the following:

1) Preparation of separated cement, coal, and talc dusts, using the ALPINE separator;
2) Determination of the physico-chemical properties of separated and non-separated dusts;
3) Testing of the filtration fabrics (15 kinds) received from the USA, using cement, coal, and talc dusts; and
4) Compilation and preliminary analysis of these results.

The tasks for the large-scale testing were similar:

1) Separation of the testing dusts, cement and talc, by a subcontractor;
2) Determination of physico-chemical properties of separated and unseparated dusts;
3) Testing of fifteen kinds of filtration fabrics received from the USA, using cement and coal dusts; and

4) Compilation and preliminary analysis of the results.

The auxiliary studies consisted of:

1) Testing the flow properties of the filtration fabrics during clean air flow;
2) Determination of the filtration fabric parameters according to Polish standards;
3) Special testing of the fabrics with regard to structural parameters;
4) Determination of the regeneration properties of the fabrics; and
5) Preliminary analyses of these results.

2.3 Fabric and Dust Selection

Fifteen types of filtration fabrics were selected for use in the majority of tests under this project, No. 5-533-4. These fabrics were supplied by EPA and were manufactured in the USA from the following raw materials:

Cotton (stable fiber): Globe-Albany Style 960;

Dacron[R] polyester (staple fiber): Styles 862B, C866B, and C868B;

Dacron[R] polyester (continuous filament): Style 865B (staple fill), Styles C890B and C892B;

Nomex[R] aromatic nylon (staple filter): Styles 852, 853, and 190;

Nomex[R] aromatic (continuous filament): Style 850;

Nylon polyamide (staple fiber): Style 820B;

Glass (staple fiber): Style Q53-875

and Glass (continuous filament): Styles Q53-870 and Q53-878 (texturized fill).

The technical characteristics of these fibers are shown in Table 1.

The test dusts used were cement, coal, talc, and fly ash. These industrial dusts were taken from appropriate points in the production processing line in order to preserve their physico-chemical properties. Separated dusts were used according to the contractors' stipulations, and so the laboratory dusts were processed by the ALPINE separator, and the dusts used in the large-scale tests were separated by subcontractors.

In accordance with suggestions from Dr. James H. Turner, EPA Project Officer, testing was performed only with dust samples containing no more than 10 percent by weight of particles with diameter greater than 20 micrometers. The subcontractor declined to separate coal dust for the large-scale testing because of the explosive properties of finely divided coal, and so the Project Officer agreed to conducting laboratory tests with separated and unseparated coal dust but large-scale tests only on unseparated coal dust. The physical and chemical properties of the test dusts are shown in Tables 2 through 6 and Figures A-1 through A-3.

Table 1. FABRIC PARAMETERS

PARAMETER	UNIT	VALUE		
Fabric Style No.		862B	C866B	C868B
Fabric Weight	g/m^2	330	379	438
Thread count in 10 cm:				
warp		138	164	164
fill		110	138	158
Thickness (pressure = 20 g/cm^2)	mm	0.87	0.92	0.96
Tensile strength: warp	kg/5 cm width	162	212	210
fill	kg/5 cm width	125	162	221
Elongation during tension: warp	%	35	34	34
fill	%	42	44	42
Permeability	dm^3/m^2/second at 10 mm H_2O	382	240	163
Weave		$\frac{1}{1}$	$\frac{2}{2}$ Z	$\frac{2}{2}$ S

Table 1 (continued)

Fabric Style No.		865B	C890B	C892B
Fabric weight	g/m^2	337	168	151
Thread count in 10 cm:				
warp		302	292	254
fill		178	262	232
Thickness (pressure = 20 g/cm^2)	mm	0.63	0.24	0.24
Tensile strength:				
warp	kg/5 cm width	330	170	162
fill	kg/5 cm width	135	136	122
Elongation during tension: warp	%	41	20	29
fill	%	37	34	33
Permeability	dm^3/m^2/second at 10 mm H_2O	166	107	70
Weave		$\frac{3}{1}$ X	$\frac{3}{1}$ Z	$\frac{3}{1}$ Z

Table 1 (continued)

Fabric Style No.		852	853	190
Fabric Weight	g/m^2	292	350	510
Thread count in 10 cm:				
warp		122	154	---
fill		100	144	---
Thickness (pressure = 20 g/cm^2)	mm	0.92	1.08	1.79
Tensile strength:				
warp	kg/5 cm width	148	175	67.4
fill	kg/5 cm width	120	148	108
Elongation during tension: warp	%	30	28	19
fill	%	23	28	56
Permeability	dm^3/m^2/second at 10 mm H_2O	457	187	97
Weave		$\frac{1}{1}$	$\frac{2}{2}$ S	---

Table 1 (continued)

Fabric Style No.		960	850	802B
Fabric Weight	g/m^2	337	155	401
Thread count in 10 cm:				
warp		384	380	140
fill		238	288	136
Thickness (pressure = 20 g/cm^2)	mm	0.74	0.24	1.08
Tensile strength:				
warp	kg/5 cm width	99	188	173
fill	kg/5 cm width	103	151	179
Elongation during tension warp	%	15	40	41
fill	%	14	35	44
Permeability	dm^3/m^3/second at 10 mm H_2O	45	148	140
Weave		$\frac{4}{1}$	$\frac{3}{1}$ Z	$\frac{2}{2}$ Z

Table 1 (continued)

Fabric Style No.		Q53-875	Q53-870	Q53-878
Fabric Weight	g/m^2	281	282	451
Thread count in 10 cm:				
warp		210	210	176
fill		204	204	96
Thickness (pressure = 20 g/cm^2)	mm	0.31	0.30	0.56
Tensile strength:				
warp	kg/5 cm width	176	188	475
fill	kg/5 cm width	160	196	248
Elongation during tension: warp	%	3.9	3.5	6
fill	%	4.1	4.1	6
Permeability	dm^3/m^2/second at 10 mm H_2O	226	58	219
Weave		$\frac{1}{3}$ S	$\frac{3}{1}$ X	$\frac{3}{1}$ S

Table 2. PHYSICAL PROPERTIES OF TEST DUST

PARAMETER	UNIT	KIND OF DUST					
		CEMENT		COAL		TALC	
		After sep.	Before sep.	After sep.	Before sep.	After sep.	Before sep.
Angle of repose of dust (on glass surface)	Degrees	41°50'	55°20'	44°40'	62°	90°	90°
Poured dust weight (1 liter)	g/dm^3	898.33	736.67	571.67	406.67	498.30	446.70
Cone angle of heaped dust	Degrees	47°17'	48°09'	41°49'	49°56'	40°01'	61°45'
Jogged dust density	g/cm^3	1.40	1.13	0.77	0.62	0.87	0.77

Table 3. PARTICLE SIZE DISTRIBUTION OF CEMENT DUST

SEPARATED FOR LABORATORY SCALE	
Density: 2.86 g/cm^3	
Range of Particle size in µm	Percent by weight
0-2.13	6.70
2.13-3.91	10.80
3.91-5.92	16.80
5.92-9.17	23.10
9.17-14.20	24.10
14.20-23.67	16.30
23.67-28.99	2.10
28.99-32.54	0.10
≥32.54	---
	100.0

SEPARATED FOR LARGE-SCALE	
Density: 2.78 g/cm^3	
Range of Particle size in µm	Percent by weight
0-2.15	11.91
2.15-3.95	18.90
3.95-5.99	30.19
5.99-9.28	24.89
9.28-14.37	10.46
14.37-23.95	3.02
23.95-29.34	0.43
29.34-32.93	0.07
32.93-60	0.13
≥60	---
	100.00

SEPARATED FOR LARGE-SCALE	
Density: 2.857 g/cm^3	
Range of Particle size in µm	Percent by weight
0-2.17	9.85
2.17-3.97	17.90
3.97-6.02	34.06
6.02-9.34	25.52
9.34-14.46	10.08
14.46-24.09	2.82
24.09-29.52	0.33
29.52-33.13	0.21
≥33.13	---
	100.77

Table 4. PARTICLE SIZE DISTRIBUTION OF COAL DUST

SEPARATED FOR LABORATORY SCALE	
Density: 1.55 g/cm^3	
Range of Particle size in µm	Percent by weight
0-2.38	7.15
2.38-4.11	13.86
4.11-8.31	30.20
8.31-12.10	21.51
12.10-20.72	23.88
20.72-36.13	3.21
36.13-45.08	0.09
45.08-51.77	0.02
51.77-60	0.01
≥60	0.07
	100.00

NON-SEPARATED FOR LARGE-SCALE	
Density: 1.48 g/cm^3	
Range of Particle size in µm	Percent by weight
0-2.95	4.70
2.95-5.41	6.89
5.41-8.19	9.90
8.19-12.70	11.28
12.70-19.67	10.86
19.67-32.78	12.07
32.78-40.16	4.26
40.16-45.08	2.25
45.08-60	8.56
60-88	10.95
88-150	12.98
150-200	3.50
≥200	2.80
	101.00

NON-SEPARATED FOR LARGE-SCALE	
Density: 1.50 g/cm^3	
Range of Particle size in µm	Percent by weight
0-2.42	2.72
2.42-4.18	4.68
4.18-8.44	6.06
8.44-12.29	12.52
12.29-21.06	12.80
21.06-36.72	12.51
36.72-45.82	5.85
45.82-52.62	3.23
52.62-60	7.02
60-88	9.70
88-150	14.00
150-200	4.56
≥200	4.35
	100.00

Table 5. PARTICLE SIZE DISTRIBUTION OF TALC DUST

SEPARATED FOR LABORATORY AND LARGE-SCALE	
Density: 2.80 g/cm^3	
Range of Particle size in μm	Percent by weight
0-2.15	6.86
2.15-3.95	14.00
3.95-5.99	20.52
5.99-9.28	25.61
9.28-14.37	18.96
14.37-23.95	11.49
23.95-29.34	2.04
29.34-32.93	0.52
$\geq$32.93	
	100.00

SEPARATED FOR LARGE-SCALE	
Density: 2.78 g/cm^3	
Range of Particle size in μm	Percent by weight
0-1.77	4.93
1.77-3.05	11.39
3.05-6.17	17.14
6.17-8.98	41.37
8.98-15.39	22.45
15.39-26.83	2.72
26.83-33.47	---
	100.00

Table 6. CHEMICAL PROPERTIES OF TEST DUSTS

SEPARATED CEMENT TEST DUST	
Component	Percent by weight
Loss by roasting	6.93
SiO_2	21.32
Fe_2O_3	2.37
Al_2O_3	6.73
CaO	54.36
MgO	1.99
SO_3	5.63
Na_2O	0.23
K_2O	0.61
Total	100.17

NON-SEPARATED COAL TEST DUST	
Component	Percent by weight
Loss by roasting	25.51
SiO_2	51.13
TiO_2	0.92
Fe_2O_3	8.58
Al_2O_3	22.96
CaO	6.91
MgO	2.62
SO_3	3.21
Na_2O	0.88
K_2O	2.35
Total	99.56

SEPARATED COAL TEST DUST	
Component	Percent by weight
Loss by roasting	24.14
SiO_2	46.75
TiO_2	1.04
Fe_2O_3	10.46
Al_2O_3	22.78
CaO	8.25
MgO	3.34
SO_3	4.42
Na_2O	0.85
K_2O	1.81
Total	99.70

3.0 LABORATORY TESTS OF FILTRATION

This section describes the testing performed in the laboratory, for both clean air flow and dust filtration. The results are presented along with the conclusions which were drawn.

3.1 Equipment and Procedures

Laboratory testing of selected filtration fabrics was concluded on a stand specially designed by the IPWMB and adapted for the testing of flat fabric specimens under ambient air conditions. This stand is shown in Figure 2.

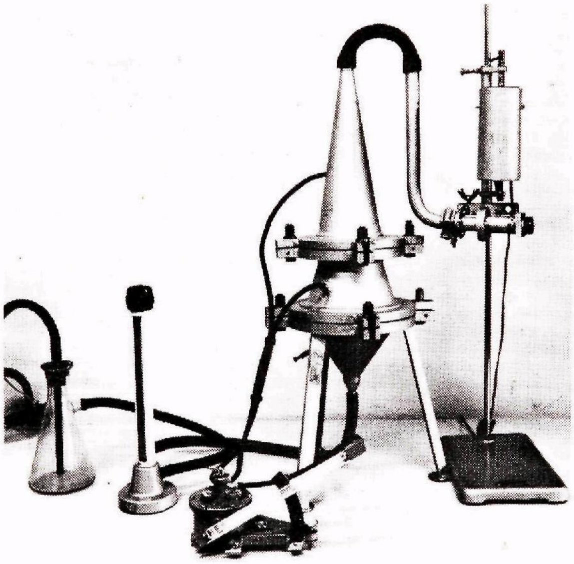


Figure 2. Illustration of laboratory stand.

The testing stand includes the testing chamber, a rotameter for measuring flow rate, a needle valve to control the flow, a vibrato-injecting dust feeder, a micromanometer for pressure-drop measurements, and a vacuum pump. These parts are illustrated in Figure 3. The testing chamber itself

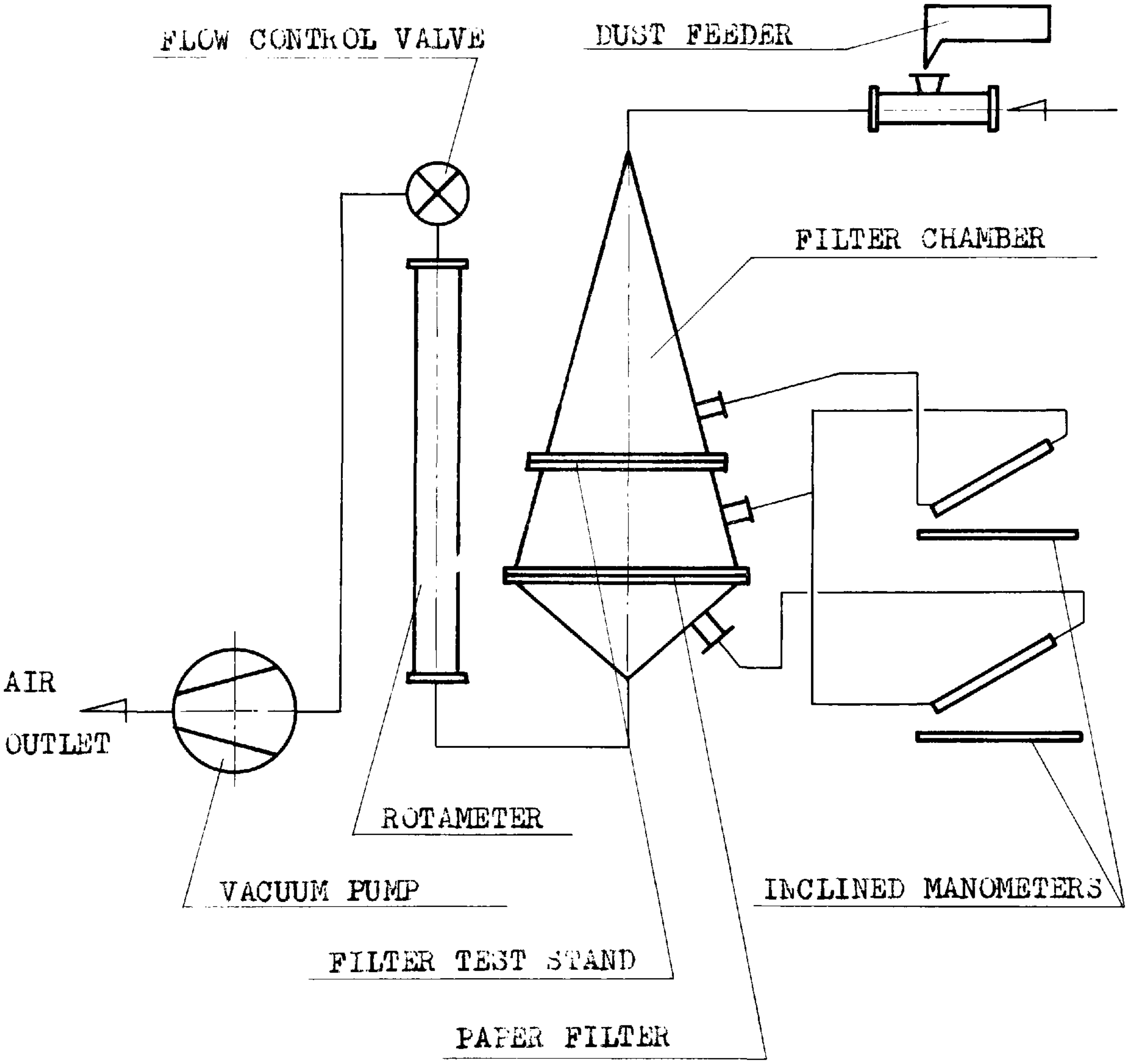


Figure 3. Diagram of the Laboratory Test Stand.

is equipped with a diffuser at the inlet end, a fabric specimen table, and a control filter table at the outlet end. A round fabric specimen with a test area of 100 cm^2 was positioned in the middle of the table, supported by wire net screening (4 cm on a side).

During testing, dusty air flows through the fabric from the top downward. The inlet diffuser provides a uniform flow across the entire test area of the fabric. After passing through the fabric specimen, the air then passes through a control filter of soft batting and paper (a disc with an area of 200 cm^2), which is positioned on the table at the outlet end and is supported by wire net screening (1 cm on a side).

The average dust collection efficiency was determined by weighing the fabric specimen and the control filter and applying the equation:

$$E = \frac{G_z}{G_c} = \frac{G_c - G_o}{G_c} = \frac{G_z}{G_z + G_o} \qquad (3.1)$$

where G_z = weight of dust collected on the fabric; G_o = weight of dust collected on the control filter; and G_o = weight of dust fed into the testing chamber.

Temperature and humidity of the ambient air were recorded for 72 hours during the test run.

With this stand data can be obtained on the mean filtration efficiency, the flow characteristics of filtration materials during clean air flow, rise in flow resistance during dusty air flow, and the degree of filling of filtration materials. Although it was specially designed for the laboratory testing of woven filtration fabrics, this stand can also be used for laboratory testing of other materials, for instance, felt.

3.2 Results and Discussion

3.2.1 Air Flow Through Clean Fabrics

Filtration fabrics are changing porous media; their spatial and surface structure can vary with the flow conditions. In general, an increase of flow leads to an increased pressure drop, but the variations in the function

$$\Delta P = f(q_g), \tag{3.2}$$

where ΔP is the static pressure drop and q_g is the gas loading on the filtration area (m^3/m^2-hr), are connected with the spatial composition of fabric structure and depend on structural parameters.

The structure of woven fabrics is much more complicated than of non-woven ones. Just as in non-woven fabrics, the basic element of structure is an elementary fiber of definite length and diameter. However, fiber parameters do not directly determine structural properties. Individual fibers make up the structure of yarn, and it is the manufacturing process that determines the blend of fibers in the yarn. Finally, in woven fabrics, the yarns are mutually crossed in definite patterns, and the flow properties result from a combination of the yarn and the weave structures Despite intensive investigations, the physical parameter structure, which is related to all the technological parameters of fiber, yarn, and fabric and the spatial composition of the fabric, has yet to be defined.

The coefficient K (flow resistance), which stems from Darcy's law, has only a statistical sense with regard to flow through fabrics. It can be used to examine the influence of the variation of individual parameters on the flow resistance, but it does not provide a physical understanding of the filtration structure. As a result, it cannot be used in fabric structure design or in prediction of flow characteristics.

Permeability is a quantity commonly used to classify woven filtration media. It has been defined experimentally as the air flow rate per unit area at a fixed pressure drop. In the USA, the pressure drop is standardized at 0.5 inches of water, and in Poland at 20 mm (sometimes 10 mm) of water. Measuring the permeability of one fabric at several different places enables an estimate of the fabric homogencity to be made; this is another qualitative parameter used by filtration fabrics producers. The absolute value of the permeability indicates the porosity of the spatial and surface structure.

From a mathematical point of view, permeability cannot be accepted even as a statistical parameter for classifying woven fabrics, because there could be infinitely many structures of differing compositions but with the same permeability. The most important use is a comparison of the functions $\Delta P = f(q_g)$ at specific values. This is the reason for conducting air flow experiments through clean filtration fabrics.

The results of these experiments are shown in Table B-1 and in Figures 4 through 6. Photographs of the fabric surfaces indicating differences in structure are shown in Figures A-4 through A-8.

Based on the technological parameters of yarn fabrics, the free-flow area through each fabric was calculated by:

$$FA = l^2 - (n_o d_o l + n_w d_w l - n_o n_w d_o d_w), \qquad (3.3)$$

where

l = 10 cm,

n_o = number of threads in warp on 10 cm,

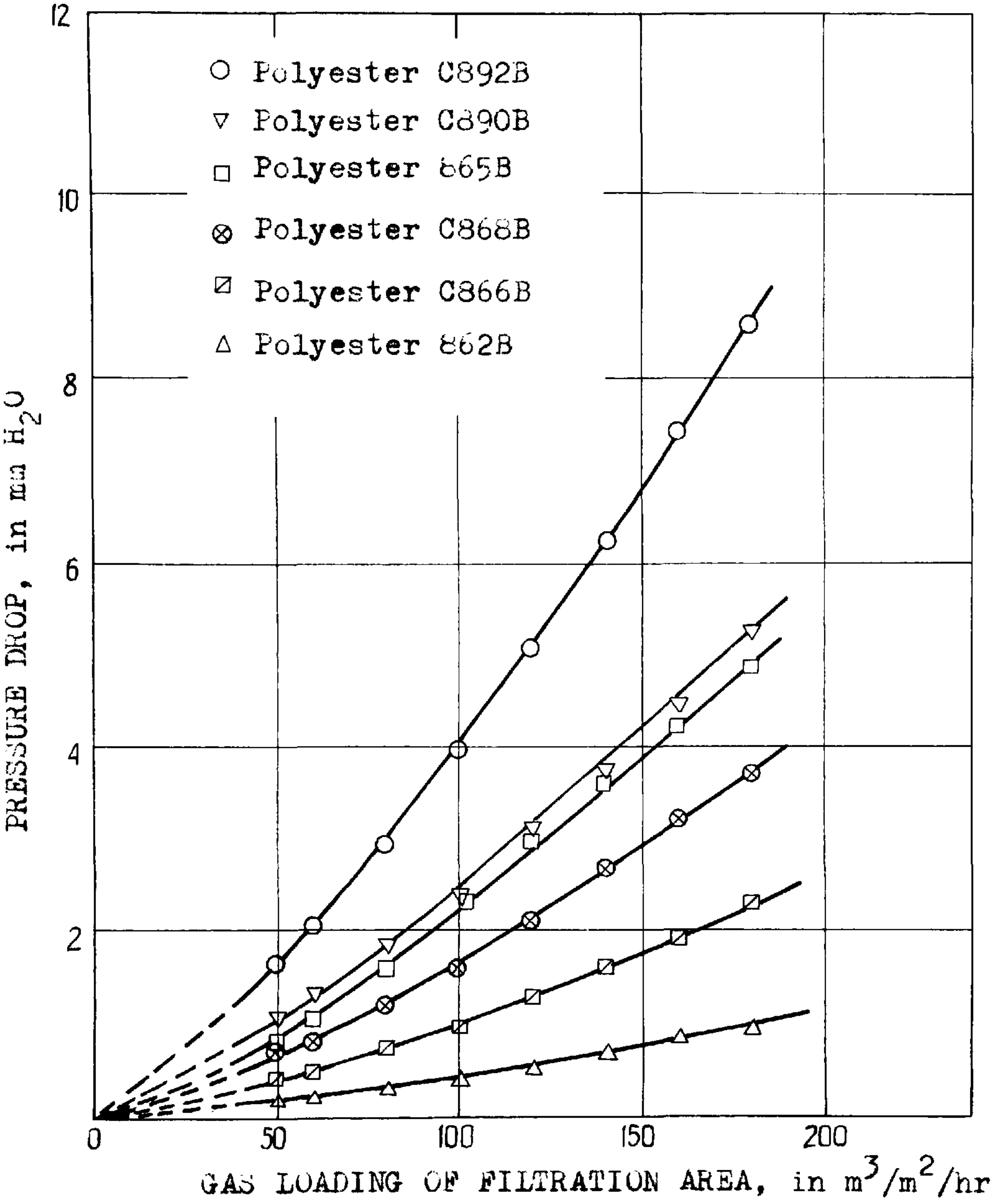


Figure 4. Flow Characteristics of Polyester Fabrics.

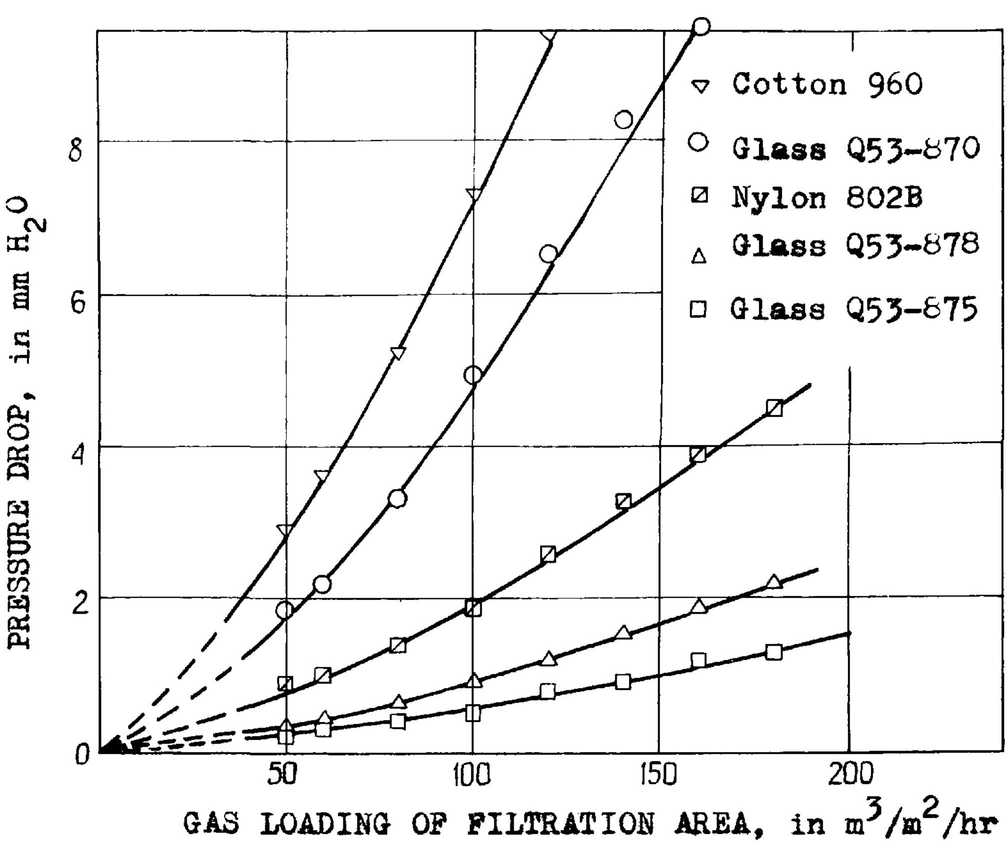


Figure 5. Flow Characteristics of Glass, Cotton and Nylon Fabrics.

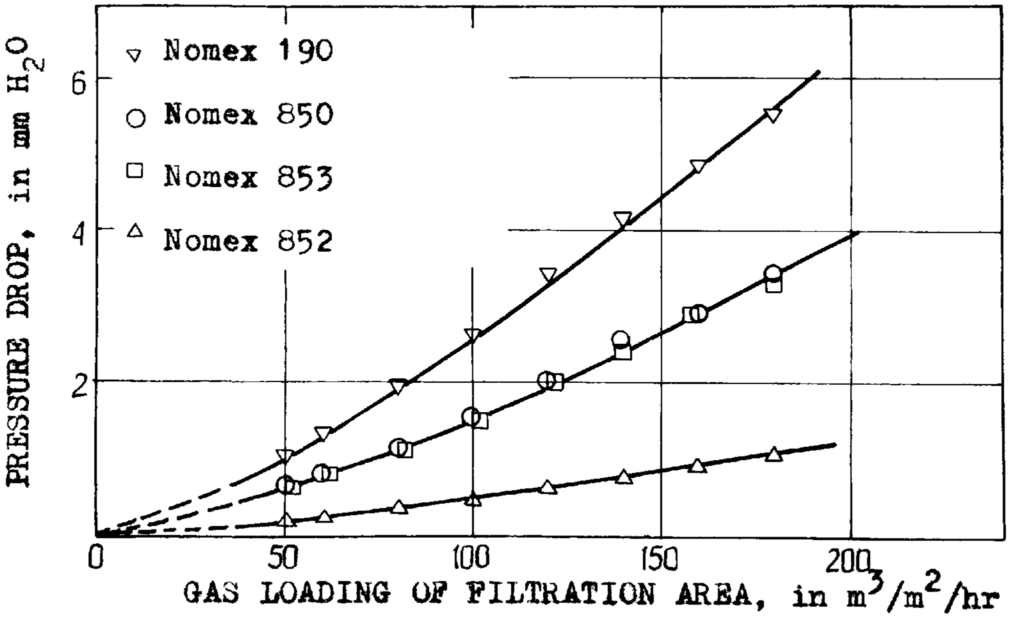


Figure 6. Flow Characteristics of Nomex Fabrics.

n_w = number of threads in fill on 10 cm,

d_o = diameter of warp yarn (cm), and

d_w = diameter of fill yarn (cm).

Diameters of the warp and fill yarns were calculated from the metrical numbers according to:

$$d_o = \frac{C}{\sqrt{Nm_o}}, \tag{3.4}$$

and

$$d_w = \frac{C}{\sqrt{Nm_w}}, \tag{3.5}$$

where Nm_o and Nm_w are the metrical numbers for the warp and fill yarns respectively, and C is a characteristic constant, depending on the kind of fiber (see Table 7).

Table 7. VALUES OF CHARACTERISTIC FACTOR "C"

Raw Materials	"C" Values
Cotton and staple viscose	1.25
Worsted wool: French System	1.26
British System	1.32
Carded wool	1.36
Polyamid silk, continuous polyester and nomex	1.50
Staple polyester	1.32
Glass	0.705

Because of the large distortions in glass yarns, FA was calculated by projected values of d_o and d_w. The results of these calculations are shown in Table 8. Values of FA for the group of fabrics tested range between zero and 17.4 percent.

The specific values of FA serve to draw a curve (See Figure 7) showing ΔP as a function of FA. The diagram was drawn for a filtration area gas loading of $q_g = 100\ m^3/m^2\text{-hr}$. It is easy to observe that points fall along two straight lines (in the range tested), intersecting in the region of FA = 5.5 percent and ΔP = 15 mm of water. Curve A shows a decreasing dependence for increasing values of FA; this agrees with intuition and is compatible with flow principles. Curve B shows an increasing function for increasing values of FA, which seems to be contradictory.

Analyzing the kinds of fabrics which fall along curves A and B, we come to the following conclusions:

1. Curve A represents the variation of FA for Polyester Styles 865B, C868B, and 862B and for Nomex Style 850, 853, (852).
2. Curve B represents the variation of FA for Polyester Styles C890B, C892B for Nylon Style 802B, and for Glass Style Q53-875, Q53-878.
3. Cotton Style 960 and Glass Style Q53-870 lie outside the curves because of principal differences in structure due to their weave. They have not been considered here.

The dependence of curve A is characteristic of fabrics made from staple fibers, while curve B is characteristic of continuous filament fabrics. The inverse dependence of curve B is a result of a significant deformation of

Table 8. FREE AREA FOR INVESTIGATED FABRICS

Kind of Raw Material	Type of Filtration Fabric	Calculated Values of "FA" (In Percent)
Cotton	960	0.969
Dacron[R] Polyester (staple fiber)	862B	13.326
	C866B	9.731
	C868B	4.514
Dacron[R] Polyester (continuous filament)	865B	0
	C890B	8.048
	C892B	13.256
Nomex[R] Aromatic Nylon (staple fiber)	852	17.422
	853	5.984
	190	---
Nomex[R] Aromatic Nylon (continuous filament)	850	5.148
Nylon Polyamide (staple fiber)	802B	6.650
Glass (staple fiber)	Q53-875	1.578 *
Glass (continuous filament)	Q53-870	1.066 *
	Q53-878	3.292 *

*For projected diameter of yarns.

the yarn in the fabric structure, caused by the reduced friction between the silky fibers. As a result, the true value of FA much lower than the calculated one and the resistance to flow increases in inverse proportion to the FA value, which is calculated from the technological parameters and weave parameters. It seems that FA is not a representative parameter for continuous filament or silk-type fabrics. Differences in structure of staple and continuous filament fabrics are shown in Table 8.

3.2.2 Laboratory Testing of Filtration Filters

The results of the laboratory tests conducted under this project are shown in Tables 9 and 10. Figures A-19 through A-33 show the increase of filter resistance during the filtration process. A comparative analysis of the fabrics tested was conducted using these results, for each raw material group, taking into consideration the final filtration efficiency and its variation as a function of the gas loading on the filtration area and also the final filtration resistivities for a specific gas loading on the filtration area (q_g) and for the estimated dust loading of the filtration area (L_o).

Cotton and Nylon Fabrics

The Cotton and Nylon Fabrics group was represented in these tests by Styles 960 and 802B. These fabrics reached the highest values of efficiency among all the tested fabrics. It is interesting to note that Nylon Fabric Style 802B reached similar values of efficiency, independent of type of dust and values of gas loading. Cotton Fabric Style 960 reached the highest efficiency, 99.99 percent, for talc at $q_g = 60$ m^3/m^2-hr

Table 9. LABORATORY EFFICIENCY (in percent) OF TESTED FILTRATION FABRICS (Dust concentration of $C_o = 10\ g/m^3$ and $L_o = 400\ g/m^2$)

Type of filtration fabrics	Gas loading of filtration area in $m^3/m^2/hr$	Kind of dust			
		Separated Cement Dust	Separated Coal Dust	Separated Talc Dust	Non-Separated Coal Dust
Cotton (staple filter)					
Style No. 960	60	99.96	99.60	99.99	
	80	99.98	99.97	99.99	
Dacron[R] polyester (staple fiber)					
Style No. 862B	60	99.83	99.89	99.87	99.68
	80	99.74	98.39*	98.96*	98.74
Style No. C866B	60	99.93	99.93	99.86	99.93
	80	99.93	99.93	99.86	99.91
Style No. C868B	60	99.95	99.92	99.95	99.95
	80	99.95	99.94	99.96	99.92

*observed ducts/canals

Table 9 (continued)

Dacron[R] polyester					
(cont. filament)					
Style No. 865B	60	99.95	99.95	99.97	99.87
	80	99.93	99.87	99.94	99.88
Style No. C890B	60	99.59	99.79	99.76	99.63
	80	98.18	98.64*	99.37	98.76
Style No. C892B	60	99.88	99.76	99.76	99.68
	80	99.45	99.12	99.55	99.19
Nomex[R] aromat. nylon					
(staple fiber)					
Style No. 852	60	99.77	99.90	99.95	
	80	99.87	99.91	99.94	
Style No. 853	60	99.95	99.95	99.94	
	80	99.90	99.96	99.92	
Style No. 190	60	99.95	99.97	99.96	
	80	99.94	99.98	99.97	
Nomex[R] aromat. nylon					
(cont. filament)					
Style No. 850	60	99.35	99.69	98.99	
	80	98.62	98.09*	97.41	

*observed ducts/canals

Table 9 (continued)

Nylon polyamide (staple fiber) Style No. 802B	60	99.96	99.96	99.97	
	80	99.96	99.99	99.97	
Glass (staple fiber) Style No. Q53-875	60	97.54*	98.60	88.21*	
	80	84.63*	82.18*	70.32*	
Glass (cont. filament) Style No. Q53-870	60	95.03*	93.03*	93.65*	
	80	86.38*	85.05*	85.97*	
Style No. Q53-878	60	94.51*	96.12*	91.74*	
	80	85.11*	78.32*	80.81*	

*observed ducts/canals

Table 10. FILTRATION RESISTANCE (in mm H_2O) AT LABORATORY TESTS

(Dust concentration C_o = 10 g/m^3 and L_o = 400 g/m^2)

Type of filtration fabrics	Gas loading of filtration in $m^3/m^2/hr$	Kind of dust			
		Separated Cement Dust	Separated Coal Dust	Separated Talc Dust	Non-Separated Coal Dust
Cotton (staple fiber) Style No. 960	60	31.60	39.97	36.82	
	80	48.35	77.58	68.41	
Dacron[R] polyester (staple fiber) Style No. 862B	60	22.52	28.44	28.52	18.86
	80	37.45	59.09	38.63	41.00
Style No. C866B	60	22.21	35.63	22.83	20.35
	80	36.42	67.31	41.23	46.05
Style No. C868B	60	23.70	31.60	25.09	21.27
	80	38.24	65.57	44.16	48.82

Table 10 (Continued)

Dacron[R] polyester (cont. filament)					
Style No. 865B	60	32.31	40.93	35.15	25.15
	80	60.99	77.42	71.73	65.41
Style No. C890B	60	43.06	63.60	54.12	42.58
	80	66.05	107.76	95.43	93.38
Style No. C892B	60	58.86	66.99	60.91	45.35
	80	99.22	126.56	113.60	100.01
Nomex[R] aromat. nylon (staple filter)					
Style No. 852	60	20.22	31.44	23.46	
	80	38.71	59.72	47.80	
Style No. 853	60	18.80	30.89	26.33	
	80	38.24	65.65	47.87	
Style No. 190	60	20.29	29.48	27.34	
	80	37.32	66.36	50.09	
Nomex[R] aromat. nylon (cont. filament)					
Style No. 850	60	44.64	53.56	47.40	
	80	73.79	99.86	92.75	

Table 10 (continued)

Nylon polyamide (staple fiber) Style No. 802B	60 80	21.68 36.18	29.15 59.33	20.79 46.61	
Glass (staple fiber) Style No. Q53-875	60 80	43.45 63.04	54.04 64.46	34.13 39.50	
Glass (cont. filament) Style No. Q53-870	60 80	59.09 88.32	58.46 92.43	58.70 79.95	
Style No. Q53-878	60 80	33.58 44.71	45.51 49.53	30.18 40.61	

NOTE: Filtration resistance are average values of the final measured pressure drop of filtration cycles.

as well as at $q_g = 80\ m^3/m^2$-hr. Both fabrics demonstrate the increase of filtration efficiency with the increase of gas loading on the filtration area in tests conducted with separated coal dusts, supposedly caused by electrostatic effects.

The high efficiency of these tested fabrics results from quite good filling of the fabric structure with fibers and from application of staple fibers to their production. Staple fibers favor a filling in of free areas by "free fibers". The effect of "free fibers" on fabric structure is illustrated in Figure 9.

The calculated values of FA are quite low for both fabrics: 0.969 percent for Fabric 960 and 6.650 percent for Fabric 802B. Filtration resistances for Nylon Fabric 802B (as measured by the final static pressure drop) are similar to those obtained for staple fiber fabrics (Polyester and Nomex). However, cotton fabrics demonstrated high filtration resistances, characteristic of this group of fabrics.

Polyester Fabrics

In this group of fabrics, the influence of staple fibers on filtration efficiency and resistivity is easily observed. The lowest values of efficiency were recorded for the continuous filament fabrics, C890 and C892B, and for the staple fiber fabric 862B. The staple fiber fabric 862B has a much more porous structure than other fabrics. Its value of FA = 13.3 percent indicates little fill of structure, and at a gas loading of $q_g = 60\ m^3/m^2$-hr, the fabric reaches an efficiency of the same level as other polyester fabrics. However, at a gas loading of $q_g = 80\ m^3/m^2$-hr, the filtration efficiency is decreasing. This is caused by the formation of ducts/canals in the empty area between yarns (see Figure 10).

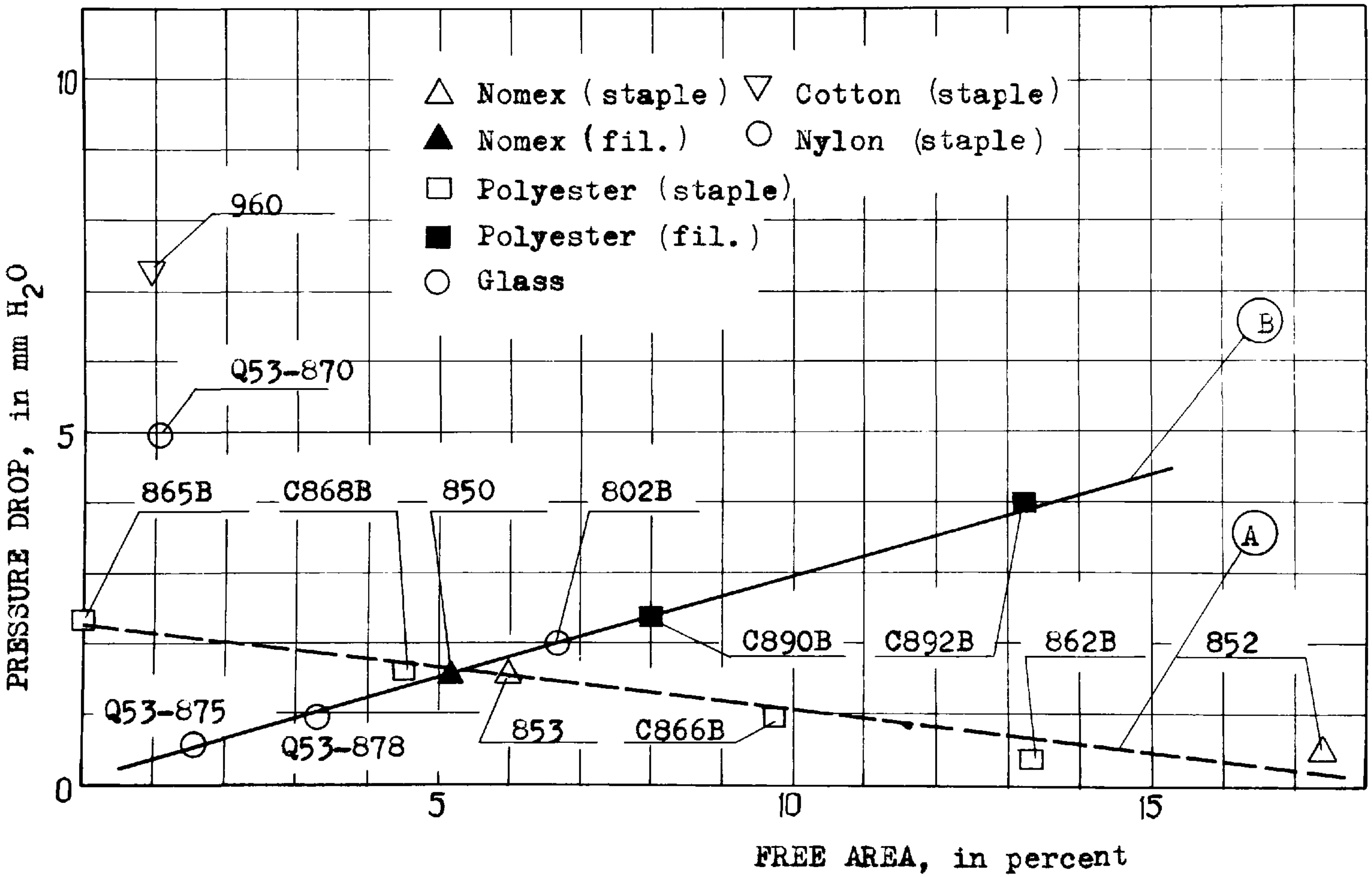
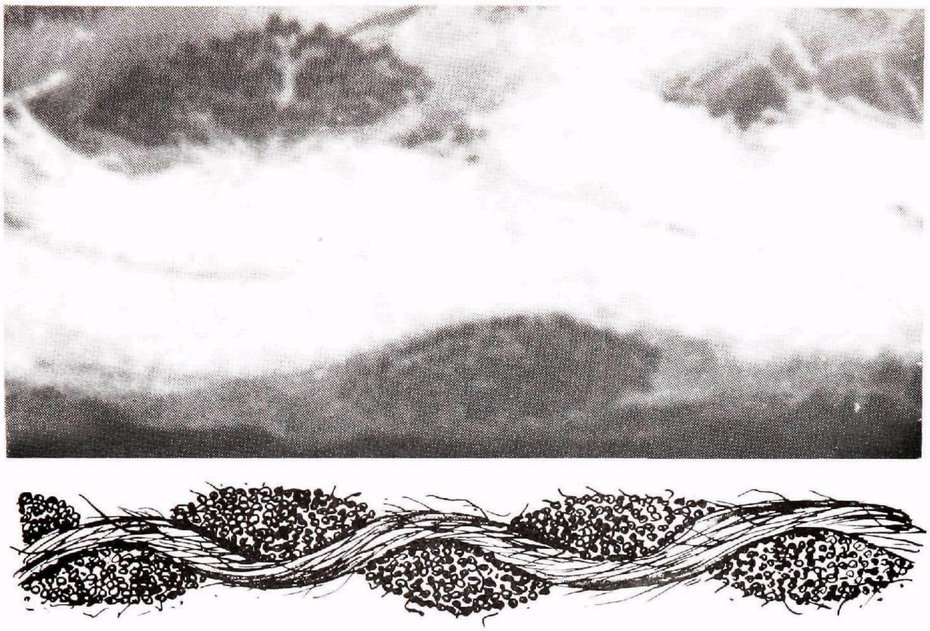
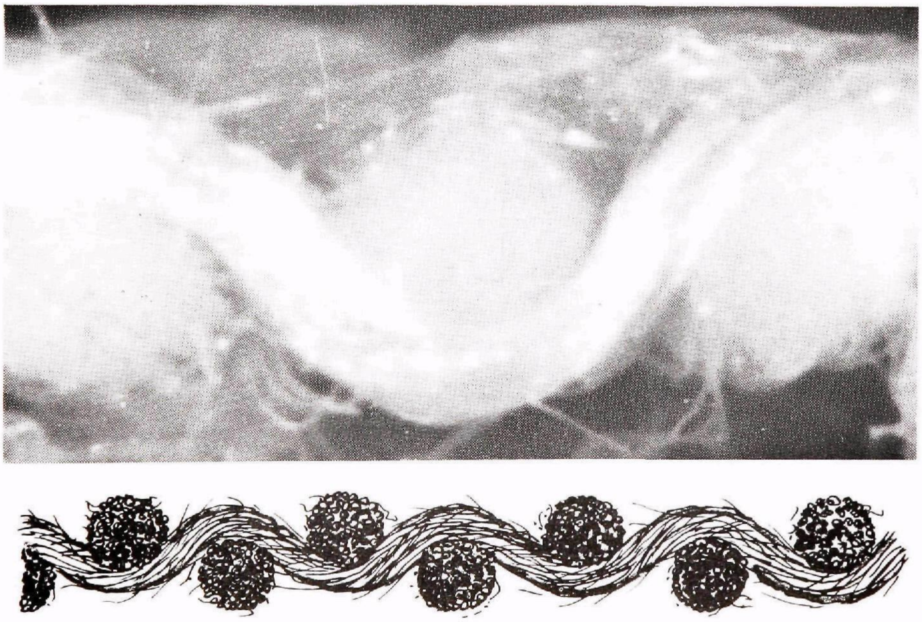


Figure 7. Pressure Drop vs. FA for Clean Air Flow (q_g = 100 $m^3/m^2/hr$)

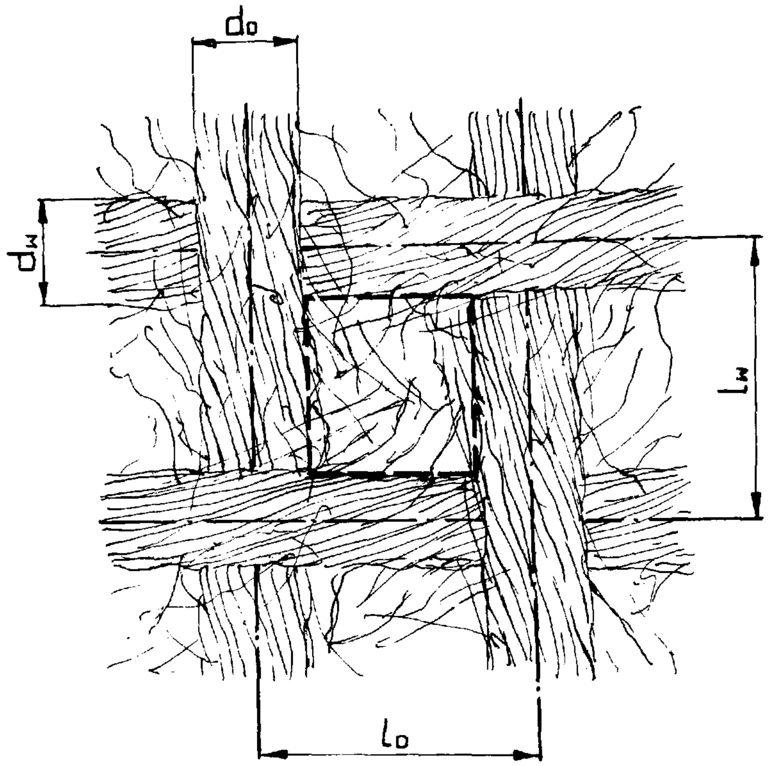


a) Continuous filament



b) Staple fibers

Figure 8. Comparison of cross-sections of threads with continuous filament and staple fibers.



▭ = **Area of calculated FA**

d_o, d_w = **Diameter of yarn (warp and fill)**

l_o, l_w = **Distance between** axes of yarns **(along warp and fill)**

Figure 9. Effect of "free fibers" on fabric structure.

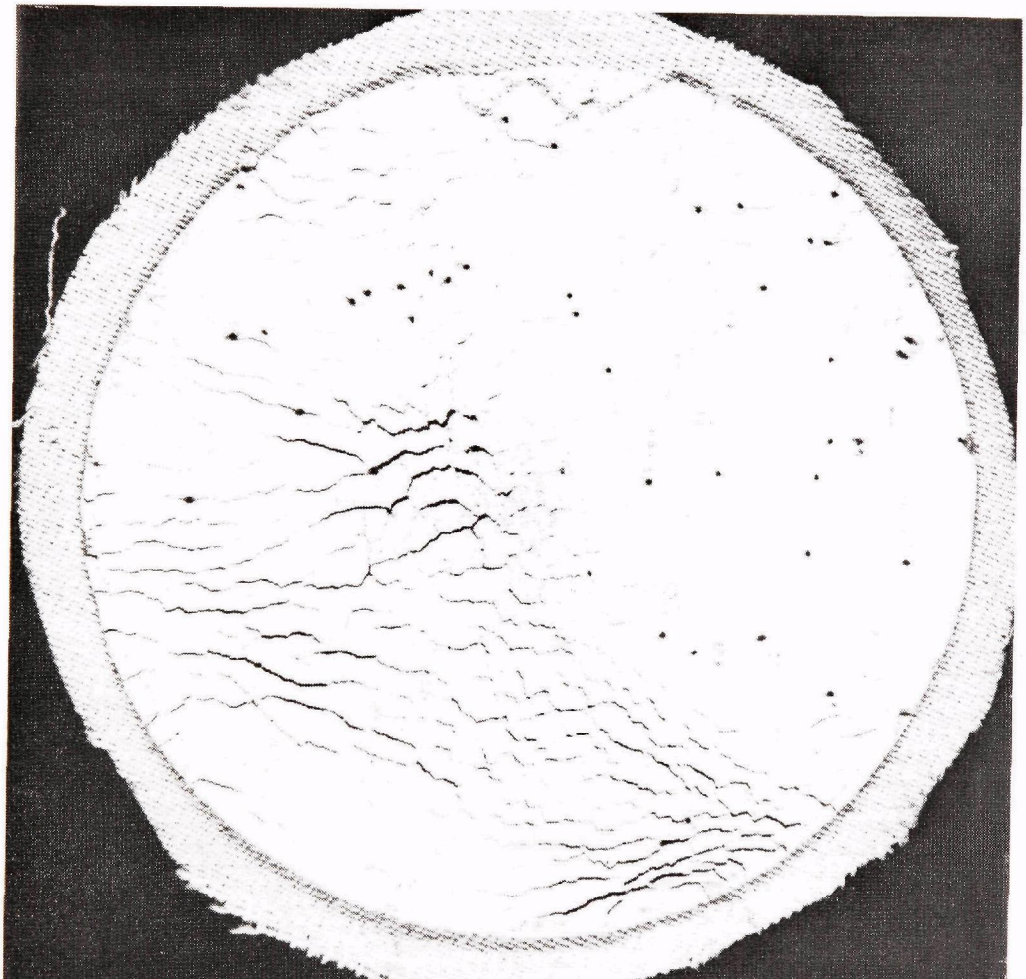


Figure 10. Surface of Dust Cake on Fabric 862B (dust: talc, $q_g = 80\ m^3/m^2/hr$).

The mechanism of ducts/canals formation is dust cake structure defects, as a result of pressure drop differences across an area of loose filtration structure (with low endurance parameters). The area of loose filtration structure is formed by "free fibers" which are susceptible to geometric formation.

The formation of ducts/canals in the filtration process was also noted for the fabric C890B during testing with separated coal dust. It can be caused by displacement of silky fibers with low coefficients of friction. The other fabrics, 865B, C866B, and C868B, have high efficiencies of about 99.95 percent and the decrease of efficiency with increasing gas loading of the filtration area is not observed in the range of our tests. The filtration resistances of continuous filament Polyester fabrics are twice as high as those of staple fiber fabrics.

Laboratory testing of polyester fabrics were conducted with two types of coal dust: separated, with MMD = 7.5 μm, and unseparated, with MMD = 28 μm. Big differences in filtration efficiency were not observed, but the filtration resistances with unseparated dusts were 30-45 percent lower than those with separated dusts. This is a result of different structures of the dust cake formed during the filtration process.

Nomex Fabrics

The results of testing the Nomex fabrics indicates they are on the same level as Polyester fabrics. Fabric 850 (continuous filament) appeared to have the lowest efficiency and highest filtration resistance in this group.

Glass Fabrics

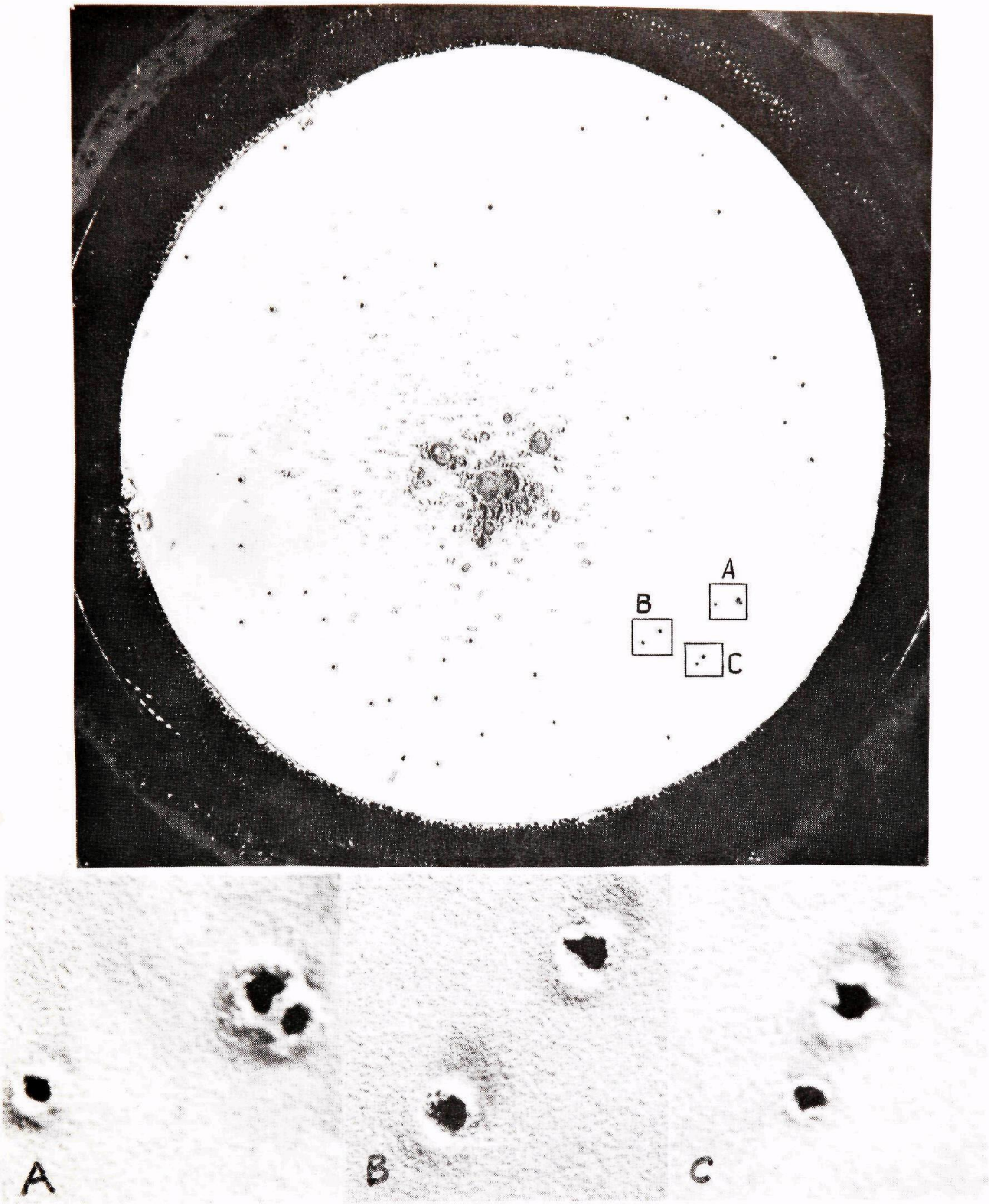
Fabrics made with glass fibers reached the lowest values of efficiency of all the fabrics tested in the laboratory experiments. Fabric Q53-875 with staple fibers appeared to be the most efficient one in this group. The low values of efficiency are caused by ducts/canals formation, favoring the penetration of dust particles through the filtration structure. The formation of free areas between yarns, the direct cause of ducts/canals formation, is characteristic of glass fabrics because glass fibers have very low coefficients of friction. That is why threads and fibers displace during air flow, forming "free areas". The influence of "free fibers" is limited by their fragility, leading to considerable penetration of particles through the filtration structure. Fabric samples with ducts/canals in the dust cake are shown in Figures 11 through 13.

In the tests conducted r. coal dust, the counting of canals was recommended. The number of ducts/canals at certain gas loadings is shown in Table 11.

Table 11. NUMBER OF DUCTS/CANALS OBSERVED IN LABORATORY TESTING (Testing of glass fabrics with separated coal dusts)

Kind of fabric	Gas loading of filtration area $m^3/m^2/hr$	Number of ducts/canals
Q53-875	60	--
	80	102
Q53-870	60	16
	80	42
Q53-878	60	7
	80	69

Figure 11. Surface of Dust Cake on Fabric Q53-875 (dust: talc, $q_g = 80\ m^3/m^2/hr$).



10x magnification

Figure 12. Surface of Dust Cake on Fabric Q53-870 (dust: cement, q_g = 80 $m^3/m^2/hr$).

Figure 13. Surface of Dust Cake on Fabric Q53-878 (dust: cement, $q_g = 80\ m^3/m^2/hr$).

The data shown in Table 11 correspond with the filtration efficiencies obtained. Fabric Q53-875, which reached the highest efficiency in the group of 98.60 percent at $q_g = 60$ m^3/m^2-hr did not have any canals in its surface. The existence of canals numbering N = 102 at $q_g = 80$ m^3/m^2-hr reduced its filtration efficiency to 82.18 percent.

Because each stage of formation of the system filtration structure - dust cake is correlated with a definite value of dust loading, L_o, in grams per square meter and with a proportionate pressure drop, ΔP_o in mm of water (which depend on the filter and dust properties), it is possible to estimate experimentally a limiting ΔP_{KR} value for the formation of ducts/canals, for a give type of dust. For instance, for Fabric Q53-875 and coal dust of MMD = 7.5 μm, the value of ΔP_{KR} is 54 mm of water, corresponding to $L_o = 400$ g/m^2 at $q_g = 60$ m^3/m^2-hr. Knowing the initial concentration, it is possible to estimate the length of the filtration process before the formation of ducts/canals, and consequently, the time of operation of the filter at its highest efficiency. For other fabrics, the gas loading of the filter which causes variations in the flow resistance is so high that ΔP_{KR} values are outside the range of our experiments. Filtration resistances for glass fabrics under these conditions are higher than for Polyester and Nomex fabrics. The high resistances occur in continuous filament glass fabrics (Q53-870).

It is interesting to note that application of texturized thread in the fill of Fabric Q53-878 did not increase the efficiency, but only caused a decrease in filtration resistance.

This comparative analysis concerns itself with Dust Filtration Type I, characteristic of laboratory testing, and so cannot be the decisive estimator for the fabrics. Qualitative parameters obtained in large-scale testing, where the dust filtration process is similar to that in industrial dust collectors (Type III Dust Filtration), will be the decisive parameters for the fabrics.

3.3 Conclusions

Using separated dusts under the given conditions of testing (q_g, L_o), the following fabrics can be regarded as satisfactory for cement, coal, and talc from a qualitative point of view:

Cotton Fabric 960

Nylon Fabric 802B

Polyester Fabrics 865B, C866B, and C868B

Nomex Fabrics 190, 852, 853

Glass Fabric Q53-875

Polyester and Nomex Fabrics based on continuous filaments and Fabric 862B with staple fibers reach satisfactory operation only at gas loadings of the filter of q_g = 60 m^3/m^2-hr.

The testing conditions of the glass fabrics were too severe for their structure, resulting in the formation of ducts/canals.

4.0 LARGE-SCALE TESTING

4.1 Equipment and Procedures

Large-scale testing of EPA-selected filtration fabrics was conducted on an apparatus specially designed by IPWMB (Single Compartment Baghouse). This apparatus is illustrated in Figure 14.

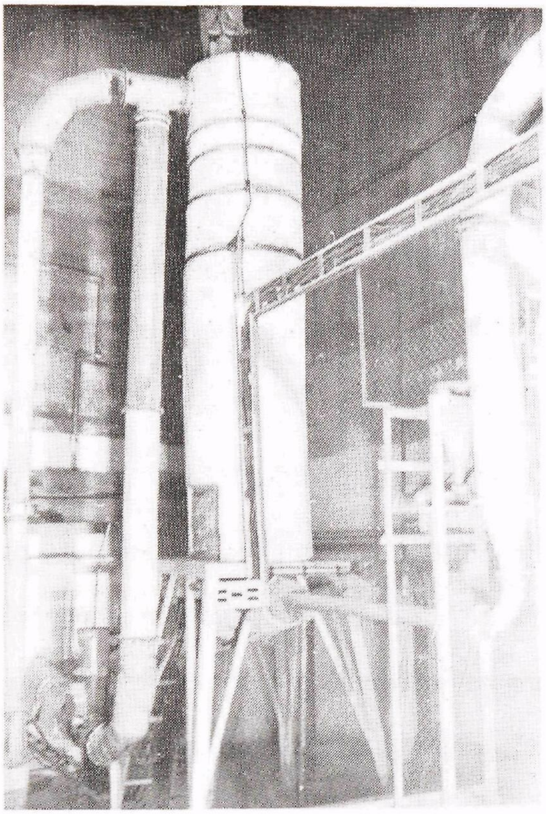


Figure 14. Illustration of large-scale stand.

This apparatus includes the following (see Figure 14): a filter chamber, collection hopper, dust feeder, fans, pipelines and valves, and control and measurement system. The filter chamber is of cylindrical form (diameter 700 mm and length 3520 mm) and is composed of four separate elements, tightly connected together. This construction enables experiments to be conducted on filter bags of various length. The last element of the filter chamber is the head, on which an optional mechanical regeneration system can be installed. The collection hopper is in the lower part of the filter chamber. The filter chamber itself is thermally insulated. The bag, 710 to 3250 mm in length and 200 mm in diameter, was installed eccentric to the filter chamber axis because of the installation of a radio-isotope probe for the measurement of dust-cake thickness deposited on the bag. The total filtration area is 2.01 m^2, and the net area is 1.884 m^2. A diagram of the single-compartment baghouse with its control and measurement system is shown in Figure 15.

The testing dust is delivered to the circulating air with a screw dust feeder with a capacity of 0.5 to 15 kg/hr $\pm$ 10 percent. A variable gear regulates the capacity of the screw dust feeder. The single-compartment baghouse is equipped with two fans. The main gas is a type MMW 14, used for keeping an underpressure throughout the testing apparatus and causing the flow through the filter chamber. It has a fan capacity of 1200 m^3/hr at a pressure of 600 mm of water. The reverse air fan is a type WP 20/1, used for reverse air flow (in a direction opposite to the gas flow during filtration). It has a capacity of 1200 m^3/hr at a pressure of 300 mm of water.

Sections of the reverse flow and circulation gases (filtered) are equipped with type NP-27 electric heaters to assure dry filtration conditions in the filter chamber. Control valves in the pipelines allow control of the gas loading on the filtration area at the set test values and assure a constant load on the fans. Some actions of the control system and the

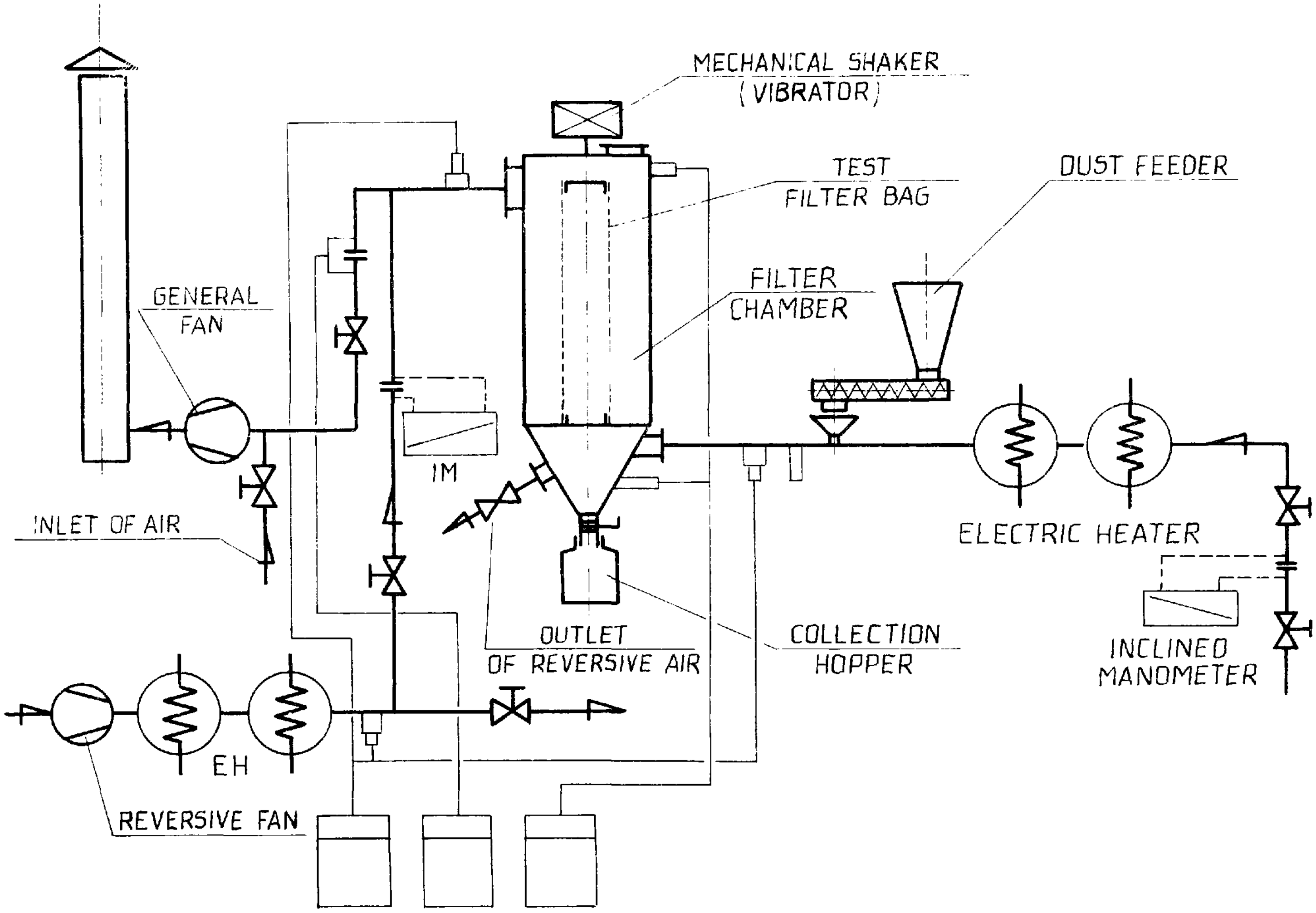


Figure 15. Diagram of the Large-Scale Test Stand.

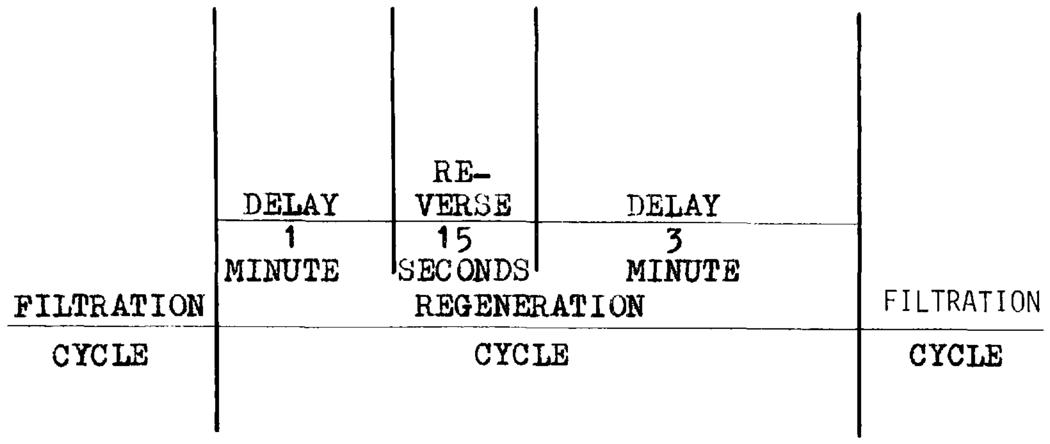
instruments of the single-compartment baghouse are remotely controlled from a desk in the operations room.

The control system allows testing in a manual mode, or automatically with one of three variations of filter bag regeneration: reverse air flow regeneration, mechanical regeneration, or mechanical regeneration with simultaneous reverse air flow.

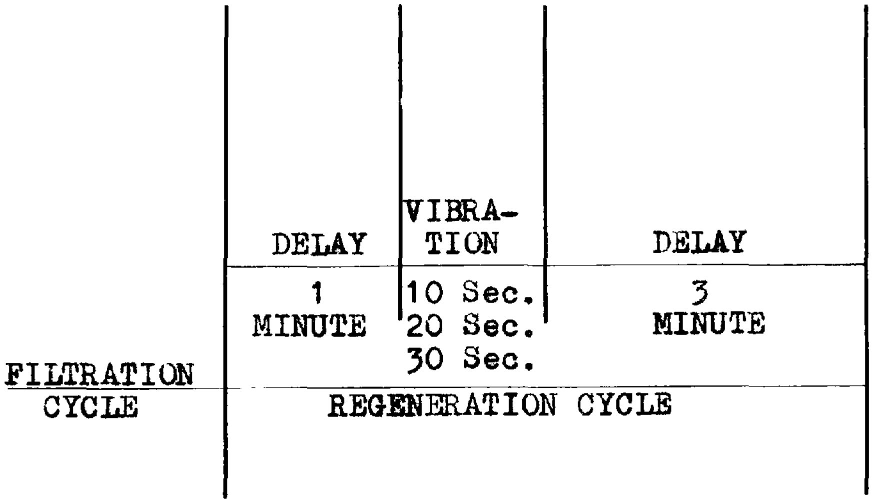
The test apparatus is equipped with several measurement devices and control-measurement sets for the recording of humidity of the gas, temperature of the gas, rate of flow, static pressure, dust concentration before and after the filter chamber, duration of particular filtration cycles and the temperature and humidity of the air in the laboratory.

The general conditions of the experiments are summarized as:

1) The maximum length of the filter bag was 3500 mm.
2) The construction of the filter bag was as in Figure 17.
3) The dispersion medium was atmospheric air taken as is.
4) The regeneration mode was reversed air flow with mechanical vibration, with only mechanical vibration on the last cycle of measurement.
5) The regeneration cycle is shown in Figure 16.
6) The reverse air loading is 20 percent higher than the gas loading during the filtration cycle.
7) The measurement of dust concentration after the filter chamber was by an aspiration method. (In some measurements, the particle size distribution was done with the use of an Andersen Impactor.)
8) Experiments on bags filled with dust were done by multiple repetitions of the filtration-regeneration cycle.



a) For research objectives



b) For final cycle.

Figure 16. Diagram of Regeneration Cycles.

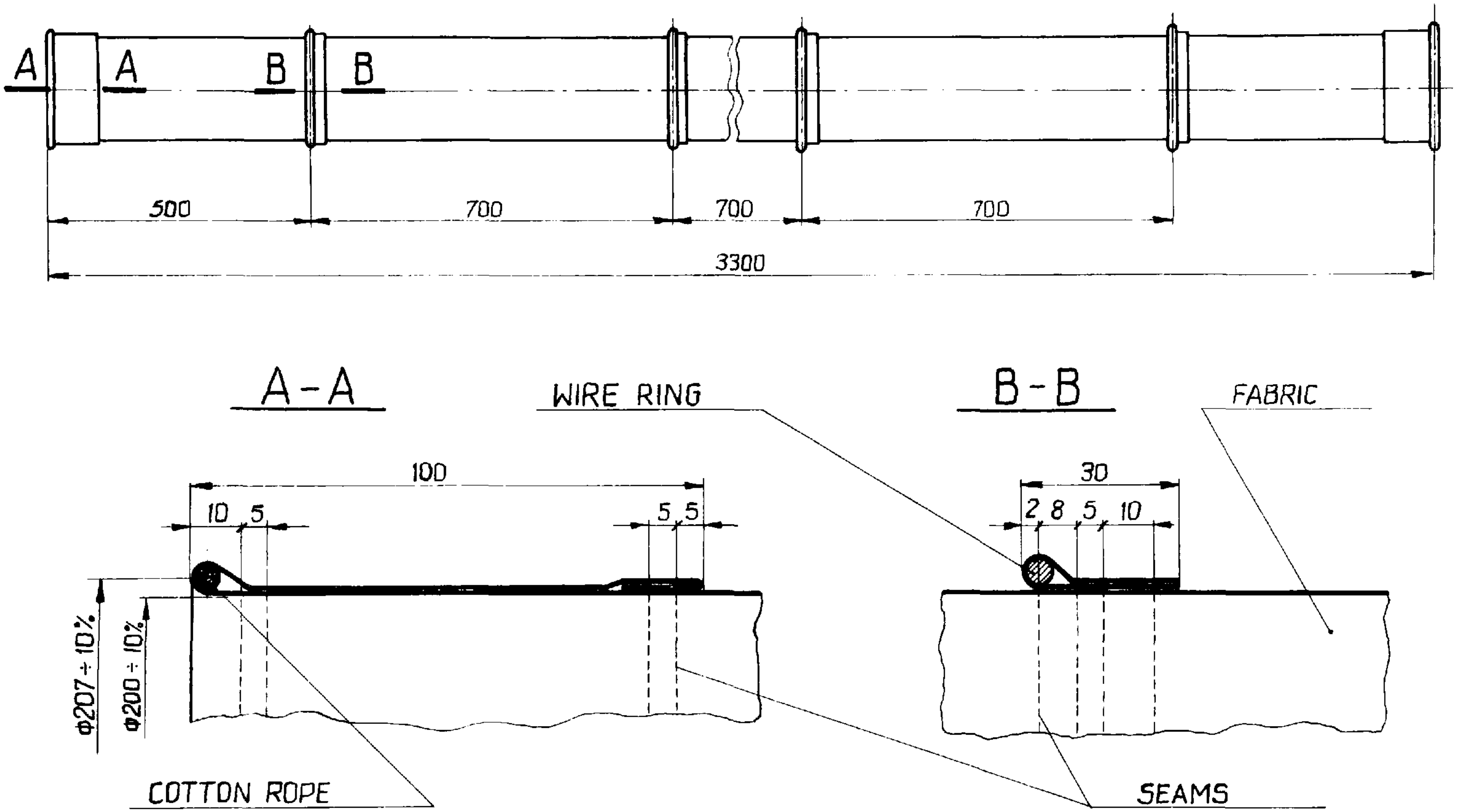


Figure 17. Construction of Bags.

Some of the steps involved with the control and measurement in the large-scale experiments are enumerated below:

1) Weighing and hanging the clean filter bag.

2) Adjusting the rate of flow so that the gas loading was compatible with established values.

3) Adjusting the rate of reverse air flow.

4) Repetitive measurements of the initial flow resistance of the clean fabric at the set gas loading by switching on the air flow.

5) Adjusting the set-point of the dust feeder.

6) Dusting of the filter bag to attain rough equilibrium. The bag must be dusted for about 8 hours, with periodic regeneration until ΔP_N is constant.

7) Weighing of the filter bag after the structure fills to determine the degree of filling L_N (after regeneration):

$$L_N = \frac{\text{weight of filled bag - weight of clean bag}}{\text{net test area}} \, .$$

8) Experimental determinations of the bag dusting time and the final resistance of the covered filter bag, ΔP_K, at a specific L_o:

$$L_o = \frac{\text{weight of covered bag-weight of clean bag}}{\text{net test area}} \, .$$

9) Conducting a measuring cycle for a specific L_o:

a) Dusting of the filter bag to coverage L_o in the predetermined time t_{Fl}.

b) Recording the increase in resistance (ΔP) in the time t_{F1}.

c) Stopping the dust feed.

d) Measuring the final resistance ΔP_K.

e) Switching off the air flow in the system.

f) Weighing of the dust which has fallen into the hopper by gravity.

g) Regeneration of the filter bag in the desired mode.

h) Measuring the bag resistance after regeneration, ΔP_N.

i) Weighing the dust collected in the hopper after regeneration of the filter bag.

Steps a through i are repeated five times.

10) Measuring the average dust concentration after the filter chamber during the fivefold dusting.

11) Removing the filter bag and weighing it to determine the degree of filling after the fivefold dusting.

12) Repetition of hanging the bag and recording its initial resistance.

13) Repetition of these steps for the next value of dust loading L_o.

14) Changing the filter bag for the next value of gas loading, qg.

Dust samples for laboratory examination are taken from the dust feeder, from the collection hopper after filtration but before regeneration, and from the filter bag after regeneration. A dust sample for fractional analysis should be taken from each new part of the dust fed to the feeder.

The filtration efficiency for the single-compartment baghouse at fixed conditions was determined from weighing according to:

$$E = \frac{G_c - G_o}{G_c} , \qquad (4.1)$$

where E is efficiency, G_c is the total weight of dust fed to the filter chamber, calculated from the dust balance or capacity of the feeder, and G_o is the weight of dust in the cleaned gas, from the measurement of emissions.

4.2 Results and Discussion

Large-scale testing was begun using separated talc. Because of the physical properties of this dust (see Table 2), we encountered several difficulties in the realization of the designed testing program. The most difficult problems were in keeping the inlet dust concentration constant at 10 g/m^3 + 10 percent and in preventing the dust from precipitating in the installation.

In order to keep the low concentration of dust at the inlet of the filtration chamber within its tolerance, we were forced to improve the dust feeder installed on the test stand. The first step was to obtain uniform dust feeding at a constant rate. Accordingly, continuous pulverization was applied in the feeder. With individual calibrations for the dust, this gave good results.

The next problem concerned the ability to quantitate the amount of dust in each part of the test stand, due to its precipitation, and the necessity of calculating the quantity of dust fed to the filter chamber in order to determine the dust loading for each cycle. In order to do that, we were forced to change the profile of some parts of the installation in the path of the aerosol, from the point of the dust inlet to the pipeline to the point of emergence from the filtration chamber. The problem of dust settling on the walls of the pipe leading to the filter chamber was brought under control by the application of vibrators and a heating assembly in the dust feeder.

Although these problems were under control during the testing, during some filtration cycles with talc the following effects were observed:

1) Exceeding the tolerance level in the concentration for tests at $q_g = 60\ m^3/m^2$-hr for Fabric: 853 (12.03 g/m^3), 190 (11.87 g/m^3), and 852 (11.60 g/m^3).

2) Overrunning the desired dust loading, L_o, for the introductory filling cycles, during the filling of the fabric. For the last five measurement cycles, the values were at the proper level. Tests conducted after this, using coal dust, were not affected in this way.

These differences were not only a result of controlling the tests at low concentrations in the inlet gas, but also from the different properties of both dusts. In contrast to coal, with talc, it was very difficult to keep the established of L_o because of the inconsistent character of the dust cake, because of the small range of particle sizes (up to 20 μm) and the strong adhesion properties. Basing the target value of $L_o = 400\ g/m^3$ on the pressure drop measured, very often at the end of a cycle, a higher or lower value of L_o was obtained.

The results of large-scale testing are shown in Table 12 and Figures 18 through 21. The table contains mean values of filtration efficiency and outlet concentrations, obtained over five measurement cycles after reaching equilibrium (with reverse air flow regeneration). The figures show the dependence of filtration efficiency as a function of gas loading on the filtration area.

Table 12. LARGE-SCALE EFFICIENCY OF TESTED FILTRATION FABRICS
(Dust concentration of C_o = 10 g/m^3 and L_o = 400 g/m^2)

Type of filtration fabrics	Gas loading of filtration area in m^3/m^2/hr	Kind of dust			
		Separated Talc Dust		Unseparated Coal Dust	
		Efficiency in percent	Outlet concentration in g/m^3	Efficiency in percent	Outlet concentration in g/m^3
Cotton (staple fiber) Style No. 960	60	99.985	0.0016	99.917	0.0090
	80	99.825	0.0148	99.984	0.0016
Dacron[R] polyester (staple fiber) Style No. 862B	60	99.975	0.0026	99.782	0.0226
	80	99.685	0.0330	99.805	0.0181
Style No. C866B	60	99.989	0.0012	99.955	0.0044
	80	99.958	0.0047	99.623	0.0037
Style No. C868B	60	99.959	0.0038	99.936	0.0017
	80	99.854	0.0131	99.912	0.0100

Table 12 (Continued)

Dacron[R] polyester					
(cont. filament)					
Style No. 865B	60	99.966	0.0033	99.986	0.0015
	80	99.947	0.0050	99.994	0.0006
Style No. C890B	60	99.964	0.0034	99.950	0.0053
	80	99.966	0.0032	99.972	0.0027
Style No. C892B	60	99.911	0.0079	99.957	0.0044
	80	99.307	0.0658	99.976	0.0024
Nomex[R] aromat. nylon					
(staple fiber)					
Style No. 852	60	99.963	0.0043	99.989	0.0010
	80	99.864	0.0126	99.974	0.0024
Style No. 853	60	99.983	0.0021	99.718	0.0287
	80	99.928	0.0069	99.979	0.0019
Style No. 190	60	99.992	0.0010	99.989	0.0012
	80	99.944	0.0051	99.978	0.0021
Nomex[R] aromat. nylon					
(cont. filament)					
Style No. 850	60	99.996	0.0005	99.959	0.0043
	80	99.995	0.0004	99.989	0.0010

Table 12 (continued)

Nylon polyamide (staple fiber) Style No. 802B	60	99.996	0.0004	99.815	0.0174
	80	99.842	0.0155	99.986	0.0015
Glass (staple fiber) Style No. Q53-875	60	99.951	0.0048	99.896	0.0128
	80	99.952	0.0046	99.895	0.0099
Glass (cont. filament) Style No. Q53-870	60	99.597	0.0406	99.817	0.0193
	80	99.690	0.0304	99.783	0.0223
Style No. Q53-878	60	99.889	0.0108	99.678	0.0323
	80	98.876	0.1123	99.501	0.0495

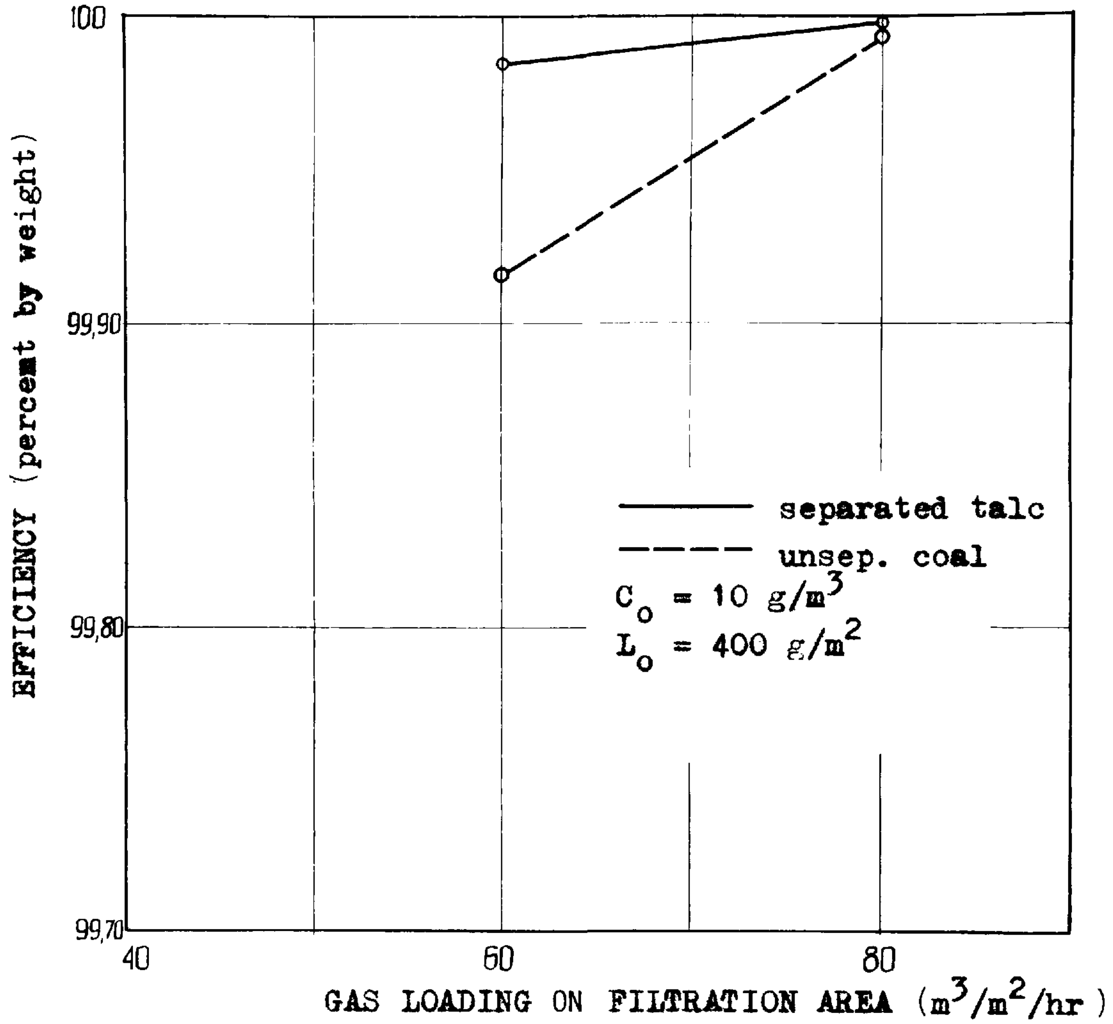


Figure 18. Efficiency vs. Gas Loading of Filtration Area for Cotton Fabric (Large-Scale Test)

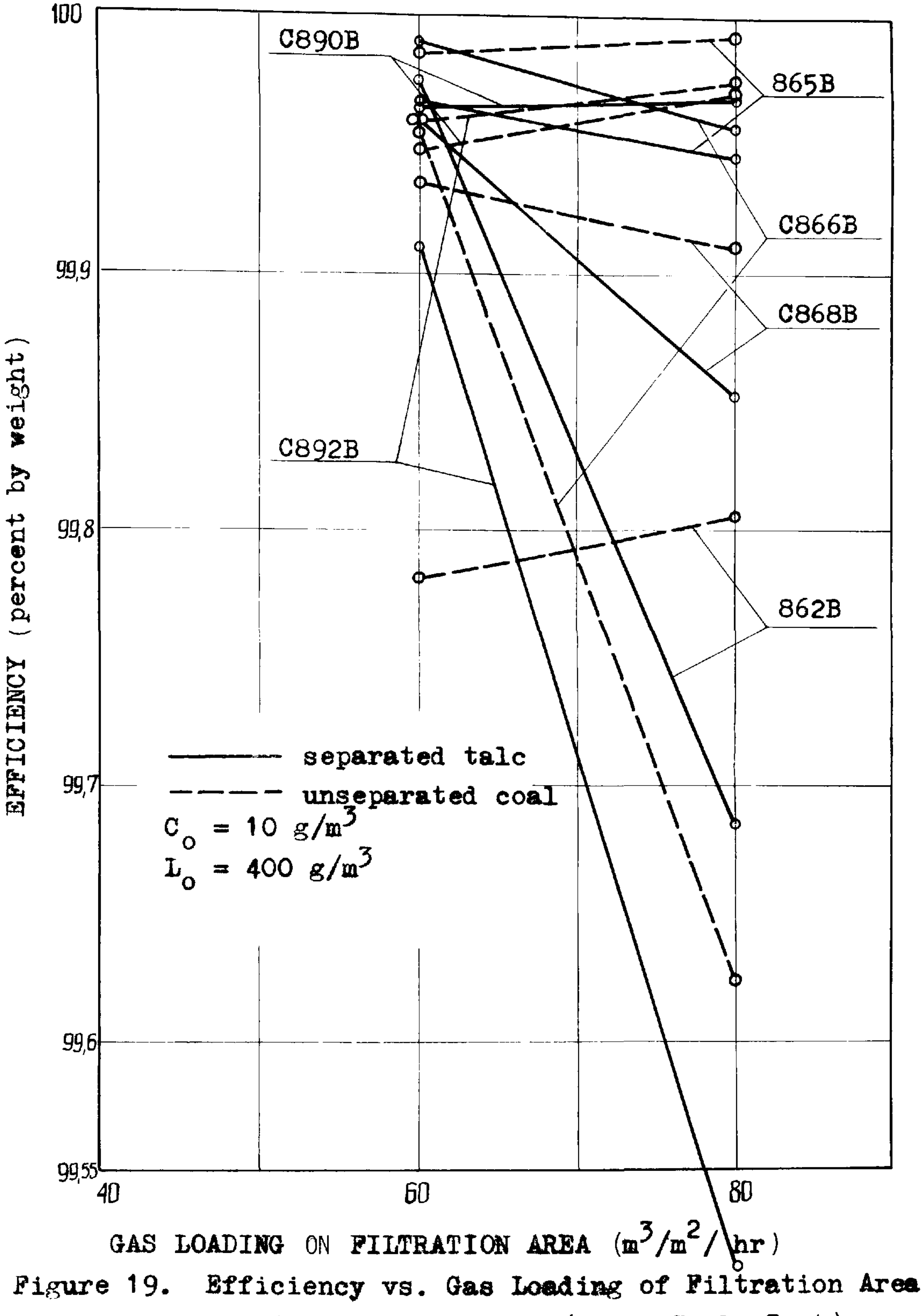


Figure 19. Efficiency vs. Gas Loading of Filtration Area for Polyester Fabrics (Large-Scale Test)

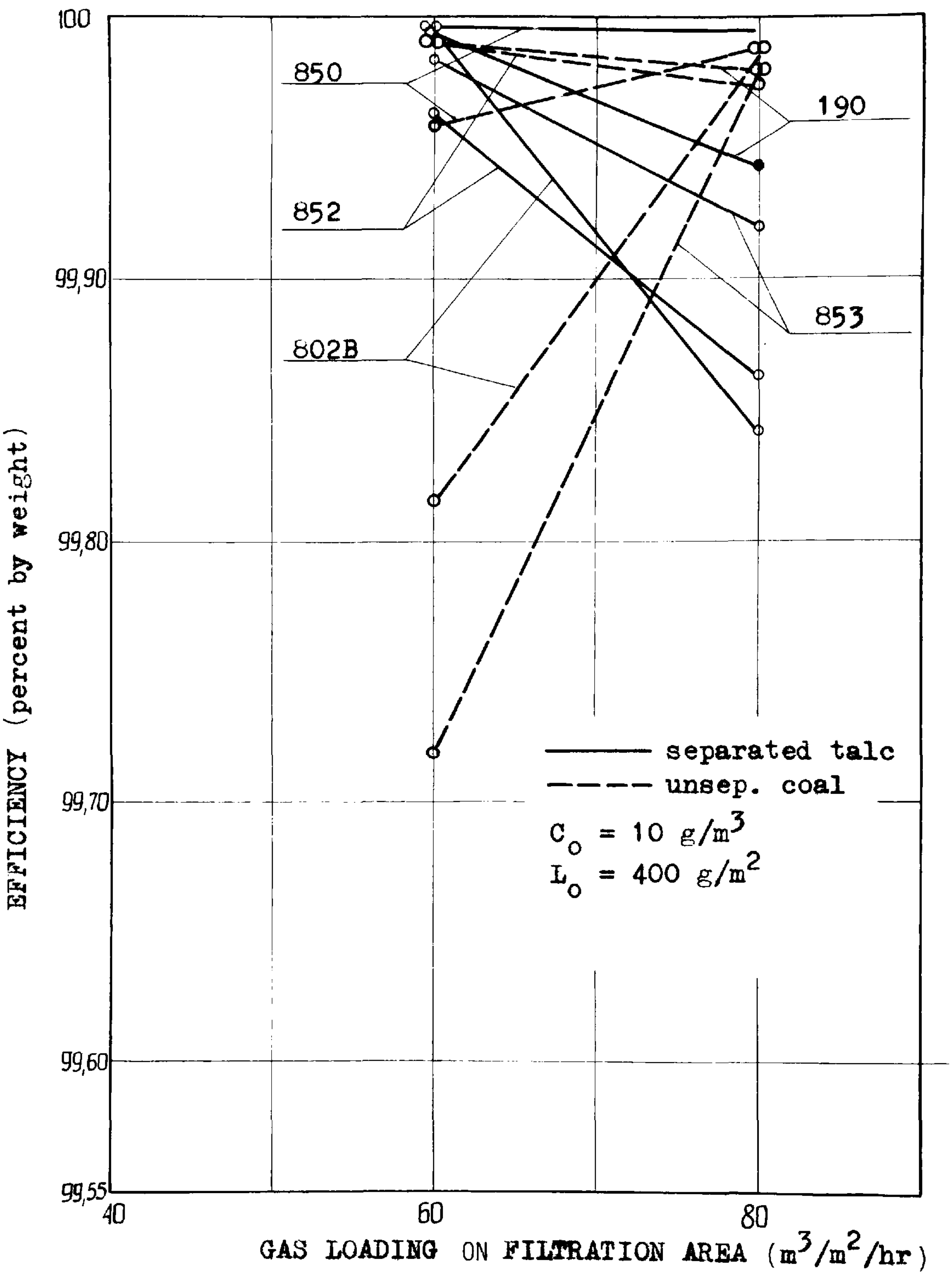


Figure 20. Efficiency vs. Gas Loading of Filtration Area for Nomex and Nylon Fabrics (Large-Scale Test)

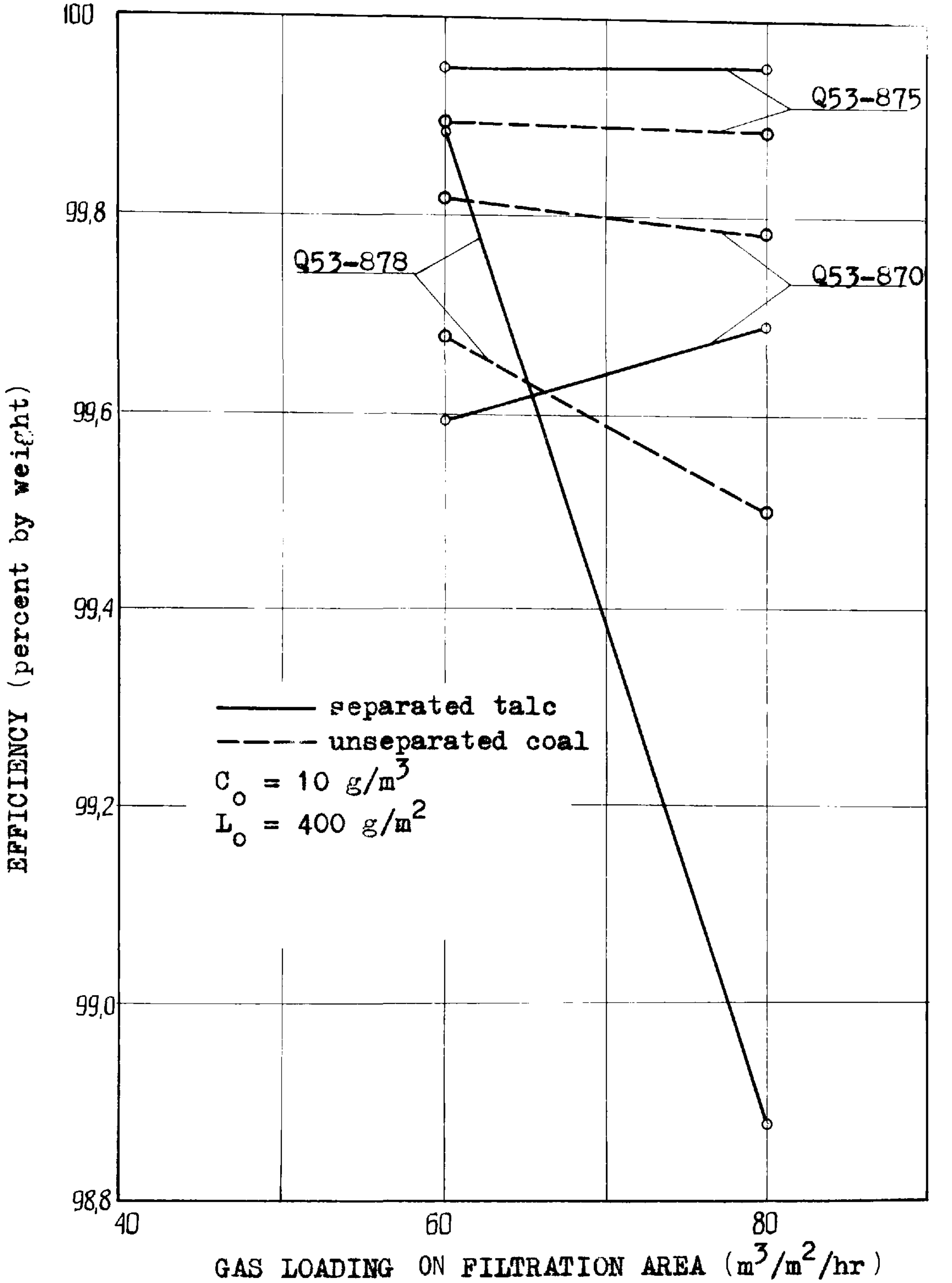


Figure 21. Efficiency vs. Gas Loading of Filtration Area for Glass Fabrics (Large-Scale Test)

In the appendix, Figures A-34 through A-93 show the change of filtration resistance as a function of time for each kind of fabric, dust, and gas loading. The detailed compilation of results will be enclosed in the final report.

In order to conduct a comparison of the results, the fabrics were ordered according to the outlet concentration in the following ranges:

less than .0025 g/m^3,

.0025 - .01 g/m^3,

.01 - .1 g/m^3, and

greater than .1 g/m^3.

Table 13 was organized with these criteria.

As shown in the table, the lowest outlet concentration was obtained for four fabrics: Cotton Fabric 960, Nylon Fabric 802B, Nomex 190, and Nomex 850 (continuous filament). For the first three fabrics, the results are the same as in the laboratory testing. The very good results of the Nomex 850 filtration fabric, which had the lowest value of efficiency in the laboratory testing, can be explained by the packed structure of the dust during the filtration process. This disagreement in rank between the laboratory testing and the industrial scale testing was observed only with the Nomex 850. The lowest efficiencies among the tested fabrics were observed in the glass fabrics. Fabric Q53-875 showed the best filtration properties in this group of fabrics, just as in laboratory testing. In some cases, increased gas loading on the filtration area resulted in increased outlet concentration. The preliminary results of these tests will be the subject of further investigations in order to explain some recorded events.

Table 13. COMPARISON OF QUALITATIVE PARAMETERS OF FABRICS

Kind of Dust	Gas loading on filtration area $m^3/m^2/hr$	Outlet concentration in g/m^3			
		below 0.0025	0.0025 - 0.01	0.01 - 0.1	above 0.1
Talc	60	960 C866B 802B 190 850 853	865B 862B C868B C890B C892B 852 Q53-875	Q53-870 Q53-878	
	80	850	C866B C890B 190 853 Q53-875	960 865B 862B C868B C892B 802B 852 Q53-870	Q53-878
Coal	60	865B C868B 190 852	960 C866B C890B C892B 850	862B 802B 853 Q53-875 Q53-870 Q53-878	
	80	960 865B C892B 802B 190 852 850 853	C866B C868B C890B Q53-875	862B Q53-870 Q53-878	

4.3 Conclusions

Large-scale testing conducted with coal dust and talc confirmed the necessity of conducting laboratory testing as a preliminary selection process for filtration fabrics. The filtration efficiencies in large scale testing are higher than those obtained in laboratory testing, due to the filling of the spatial structure to equilibrium. For the testing conditions (q_g, L_o) and dusts given (separated talc, unseparated coal), the following fabrics can be regarded as satisfactory from a quantitative point of view:

For separated talc dust:

Polyester Fabrics C866B, C890B;

Nomex Fabrics 190, 850, 853; and

Glass Fabrics Q53-875;

For unseparated coal dust:

Cotton Fabric 960,

Polyester Fabrics 865B, C866B, C868B, C890B, C892B, and

Nomex Fabrics 190, 852, 850.

The Cotton 960 and Nylon 802B fabrics had satisfactory efficiencies for separated talc dust at a gas loading of $q_g = 60\ m^3/m^2$-hr.

5.0 STUDY OF REGENERATION PROPERTIES OF FABRICS

5.1 Introduction

During the life of a fabric filter, the material exists in one of three states: as clean fabric, which has not had any contact with the dust or gas medium; as filled fabric, which has been in contact with the dust or gas medium, but which was regenerated; and dust-covered fabric, which is fully filled with dust and dust cake. The thickness of the dust cake depends on the length of contact with the gas-dust medium.

These stages of the filtration fabrics are characterized by separate resistivities (static pressure drops) at specific values of gas loading:

ΔP_o = clean fabric resistivity,

ΔP_N = filled fabric resistivity, and

ΔP_K = dust-covered fabric resistivity.

Following the principle of superposition, the following relation holds:

$$\Delta P_K = \Delta P_N + \Delta P_W \quad , \quad q_g = \text{const.}, \qquad (5.1)$$

where ΔP_W is the dust cake resistivity.

This relation shows the specific problems of a practical nature connected with accurately measuring the fabric regeneration process. The dust-covered fabric resistivity (the final resistivity of a filtration cycle) is dependent upon the clean fabric resistivity, the physico-chemical properties of the dust, and the gas loading.

Figures 22 and 23 show the theoretical and actual course of the filtration and regeneration processes in the bag filter, with significant values indicated. In a theoretical run, at constant gas and dust loading, the duration of filtration in a particular cycle is constant, resulting in a final resistance in each cycle, ΔP_K, which is constant. However, in actual conditions where the values characterizing gas and dust loadings are variable in time and mean values only are used, the distribution of the flow pressure drop is completely different (Figure 23).

The duty life of a filtration fabric in a bag filter depends to a large degree on the method of regulating the regeneration system. For a given concentration, the final resistivity of dust-covered fabric should attain a definite level ΔP_K. Multiple repetitions of filtration-regeneration cycles lead to a certain increase of the filled fabric resistivity, measured during regeneration. The increase tends toward a specific value, ΔP_{NK}, for a given mode of regeneration, as a result of a fabric structure of large specific area and thickness.

The fabric susceptibility for regeneration can be easily determined by measuring this final value of resistance for a given mode of regeneration. In order to compare filtration fabrics, the following equation for the susceptibility for regeneration was developed:

$$S_R = 1 - \frac{\Delta P_{NK} - \Delta P_o}{\Delta P_K - \Delta P_o} , \qquad (5.2)$$

at constant dust loading (q_p in g/m^2-hr), constant gas loading (q_g in m^3/m^2-hr) and constant initial concentration (C_o in g/m^3); ΔP_o and ΔP_K are defined as

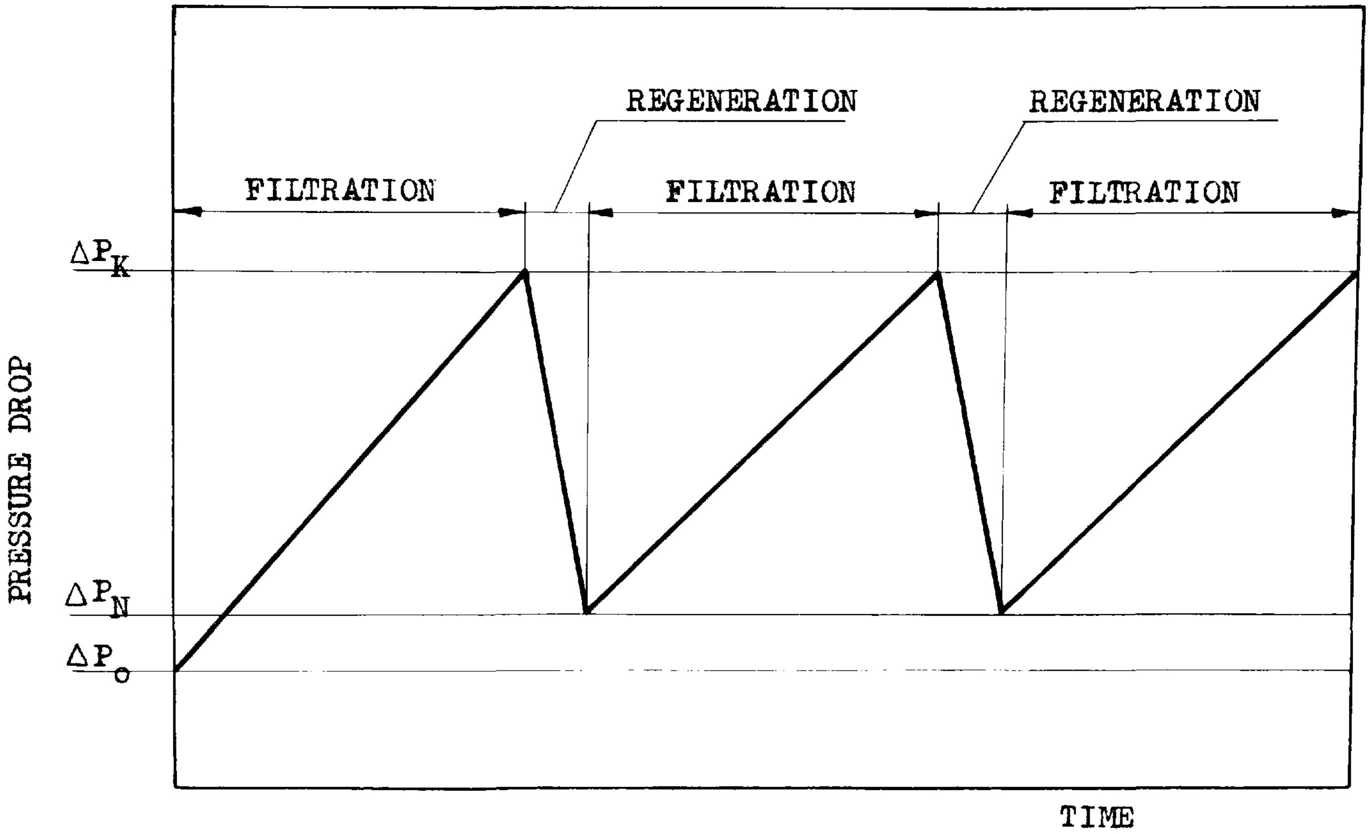


Figure 22. Theoretical Run of Filtration and Regeneration Process.

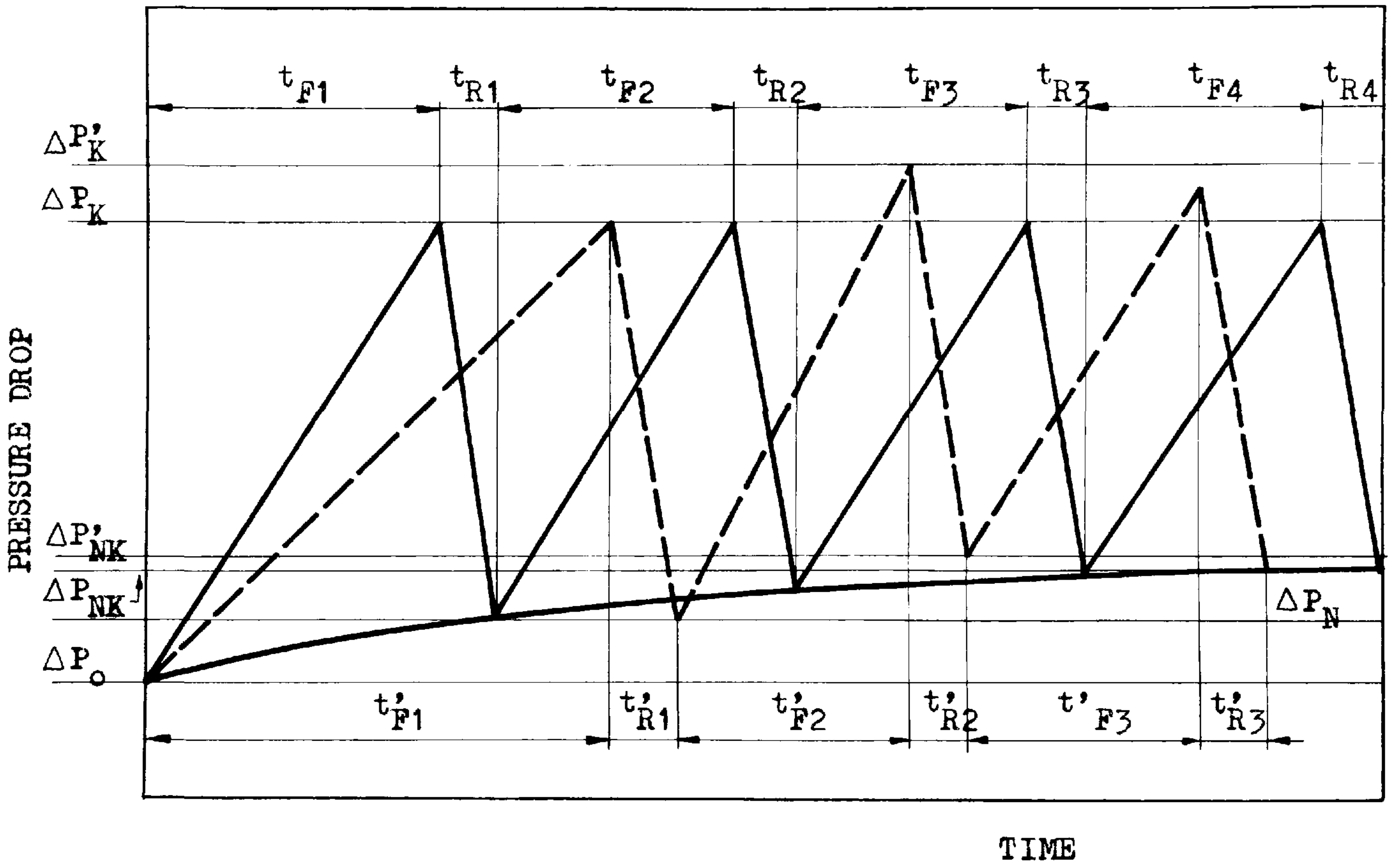


Figure 23. Practical Run of Filtration and Regeneration Process.

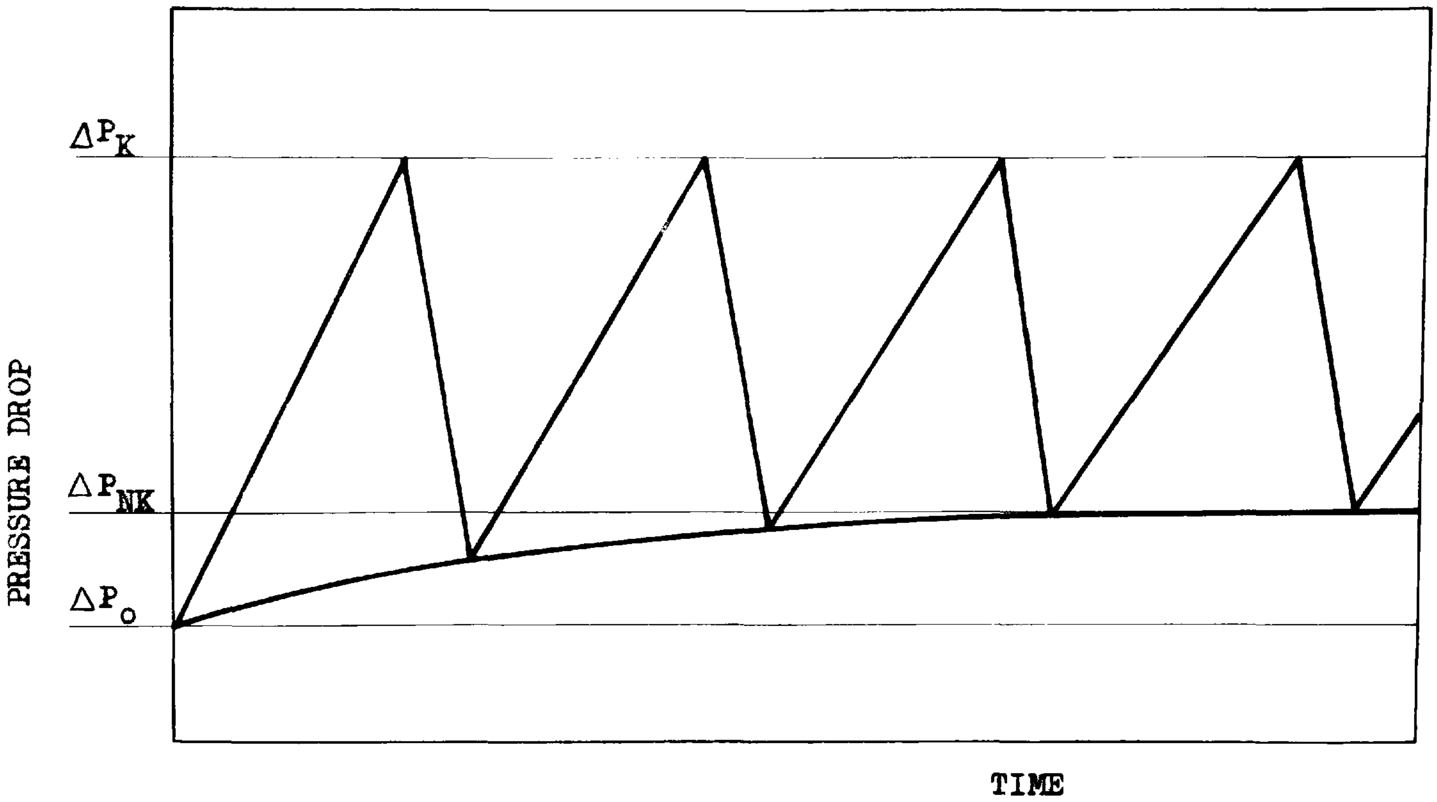


Figure 24. Characteristic of Pressure Drop Values in Dust Filtration Process.

before, and ΔP_{NK} is the final filled-fabric resistivity for a definite mode of resistivity. The values of fabric susceptibility range from 0 to 100 percent.

5.2 Results and Discussion

The estimation of regeneration properties for the group of fabrics examined was conducted with values of the susceptibility for regeneration calculated as above. Suitable values of pressure drop were taken from data recorded during industrial scale testing and are shown in Tables B-2 through B-9. The susceptibility was calculated for the fabrics after four stages of regeneration:

1) after reverse flow regeneration, S_{RR};
2) after mechanical shaking (vibration) for 10 seconds, S_{RM1};
3) after mechanical shaking (vibration) for 20 seconds, S_{RM2}; and
4) after mechanical shaking (vibration) for 30 seconds, S_{RM3}.

The results of testing with specific gas loadings and dusts are shown in Tables 14 through 17.

The susceptibility for regeneration, which is a property of the fabric surface, depends to a large degree on adhesion effects at the interface between the fabric and the dust cake. Thus, it depends on fiber properties as well as on dust properties. The interaction of dust particles and fibers (of solid state) is conditioned by different kinds of mechanisms. The main mechanisms contributing to adhesion are molecular forces, electrostatic forces, and capillary attraction. In dry filtration, the participation of capillary forces is much weaker than electrostatic effects. Tests conducted in our Institute confirm the large influence of electrostatic effects, not only on filtration efficiencies, but also on their susceptibility for regeneration.

Table 14. Susceptibility for Regeneration of Fabrics Tested with Talc Dust (in percent)(Gas loading of filtration area q_g = 60 $m^3/m^2/hr$).

Kind of Fabric	Susceptibility for Regeneration			
	S_{RR}	S_{RM1}	S_{RM2}	S_{RM3}
Style 960	67.3	63.6	61.4	61.4
Style 190	82.7	79.5	78.7	78.7
Style 852	86.3	90.6	89.8	90.0
Style 850	64.3	65.3	65.1	64.5
Style 853	43.4	40.4	38.2	38.2
Style 802B	70.3	63.6	63.2	63.2
Style 862B	81.1	81.1	82.7	83.7
Style 865B	79.2	79.5	79.5	80.1
Style C866B	77.1	78.0	74.8	74.8
Style C868B	68.9	70.9	69.4	69.9
Style C890B	70.2	69.1	71.3	72.4
Style C892B	75.3	70.9	73.9	74.7
Style Q53-870	66.3	63.0	63.0	62.5
Style Q53-875	77.6	72.7	79.1	80.9
Style Q53-878	73.9	70.7	70.7	71.5

S_{RR} = reverse flow regeneration

S_{RM1} = mechanical shaking during 10 sec

S_{RM2} = mechanical shaking during 20 sec

S_{RM3} = mechanical shaking during 30 sec

Table 15. Susceptibility for Regeneration (in percent) of Fabrics Tested with Talc Dust. (Gas loading of filtration area q_g = 80 $m^3/m^2/hr$).

Kind of Fabric	Susceptibility for Regeneration			
	S_{RR}	S_{RM1}	S_{RM2}	S_{RM3}
Style 960	63.2	61.3	60.7	60.7
Style 190	80.5	78.5	77.9	78.5
Style 852	74.6	54.9	59.2	60.6
Style 850	73.1	69.5	68.6	68.9
Style 853	57.5	57.3	57.3	57.3
Style 802B	68.9	64.8	63.9	64.8
Style 862B	85.9	83.8	84.4	85.0
Style 865B	83.5	77.8	78.0	78.6
Style C866B	78.1	73.4	75.2	77.1
Style C868B	68.7	62.2	62.6	63.7
Style C890B	80.1	71.7	71.2	71.9
Style C892B	83.6	85.2	90.3	91.7
Style Q53-870	74.8	71.3	69.6	69.9
Style Q53-875	86.1	79.2	80.2	83.5
Style Q53-878	77.7	74.2	73.8	74.2

S_{RR} = reverse flow regeneration

S_{RM1} = mechanical shaking during 10 sec

S_{RM2} = mechanical shaking during 20 sec

S_{RM3} = mechanical shaking during 30 sec

Table 16. Susceptibility for Regeneration (in percent) of Fabrics tested with Coal Dust. (Gas loading of filtration area q_g = 80 $m^3/m^2/hr$).

Kind of Fabric	Susceptibility for Regeneration			
	S_{RR}	S_{RM1}	S_{RM2}	S_{RM3}
Style 960	58.2	55.4	55.4	55.4
Style 190	80.6	77.5	77.5	77.5
Style 852	75.2	73.2	72.4	73.2
Style 850	77.3	74.0	71.7	70.0
Style 853	70.9	68.4	69.6	69.6
Style 802B	77.4	75.3	74.7	75.3
Style 862B	83.9	83.9	84.6	85.0
Style 865B	82.2	75.9	77.1	78.3
Style C866B	79.6	78.7	80.1	81.5
Style C868B	78.4	78.0	77.3	77.3
Style C890B	83.3	83.3	79.5	78.6
Style C892B	86.1	85.5	84.7	84.7
Style Q53-870	76.6	69.2	66.7	64.7
Style Q53-875	89.1	84.3	84.9	85.5
Style Q53-878	88.9	85.8	85.1	85.1

S_{RR} = reverse flow regeneration

S_{RM1} = mechanical shaking during 10 sec

S_{RM2} = mechanical shaking during 20 sec

S_{RM3} = mechanical shaking during 30 sec

Table 17. Susceptibility for Regeneration (in percent) of Fabrics tested with Coal Dust. (Gas loading of filtration area q_g = 80 $m^3/m^2/hr$).

Kind of Fabric	Susceptibility for Regeneration			
	S_{RR}	S_{RM1}	S_{RM2}	S_{RM3}
Style 960	62.8	57.7	56.5	55.0
Style 190	84.1	79.3	80.9	81.9
Style 852	84.2	84.6	82.7	83.8
Style 850	77.4	60.9	64.6	67.3
Style 853	76.3	69.8	68.3	67.8
Style 802B	75.7	74.5	74.5	74.5
Style 862B	84.5	82.0	82.9	83.8
Style 865B	86.6	86.9	85.9	85.9
Style C866B	83.1	81.4	81.6	82.4
Style C868B	80.7	78.9	80.3	81.0
Style C890B	85.9	76.7	75.4	74.4
Style C892B	83.1	77.5	73.9	76.9
Style Q53-870	84.2	79.5	79.5	82.1
Style Q53-875	88.4	80.4	80.4	82.0
Style Q53-878	92.2	92.4	91.8	91.8

S_{RR} = reverse flow regeneration

S_{RM1} = mechanical shaking during 10 sec

S_{RM2} = mechanical shaking during 20 sec

S_{RM3} = mechanical shaking during 30 sec

For preliminary interpretation of the calculated results of the susceptibility, the following classifications were used:

1) Good - a susceptibility for regeneration of 80-90 percent.

2) Satisfactory - a susceptibility of 70-80 percent.

3) Bad - a susceptibility below 70 percent.

According to these criteria, the reverse air flow regeneration using unseparated coal dust is ranked

Good for Fabrics 190, 862B, 865B, C890B, C892B, Q53-875, and Q53-878;

Bad for Fabric 960; and

Satisfactory for the remaining fabrics.

Using separated talc dust, the ranking of fabrics is:

Good for Fabrics 190, 852, 862B, and 865B;

Bad for Fabrics 960, 850, 853, 802B, C868B, and Q53-870; and

Satisfactory for the remaining fabrics.

With mechanical regeneration alone, with a vibrator amplitude of 3 mm at a frequency of 1400 per minute, the susceptibility for regeneration is 5-10 percent lower than with reverse air flow.

The considerably lower regeneration properties for the filtration of the aerosol containing talc could be caused by the smaller MMD of talc as compared with the MMD of unseparated coal dust. The differences between the shape of the particles and the surface structure of the fabric are also of great importance. These problems ought to be further investigated and their results applied by filtration fabrics manufacturers.

5.3 Conclusions

For specific conditions of filtration and regeneration processes, an estimation of the regeneration properties of fabrics can be obtained by measuring the pressure drops across the filter. An improvement in regeneration effects for the fabrics can be obtained by increasing the intensity of regeneration.

6.0 CONCLUSIONS

Test measurements, conducted in laboratory and large scale experiments on fifteen kinds of USA-manufactured filtration fabrics, led to the following initial conclusions.

1) Although the dust filtration process characteristic of laboratory testing is different from the process in large-scale testing, fabrics which performed well in laboratory testing were also found to perform well in large-scale testing.

2) With clean air flow through filtration fabrics, FA calculated from the technical parameters of the fabrics is a value characterizing the fabric structure for staple fibers. For continuous filament fabrics, FA is not a representative value because of the deformation of structure.

3) Fabrics manufactured with silk-like fibers with low coefficients of friction are very sensitive to increases in the gas loading of the filtration area, leading to the formation of ducts/canals and reducing their filtration efficiency (for certain experimental conditions and fabrics).

4) Because the test conditions for the glass fabrics were too severe, leading to the formation of ducts/canals, the efficiencies were low and do not indicate the true filtration properties.

5) The regeneration properties depend on the materials of the fabrics and dusts, and on the surface properties of structure, but do not depend on the gas loading on the filtration area at which the process was realized.

7.0 RECOMMENDATIONS

Further research is deemed necessary. The completion of all cycles of investigation will enable the definition of more detailed results, especially in the comparison range between laboratory and large-scale testing and in estimation of the regeneration properties of filtration fabrics. The comparison of filtration and regeneration properties between American and Polish fabrics is also foreseen.

The data obtained will be used in Project 5-533-5.

APPENDIX A

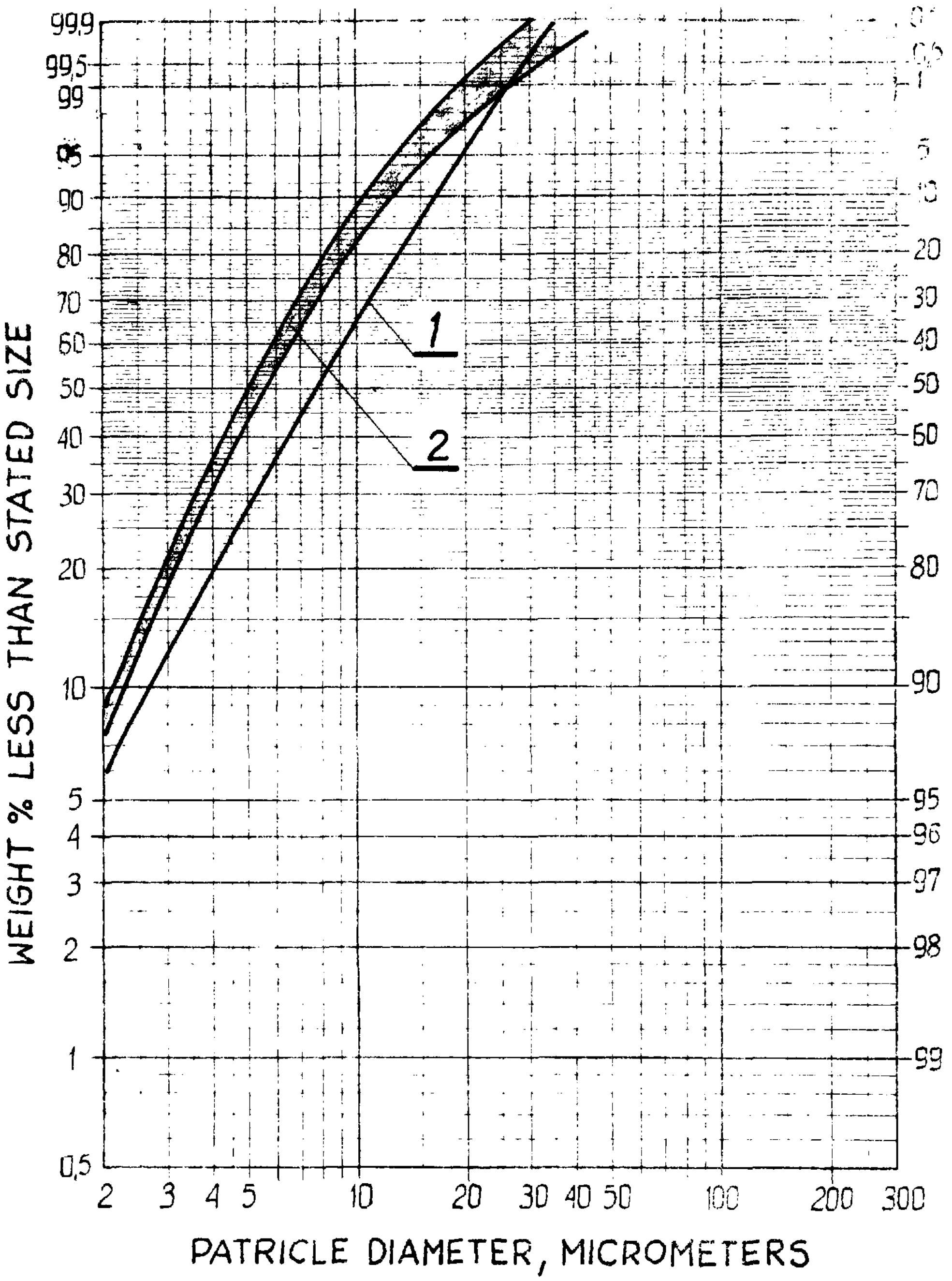


Figure A-1. Particle Size Distribution of Cement Tested Dust (1 - for laboratory testing, 2 - for large-scale testing).

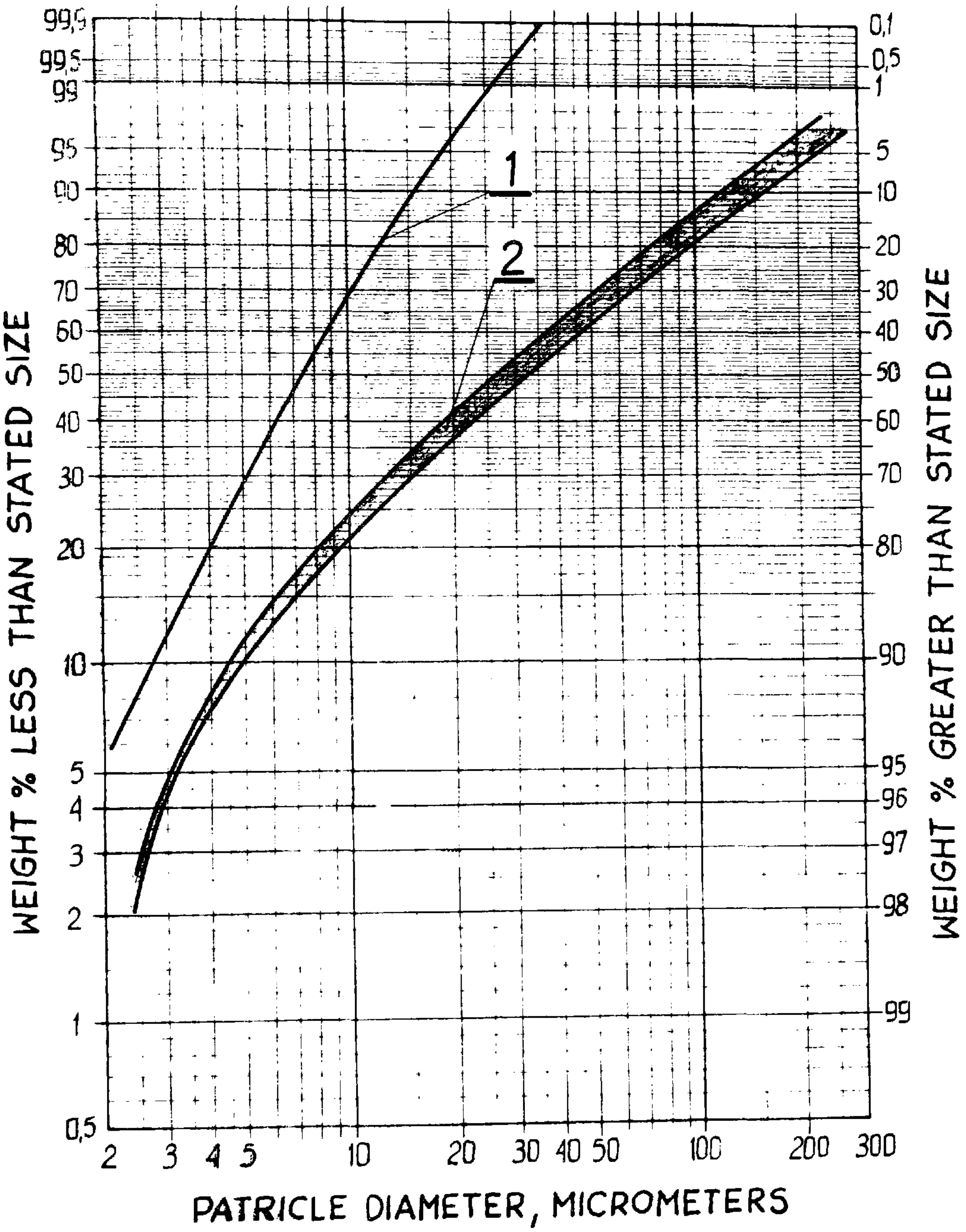


Figure A-2. **Particle Size Distribution of Coal Tested Dust (1 - for laboratory testing, 2 - for large-scale testing).**

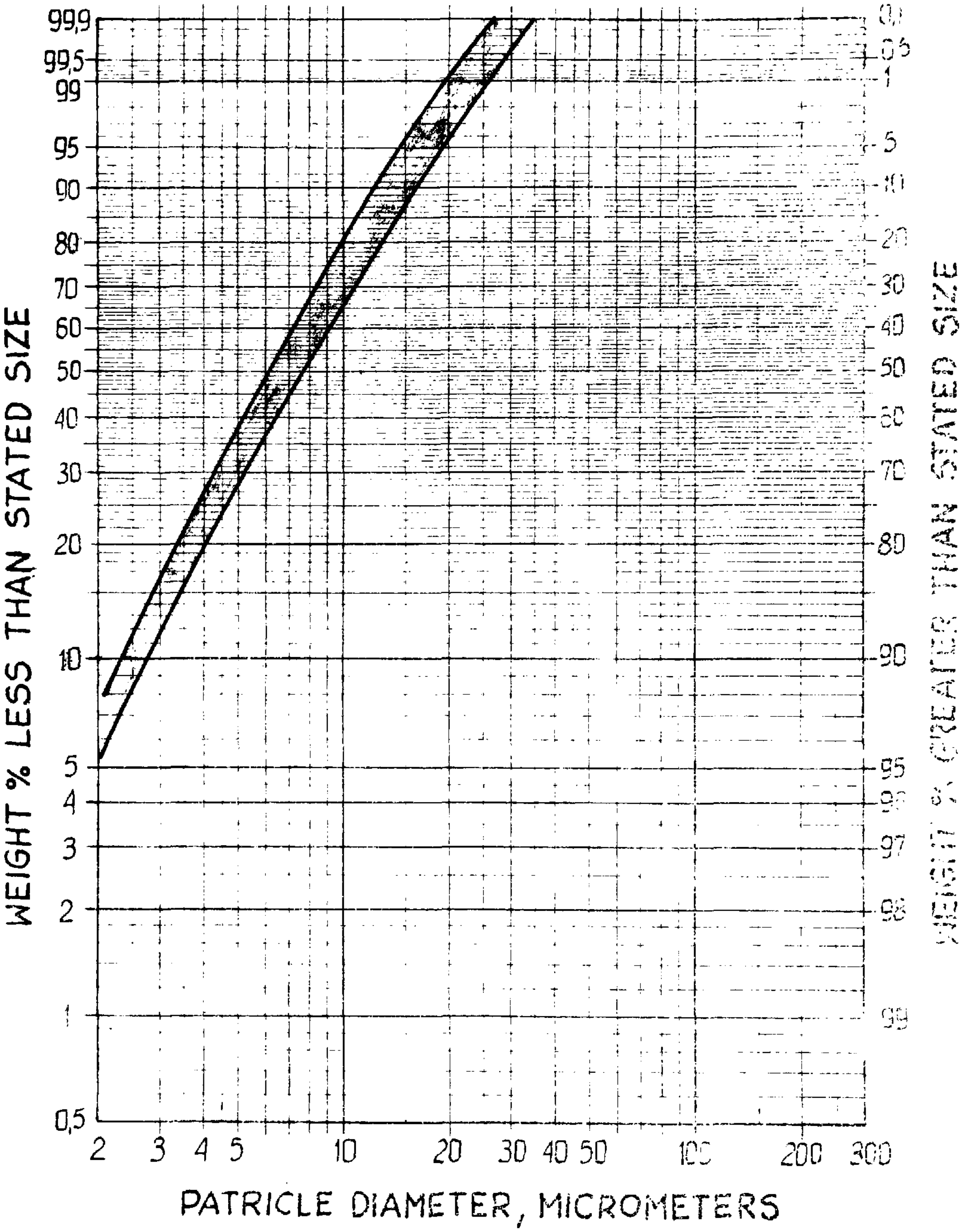


Figure A-3. Particle Size Distribution of Talc Tested Dust.

Figure A-4. Surface of Clean Fabric Style 960 (cotton fiber).

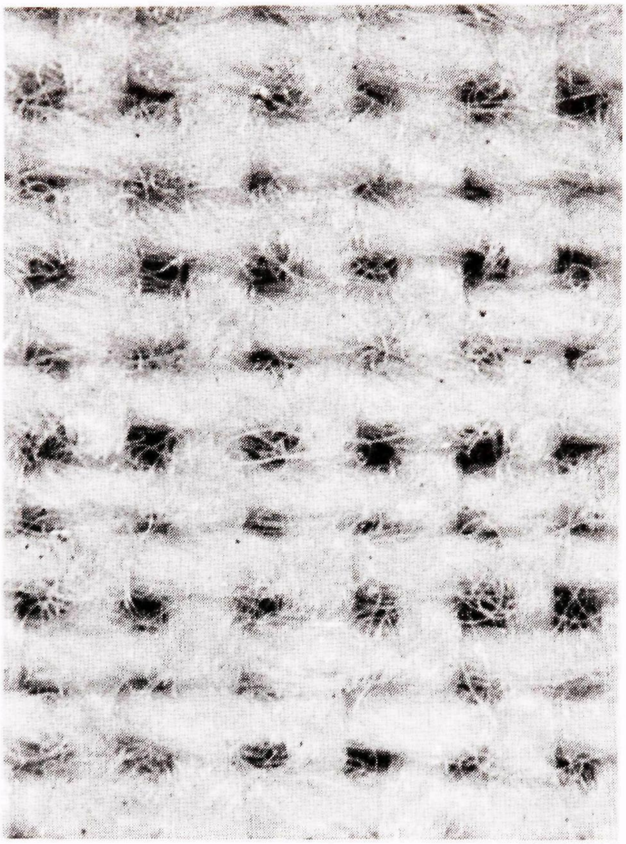


Figure A-5. Surface of Clean Fabric Style 862B
(polyester fiber)

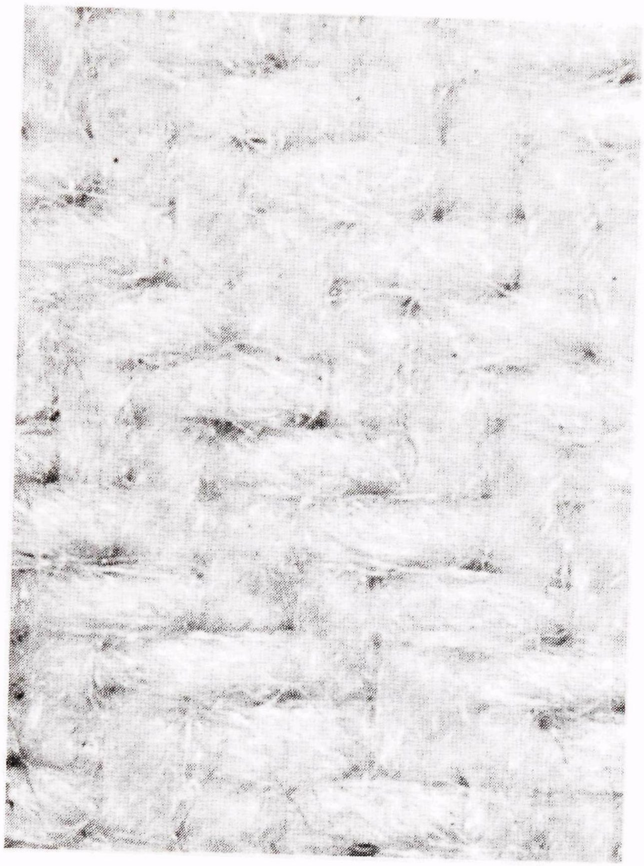


Figure A-6. Surface of Clean Fabric Style C866B (polyester fiber)

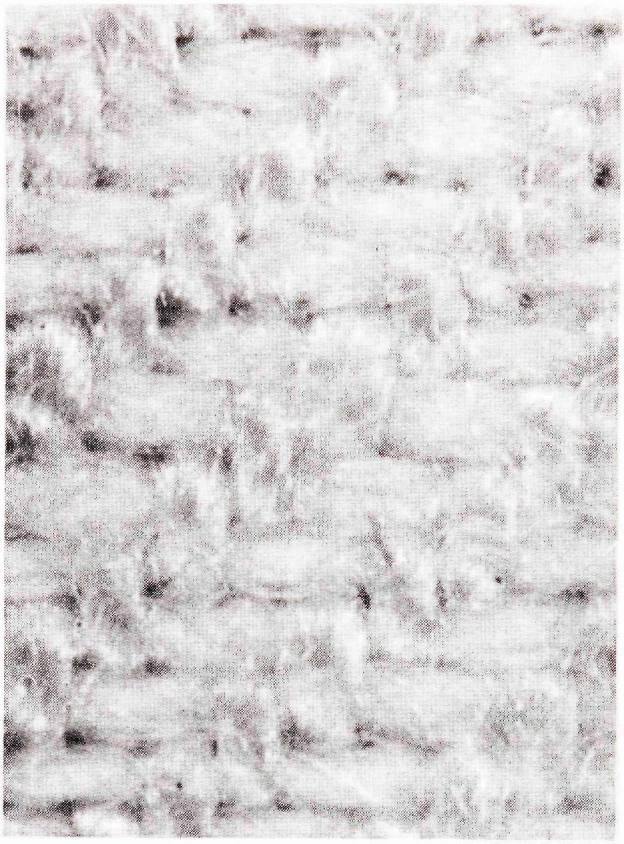
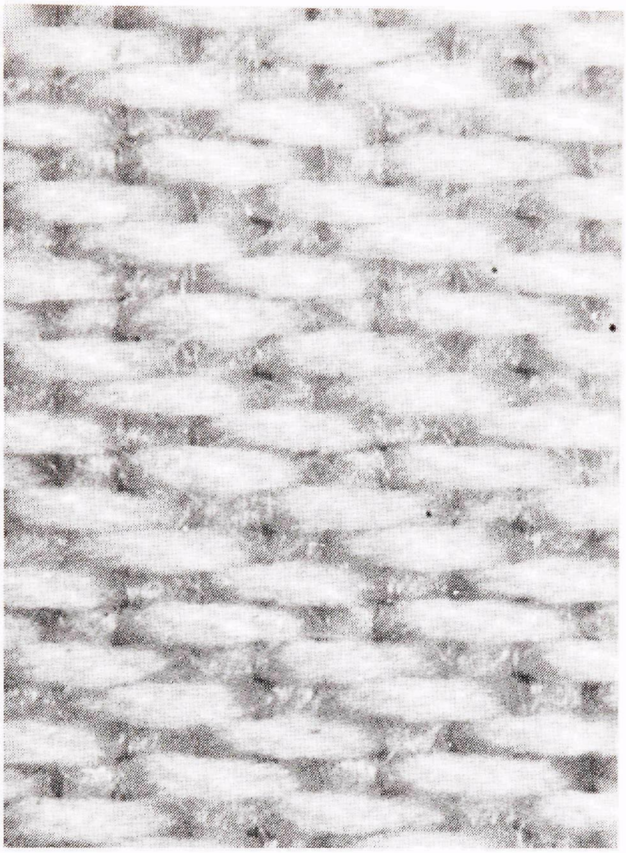


Figure A-7. Surface of Clean Fabric Style C868B (polyester fiber)



gure A-8. Surface of Clean Fabric Style 865B
(polyester fiber)

Figure A-9. Surface of Clean Fabric Style C890B
(polyester fiber)

Figure A-10. Surface of Clean Fabric Style C892B (polyester fiber)

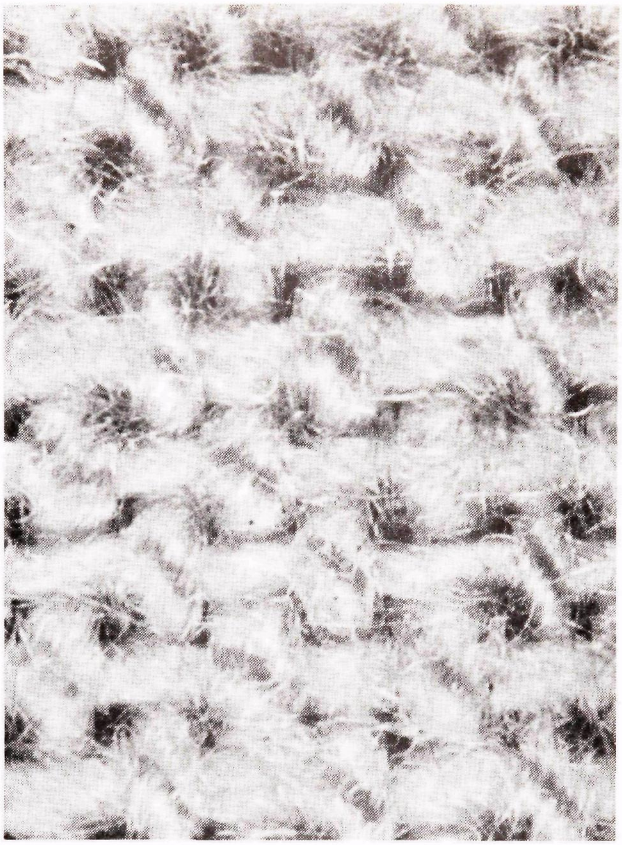


Figure A-11. Surface of Clean Fabric Style 852
(nomex fiber)

Figure A-12. Surface of Clean Fabric Style 853 (nomex fiber)

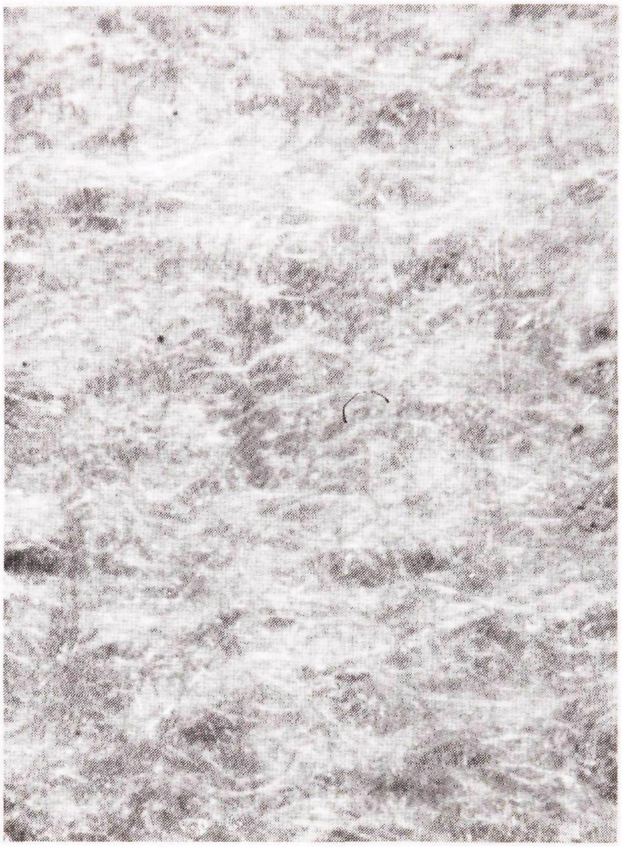


Figure A-13. Surface of Clean Fabric Style 190 (nomex fiber)

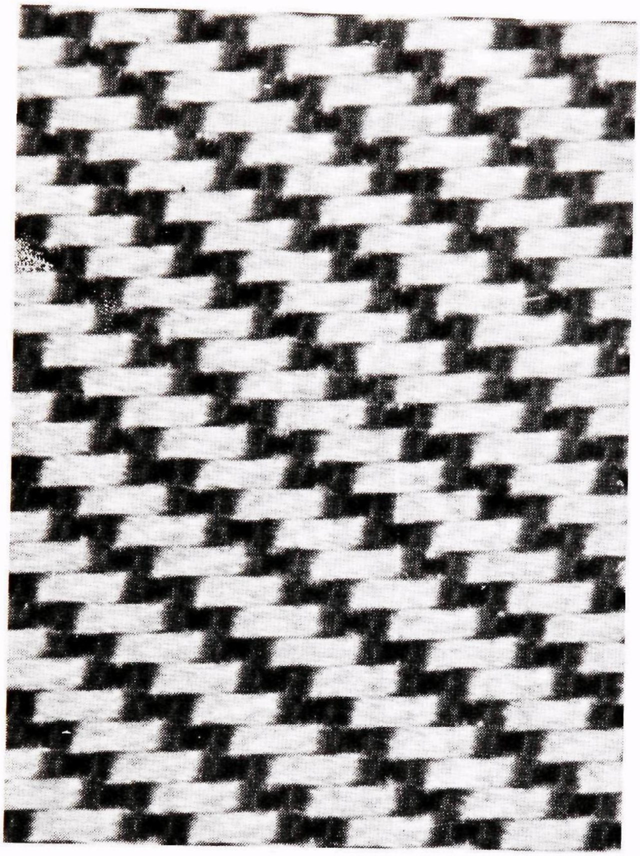


Figure A-14. Surface of Clean Fabric Style 850 (nomex fiber)

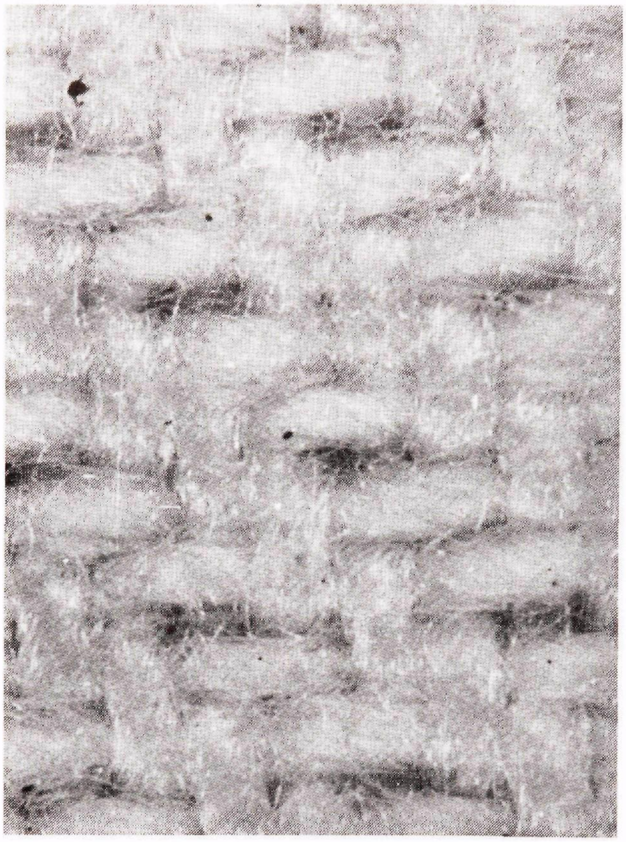


Figure A-15. Surface of Clean Fabric Style 802B (nylon fiber)

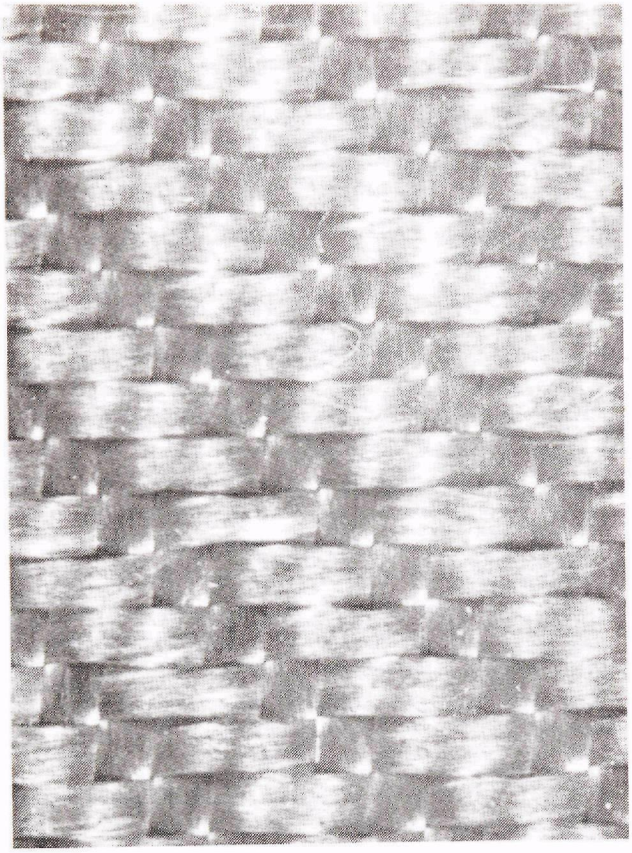


Figure A-16. Surface of Clean Fabric Style Q53-875 (glass fiber)

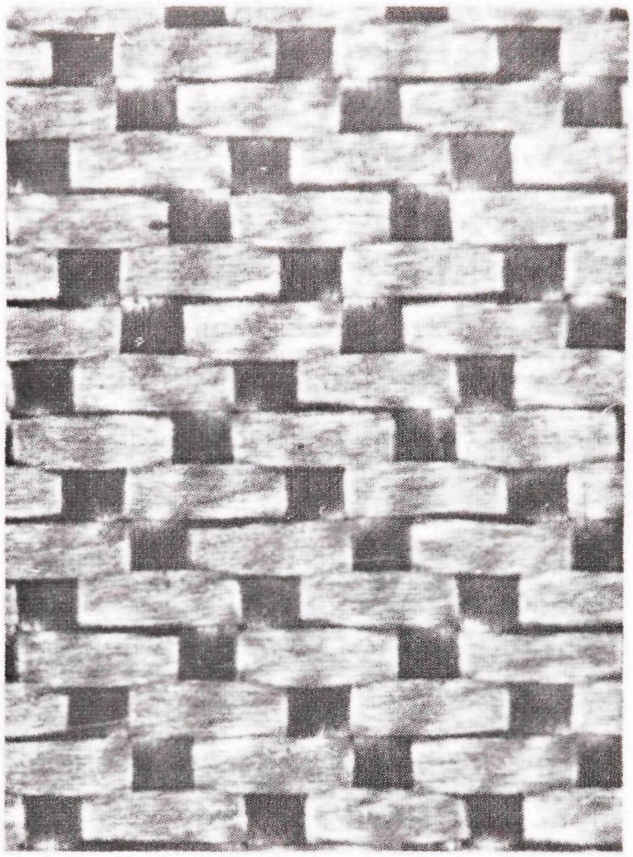


Figure A-17. Surface of Clean Fabric Style Q53-870 (glass fiber)

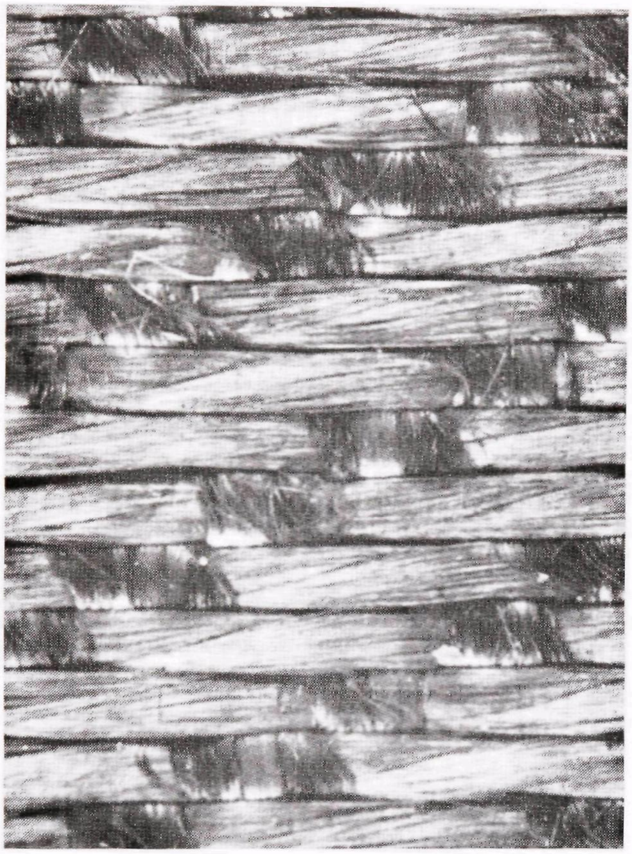


Figure A-18. Surface of Clean Fabric Style Q53-878 (glass fiber)

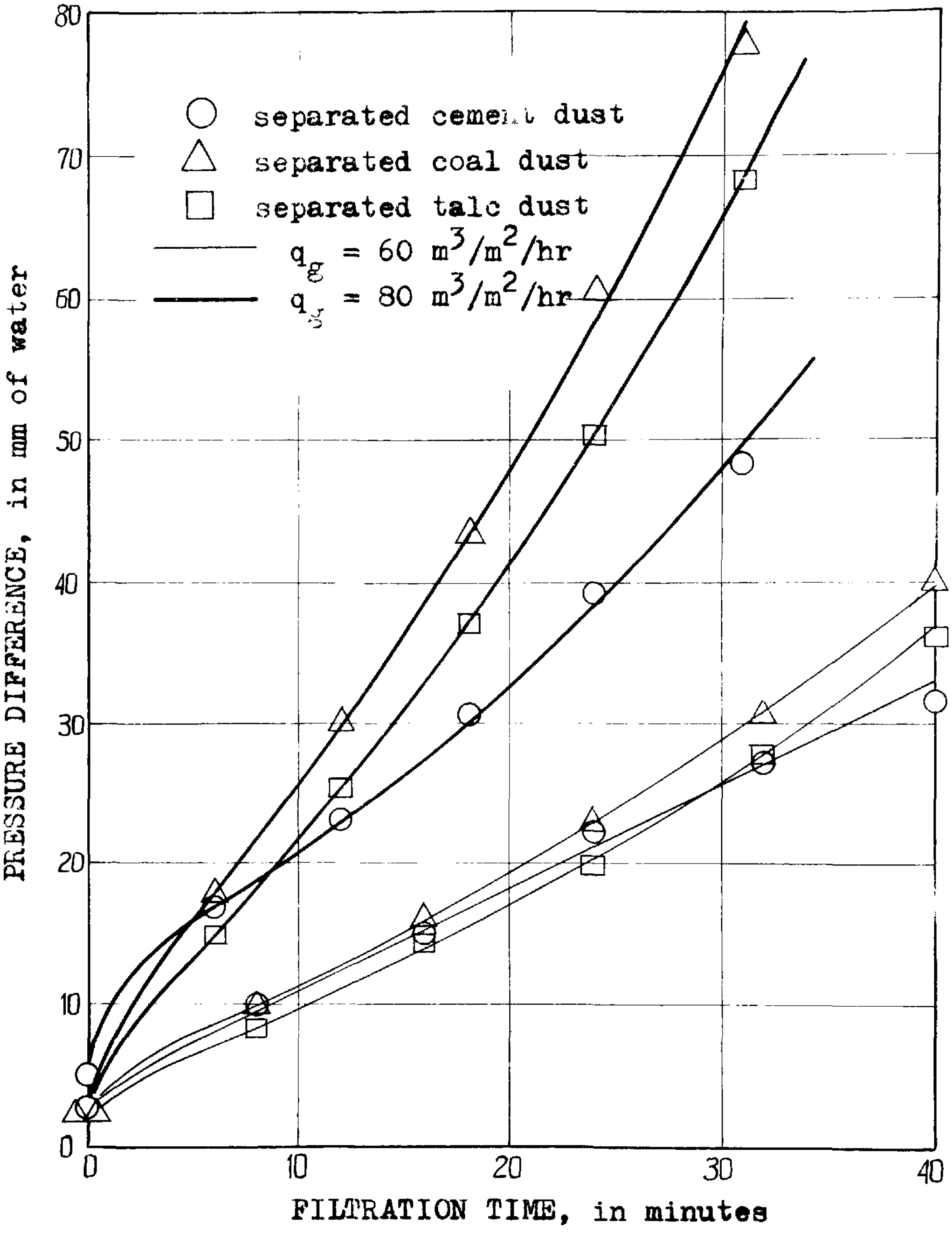


Figure A-19. Pressure Difference vs. Filtration Time for Fabric Style 960.

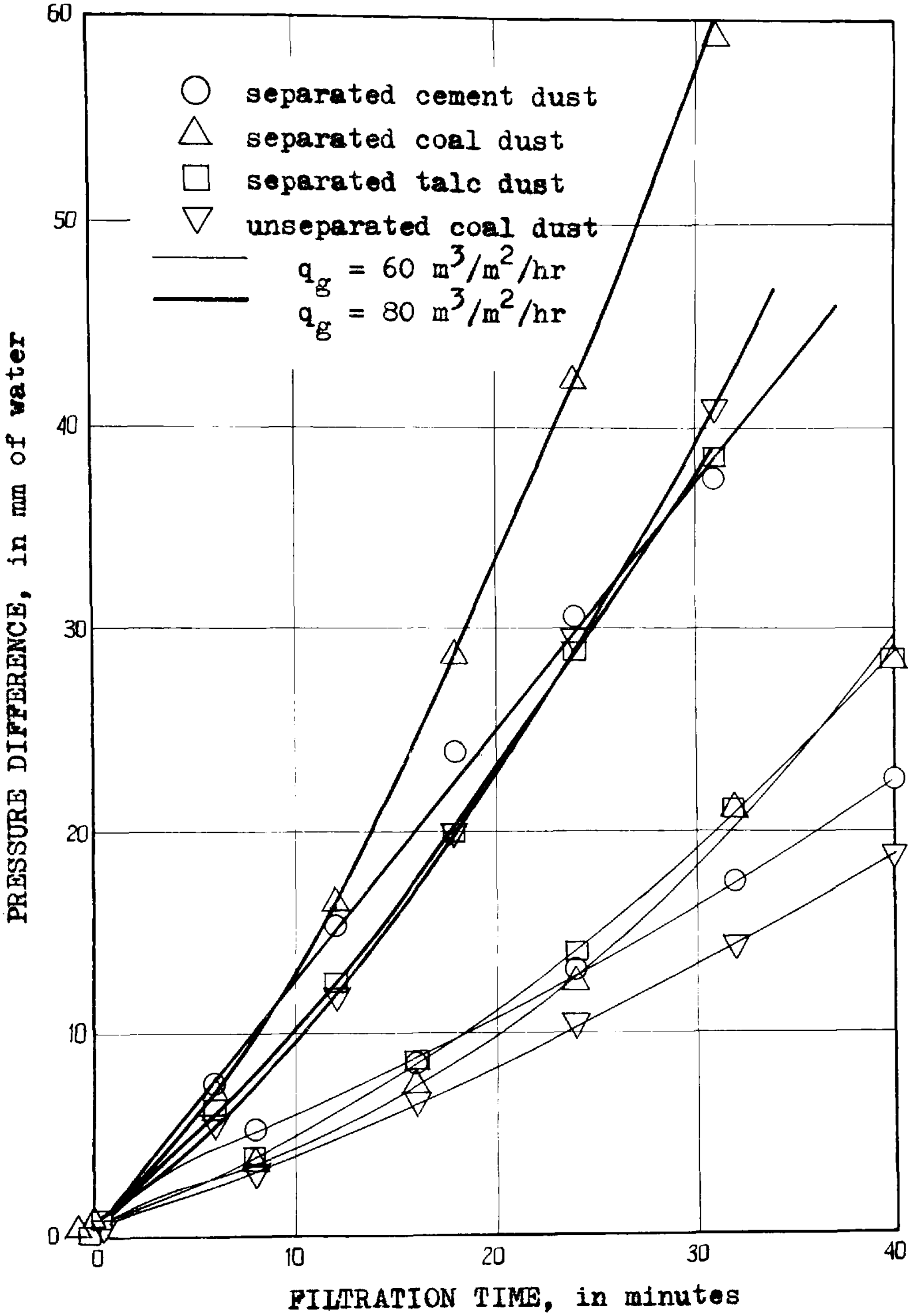


Figure A-20. Pressure Difference vs. Filtration Time for Fabric Style 862B.

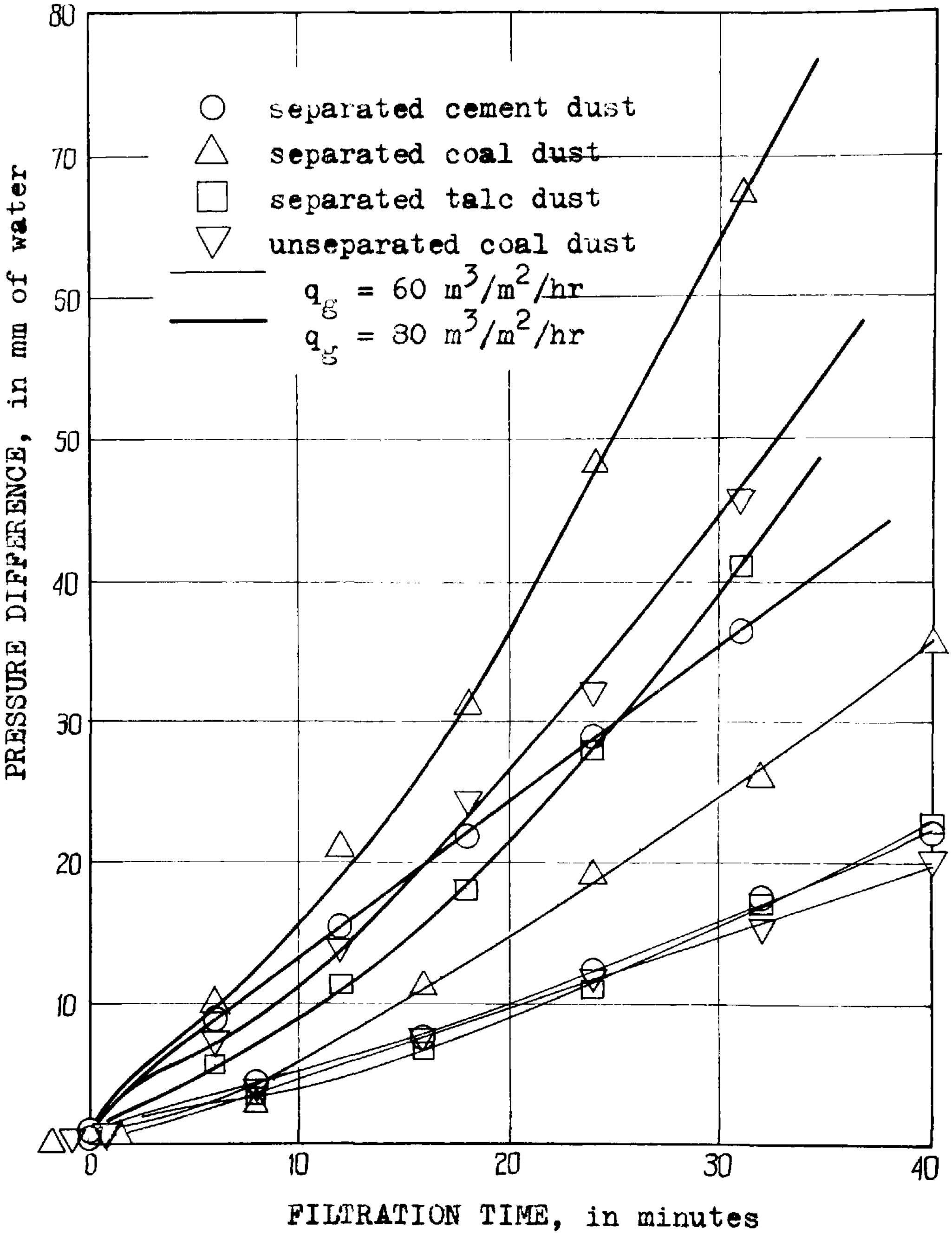


Figure A-21. Pressure Difference vs. Filtration Time for Fabric Style C866B.

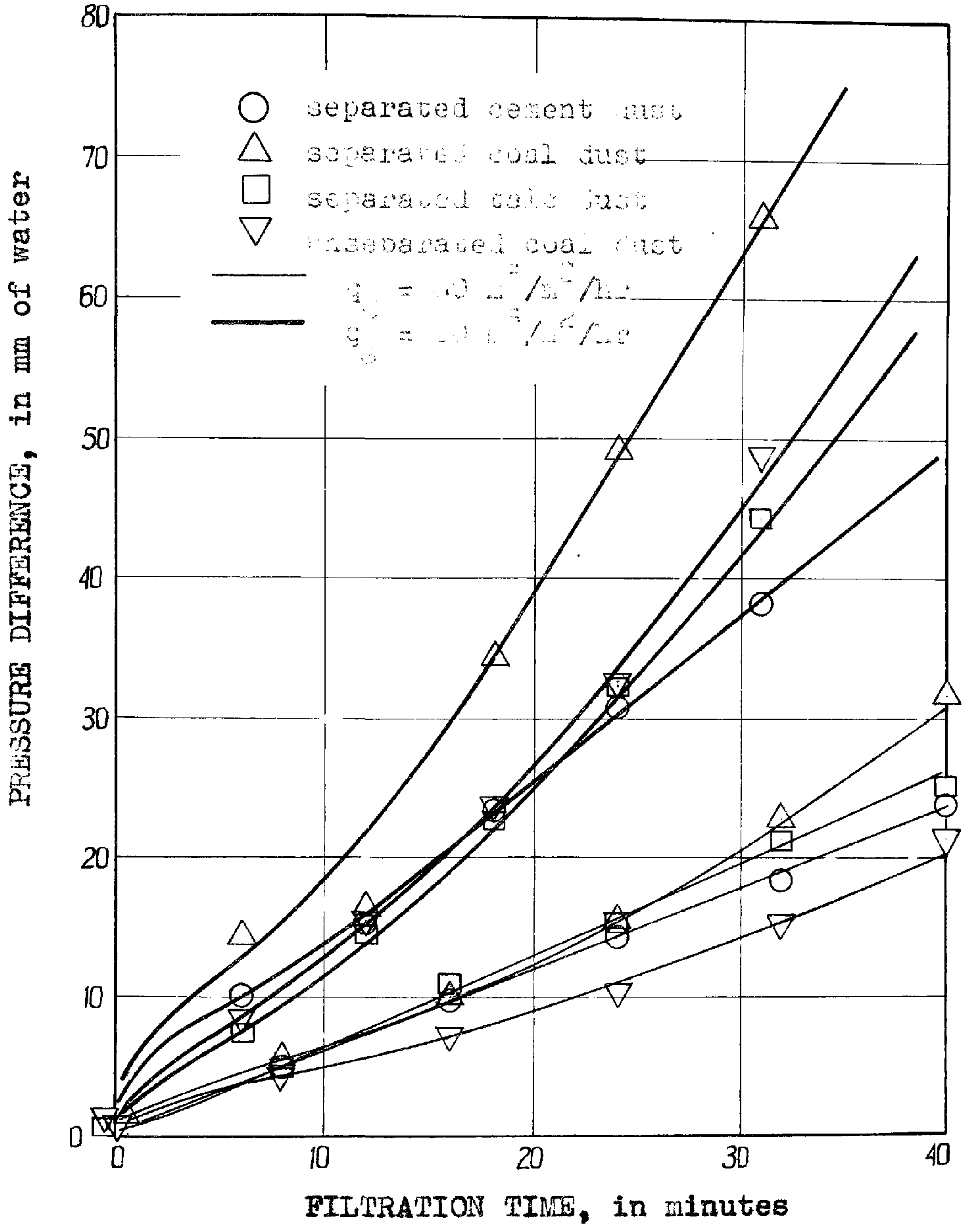


Figure **A-22. Pressure Difference vs. Filtration Time for Fabric Style C868B.**

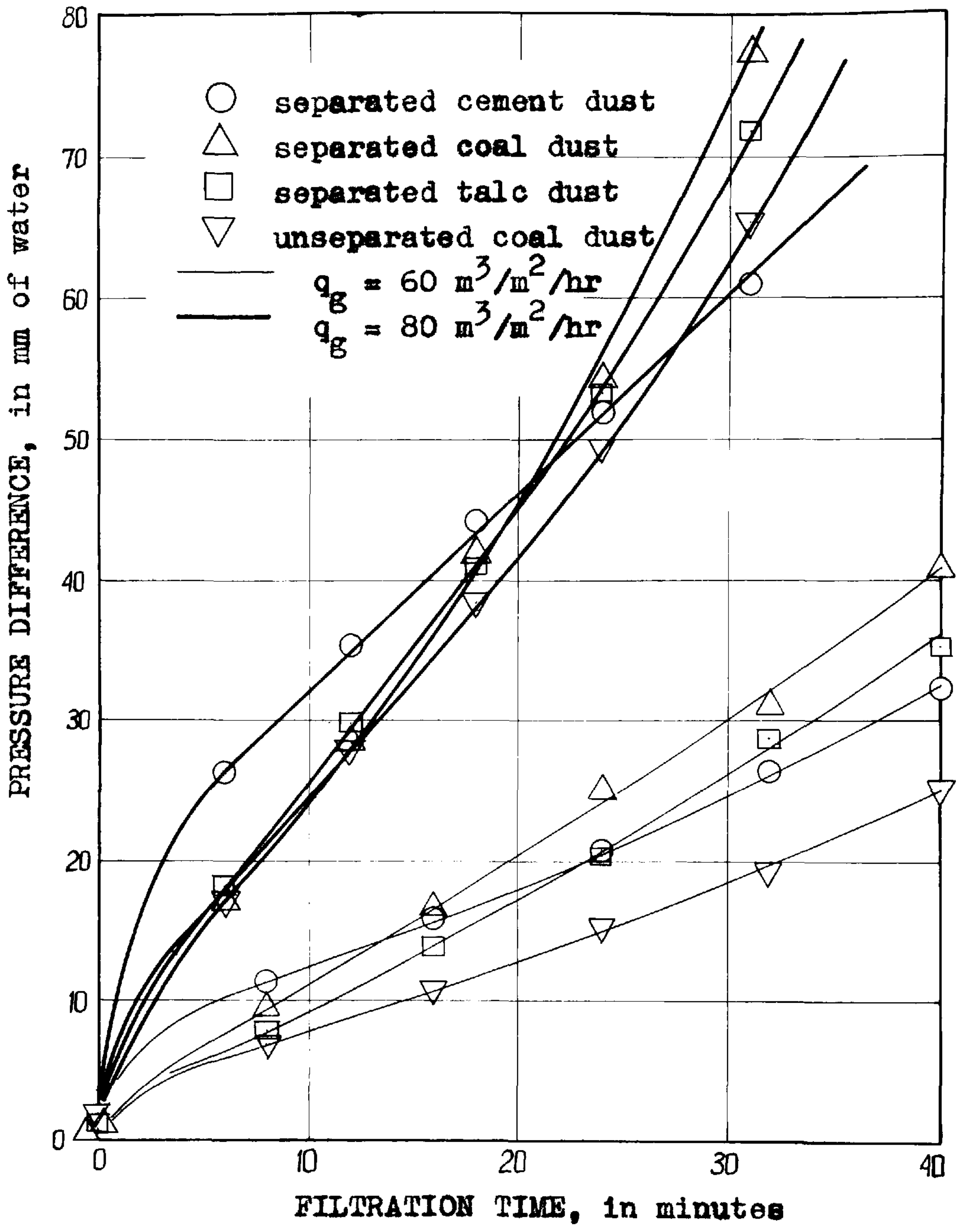


Figure A-23. Pressure Difference vs. Filtration Time for Fabric Style 865B.

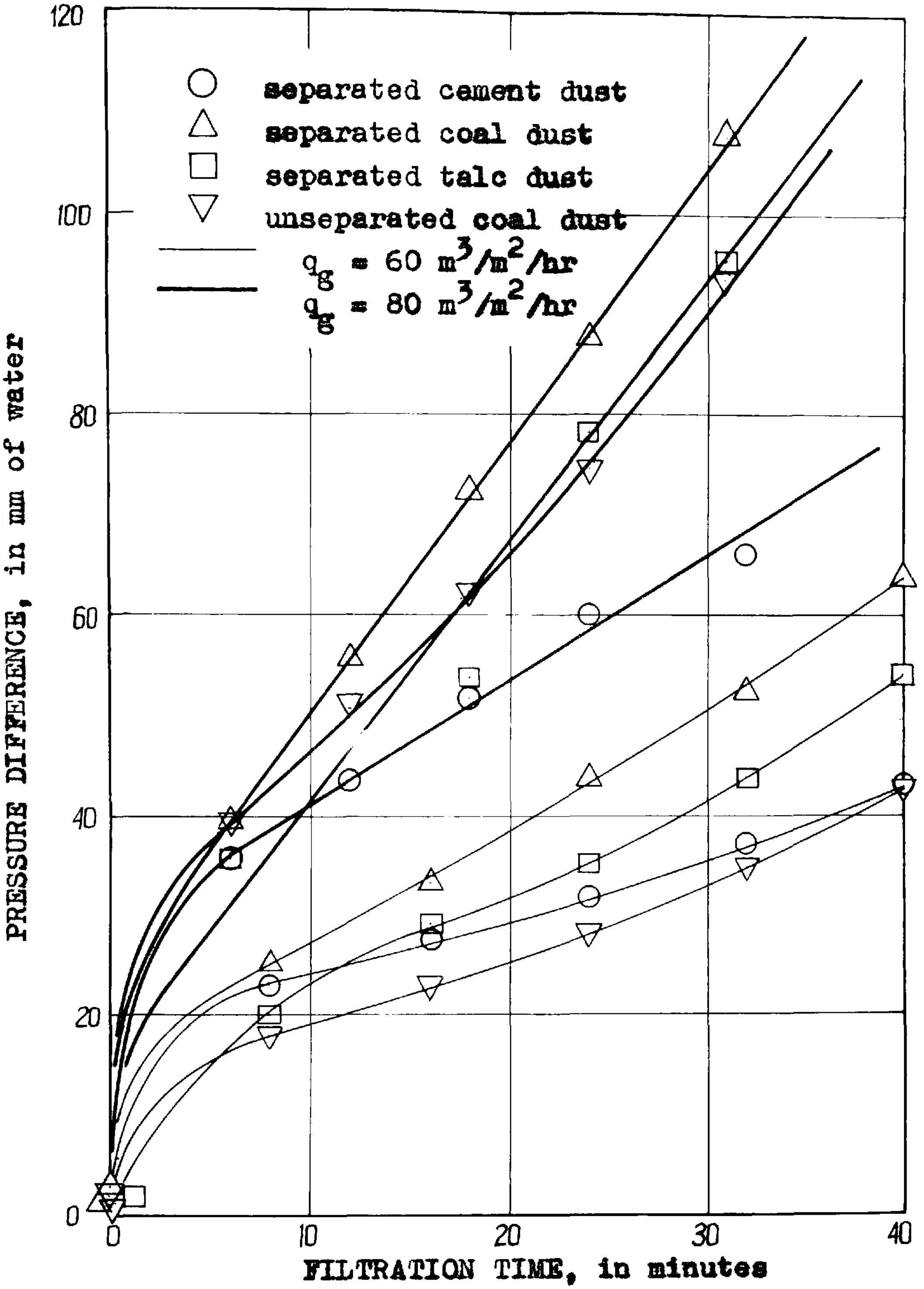


Figure A-24. Pressure Difference vs. Filtration Time for Fabric Style C890B.

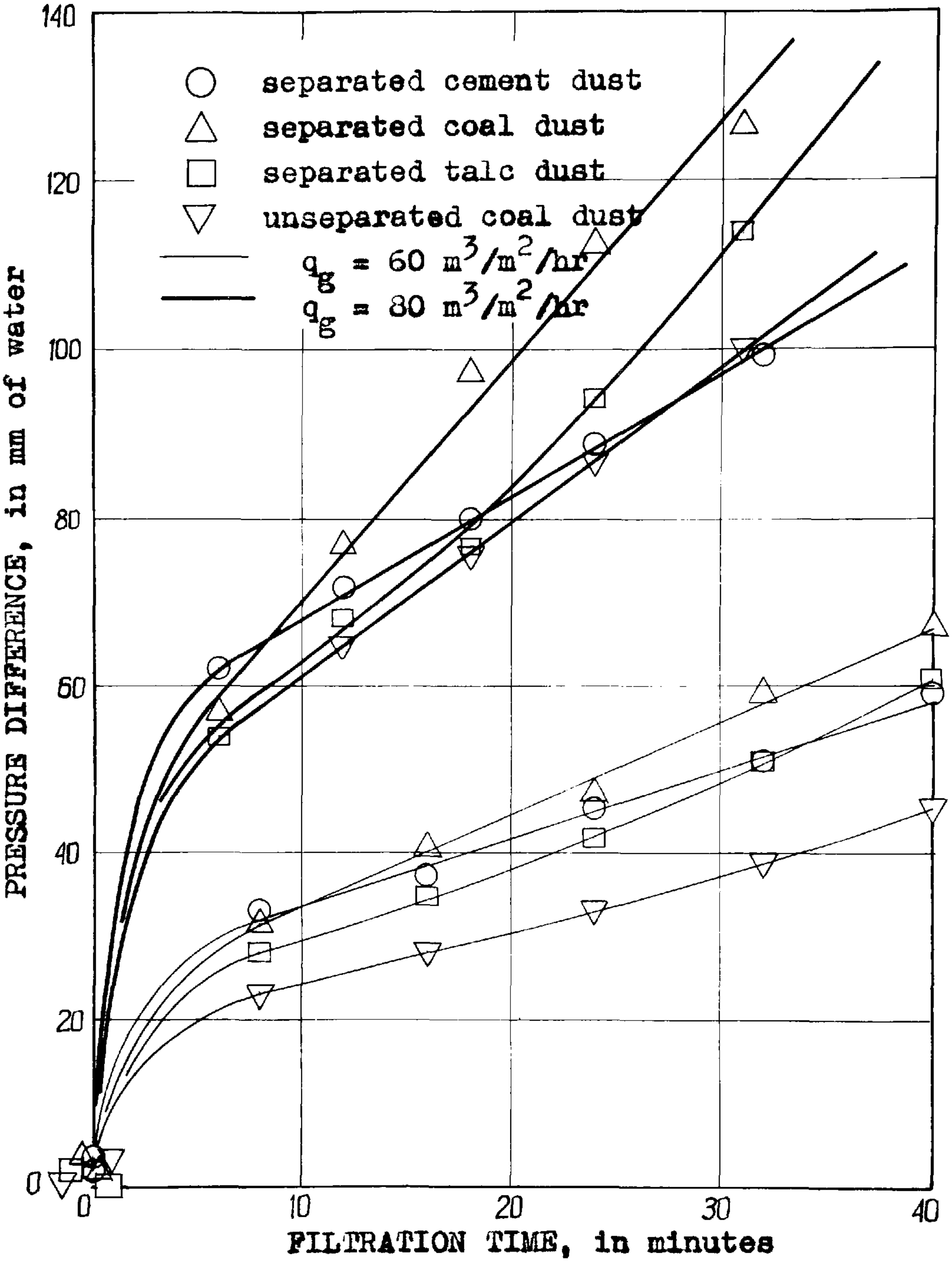


Figure A-25. Pressure Difference vs. Filtration Time for Fabric Style C892B.

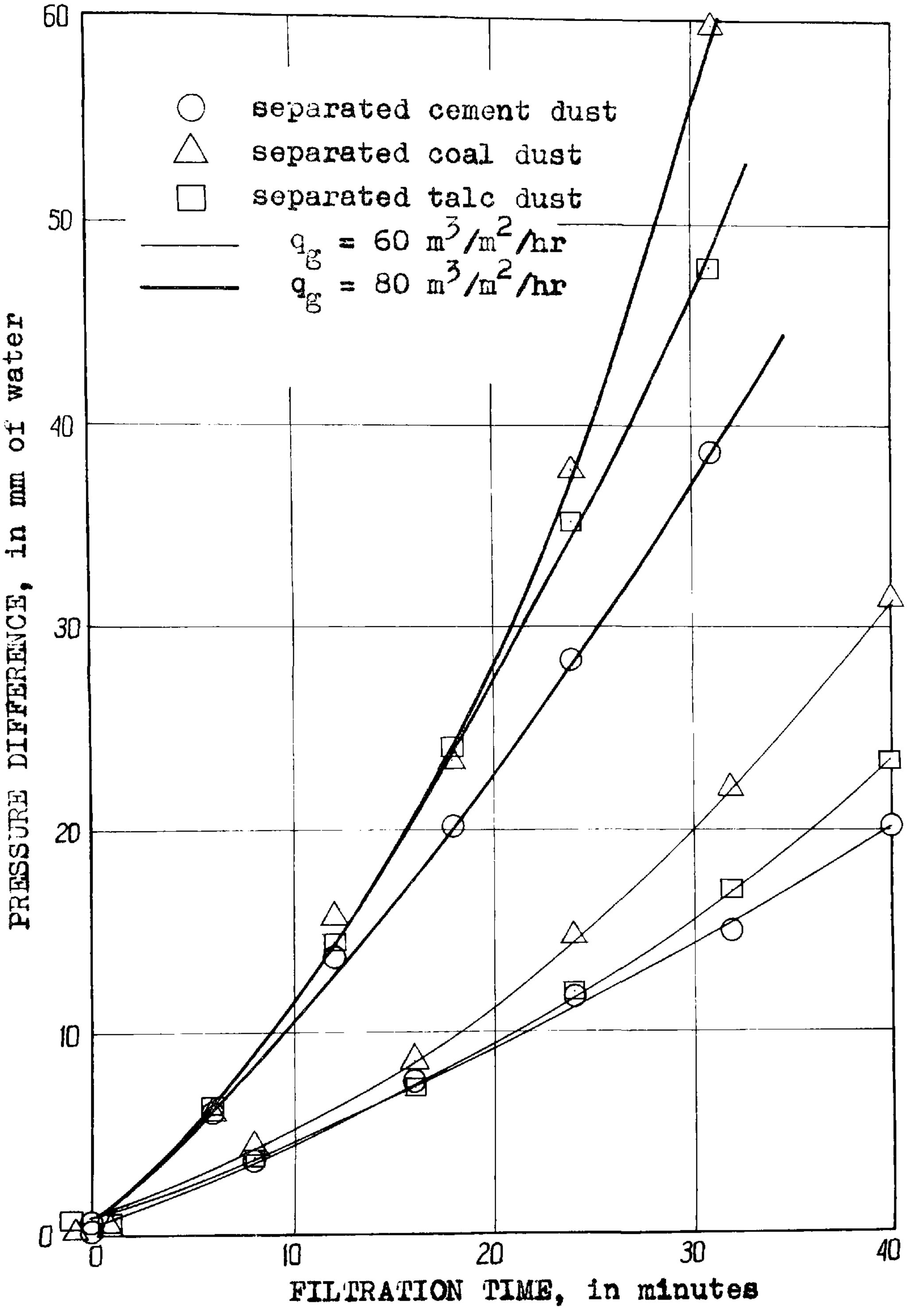


Figure A-26. Pressure Difference vs. Filtration Time for Fabric Style 852.

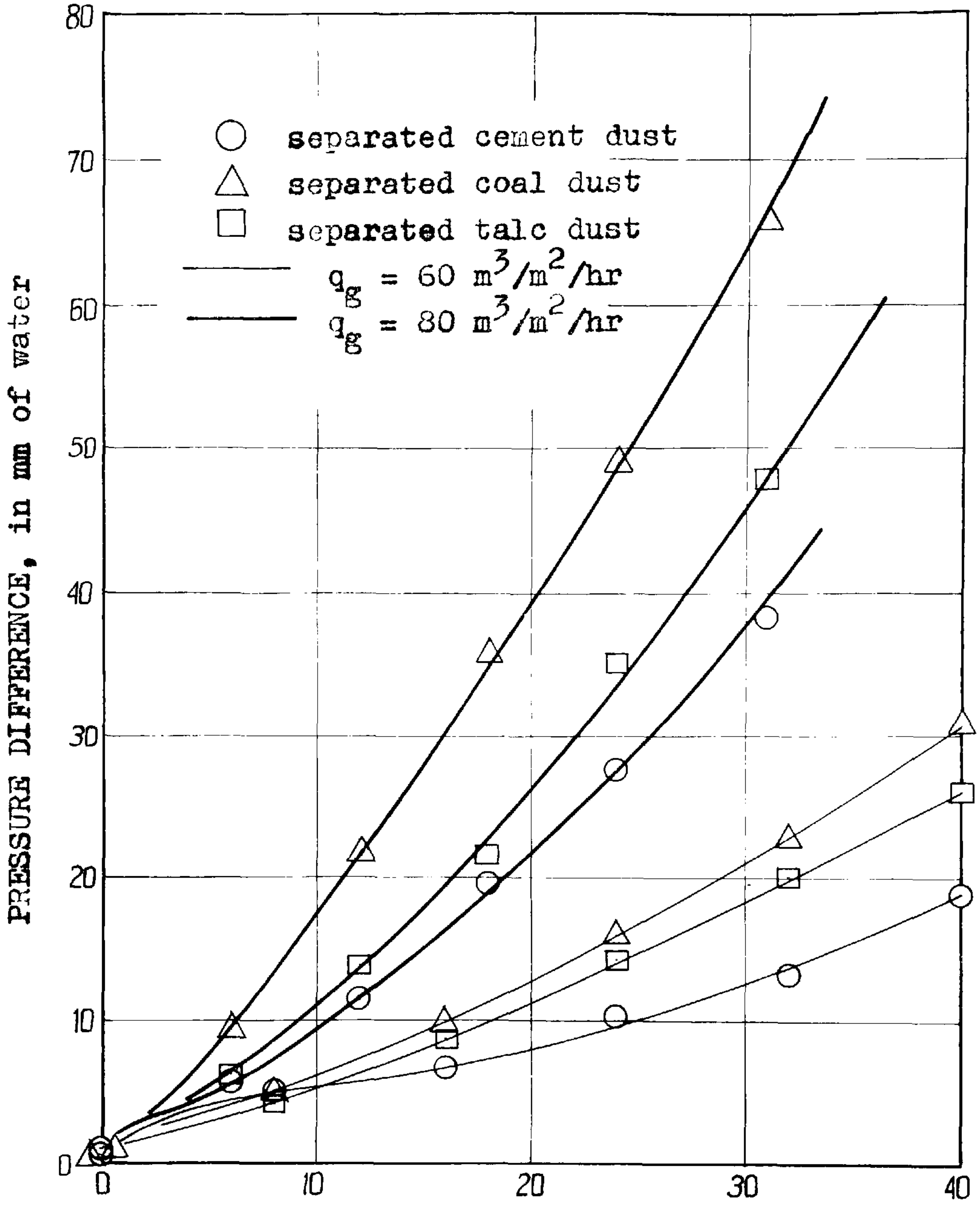


Figure A-27. Pressure Difference vs. Filtration Time for Fabric Style 853.

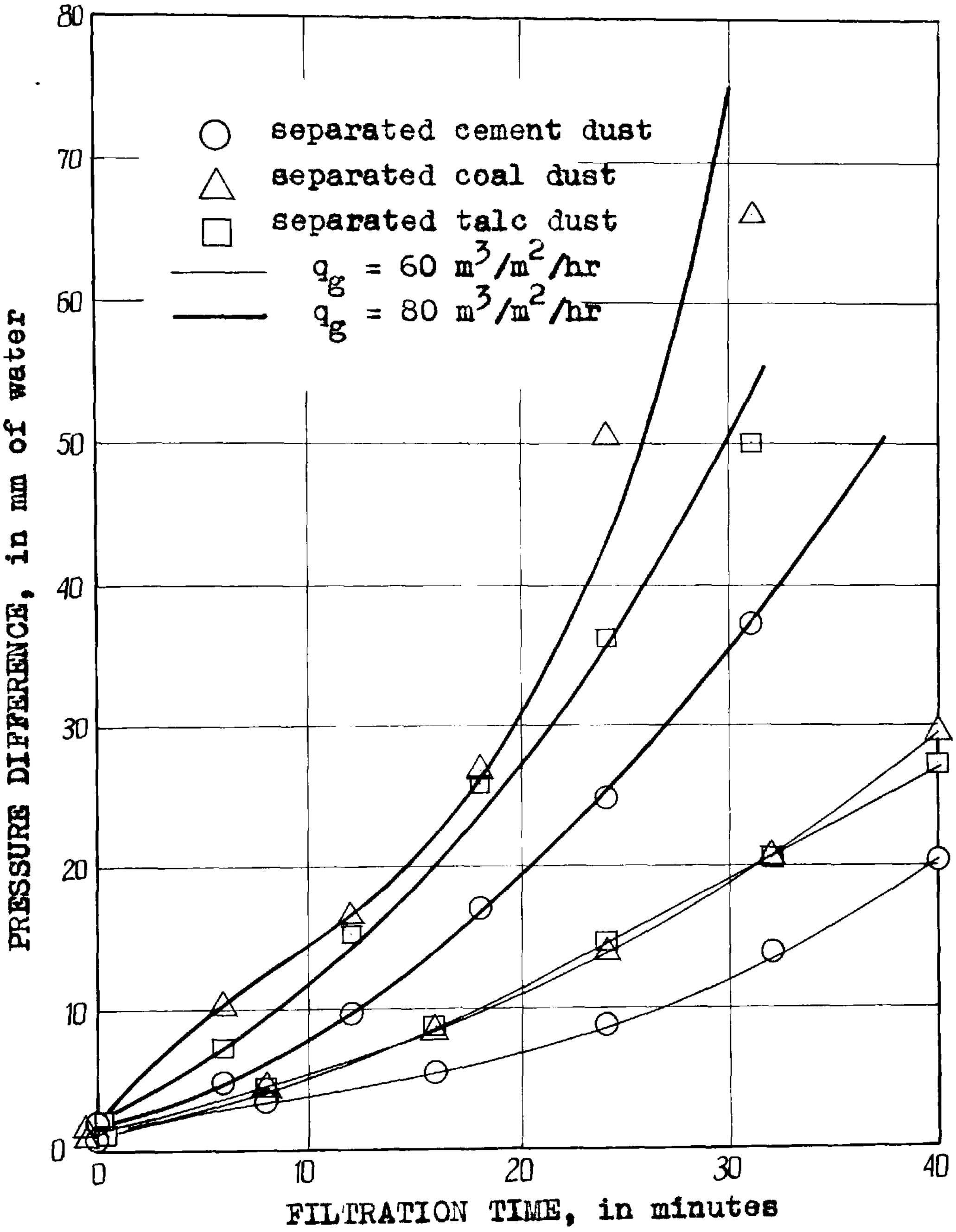


Figure A-28. Pressure Difference vs. Filtration Time for Fabric Style 190.

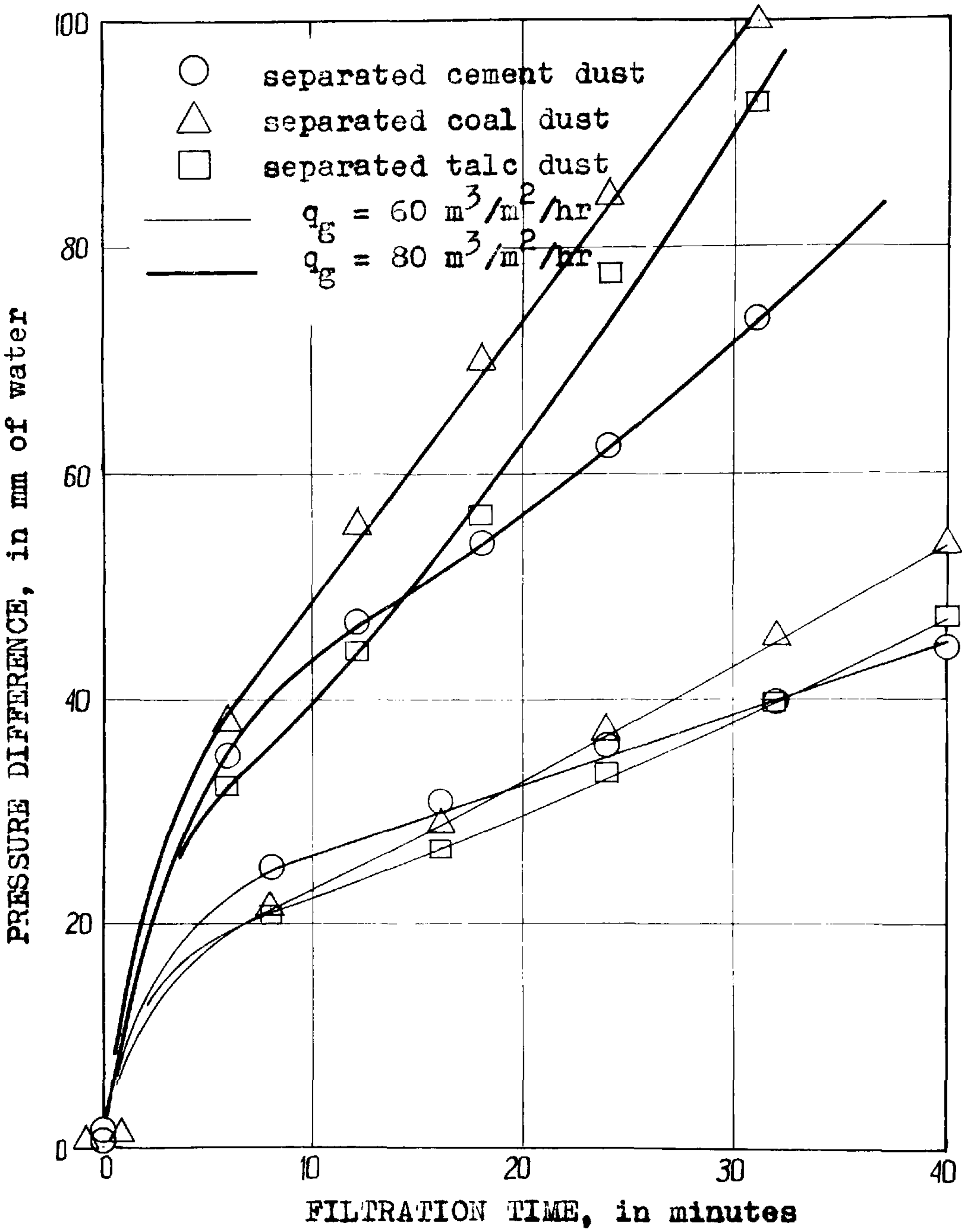


Figure A-29. Pressure Difference vs. Filtration Time for Fabric Style 850.

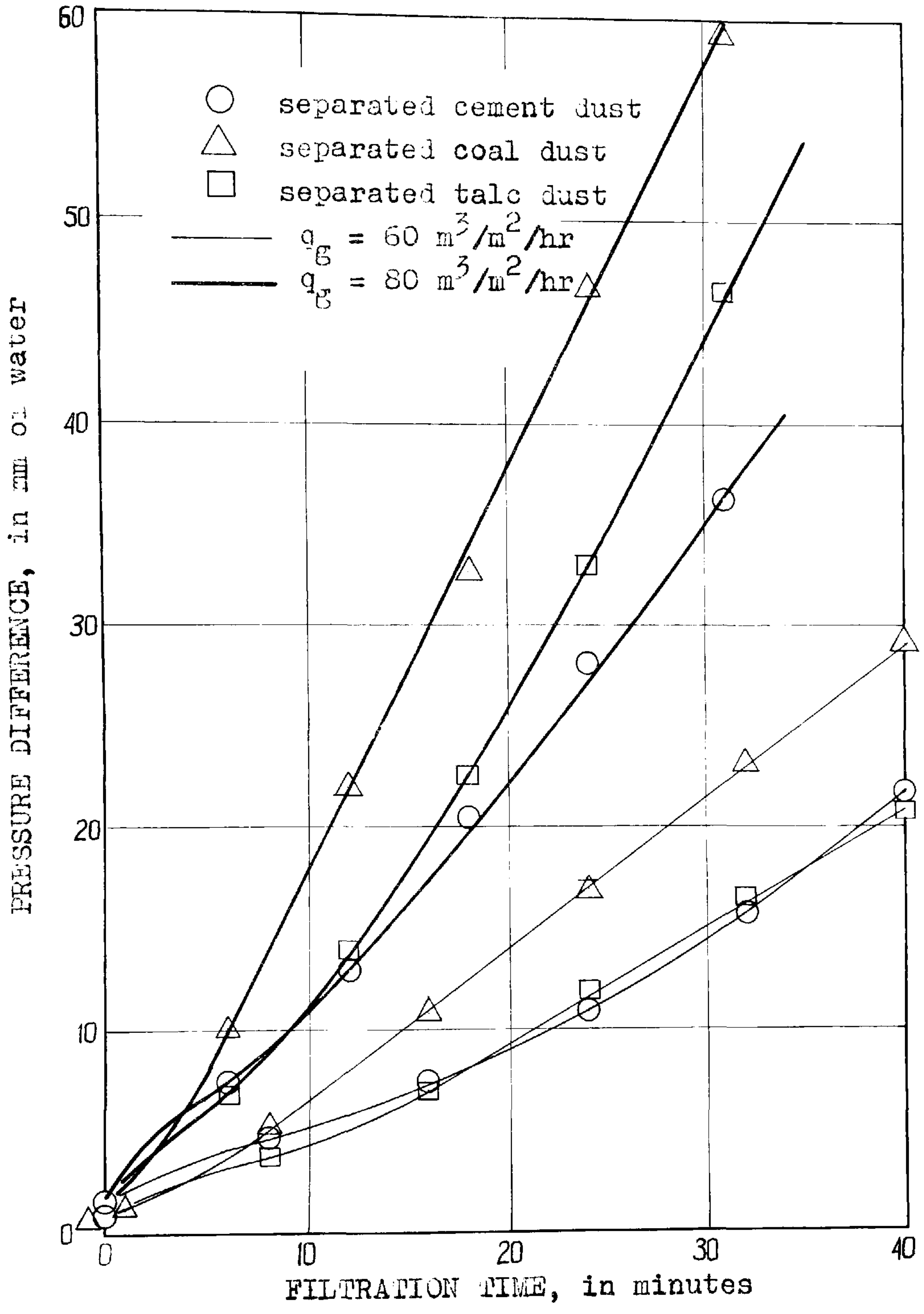


Figure A-30. Pressure Difference vs. Filtration Time for Fabric Style 802B.

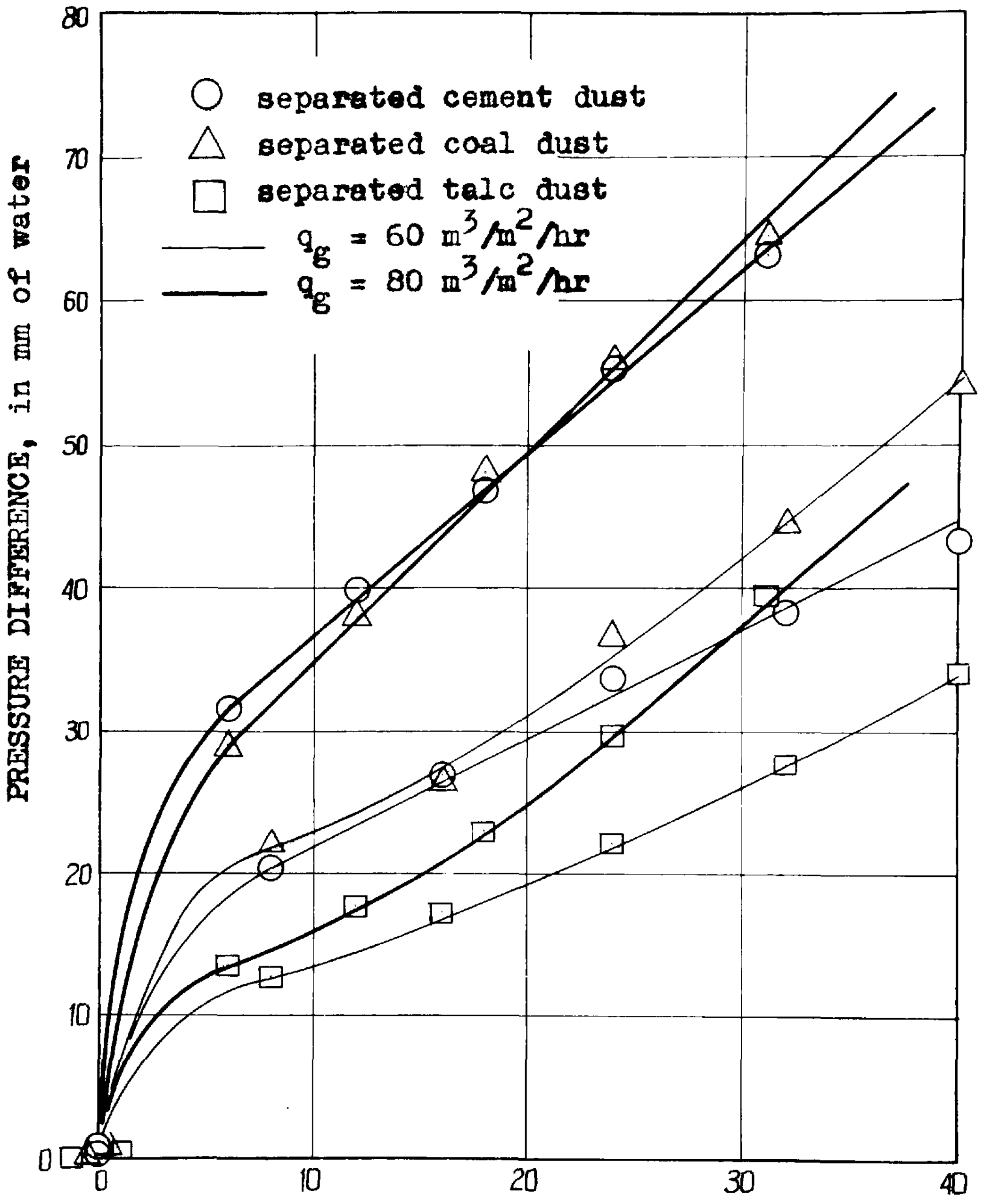


Figure A-31. Pressure Difference vs. Filtration Time for Fabric Style Q53-875.

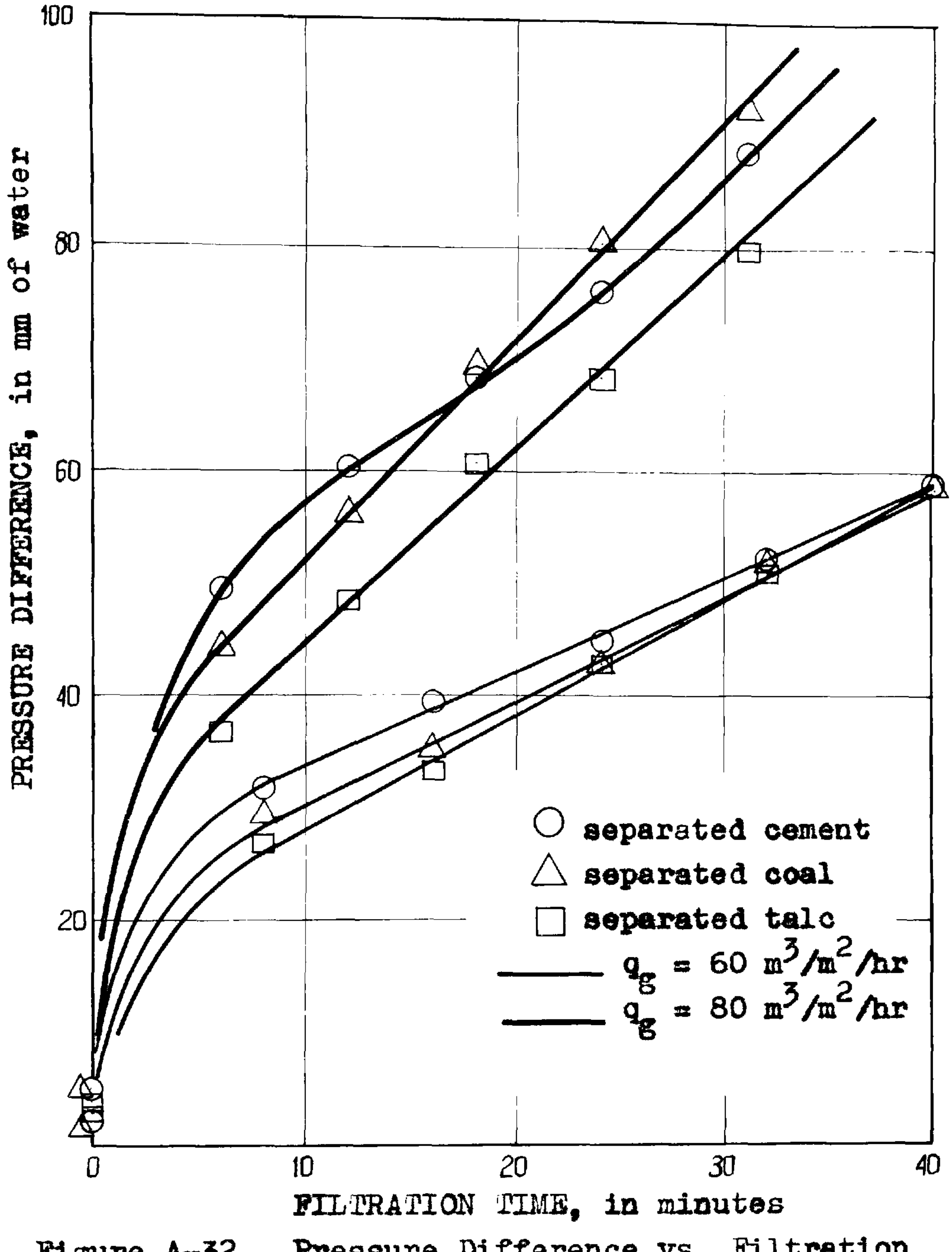


Figure A-32. Pressure Difference vs. Filtration Time for Fabric Style Q 53-870.

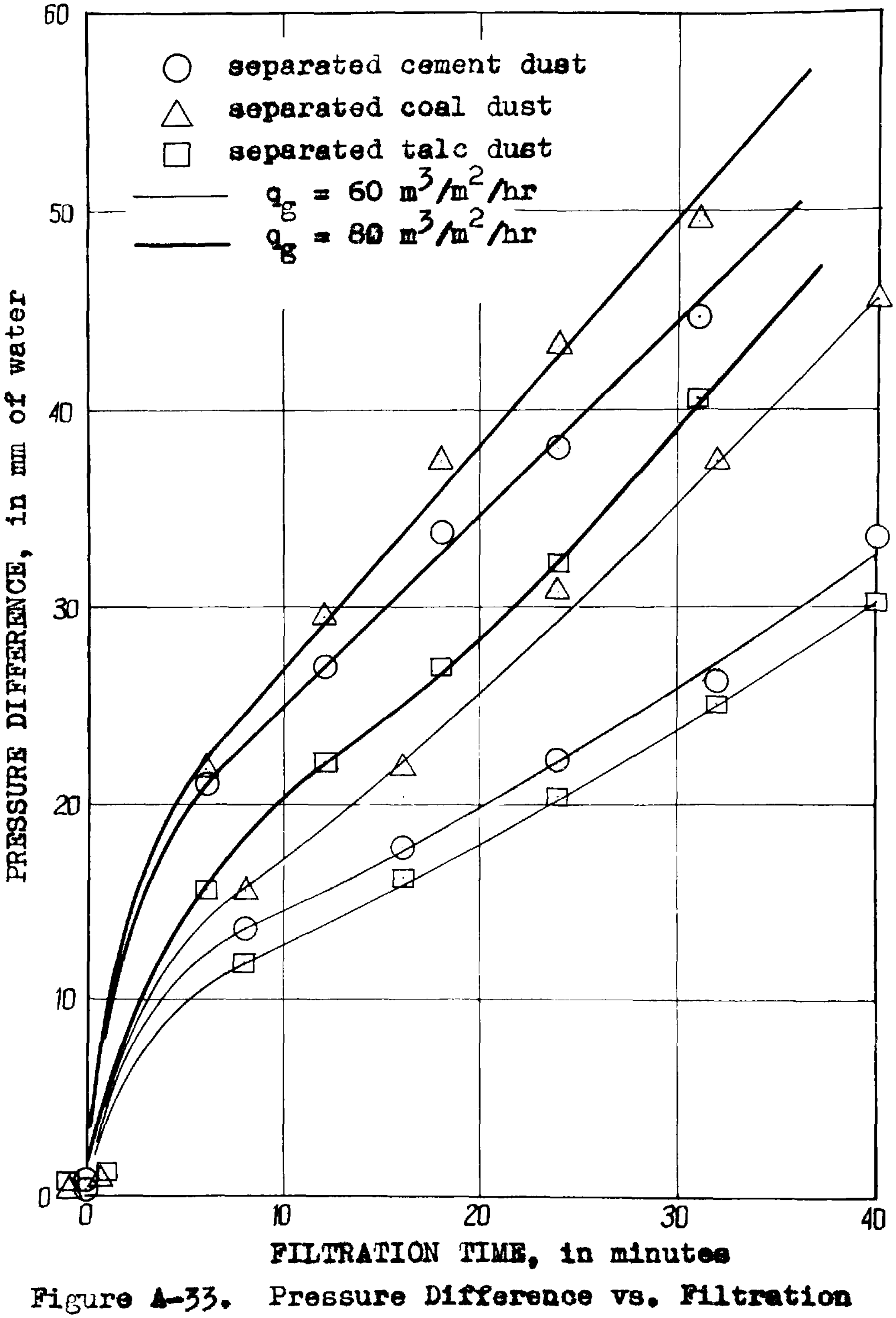


Figure A-33. Pressure Difference vs. Filtration Time for Fabric Style Q 53-878.

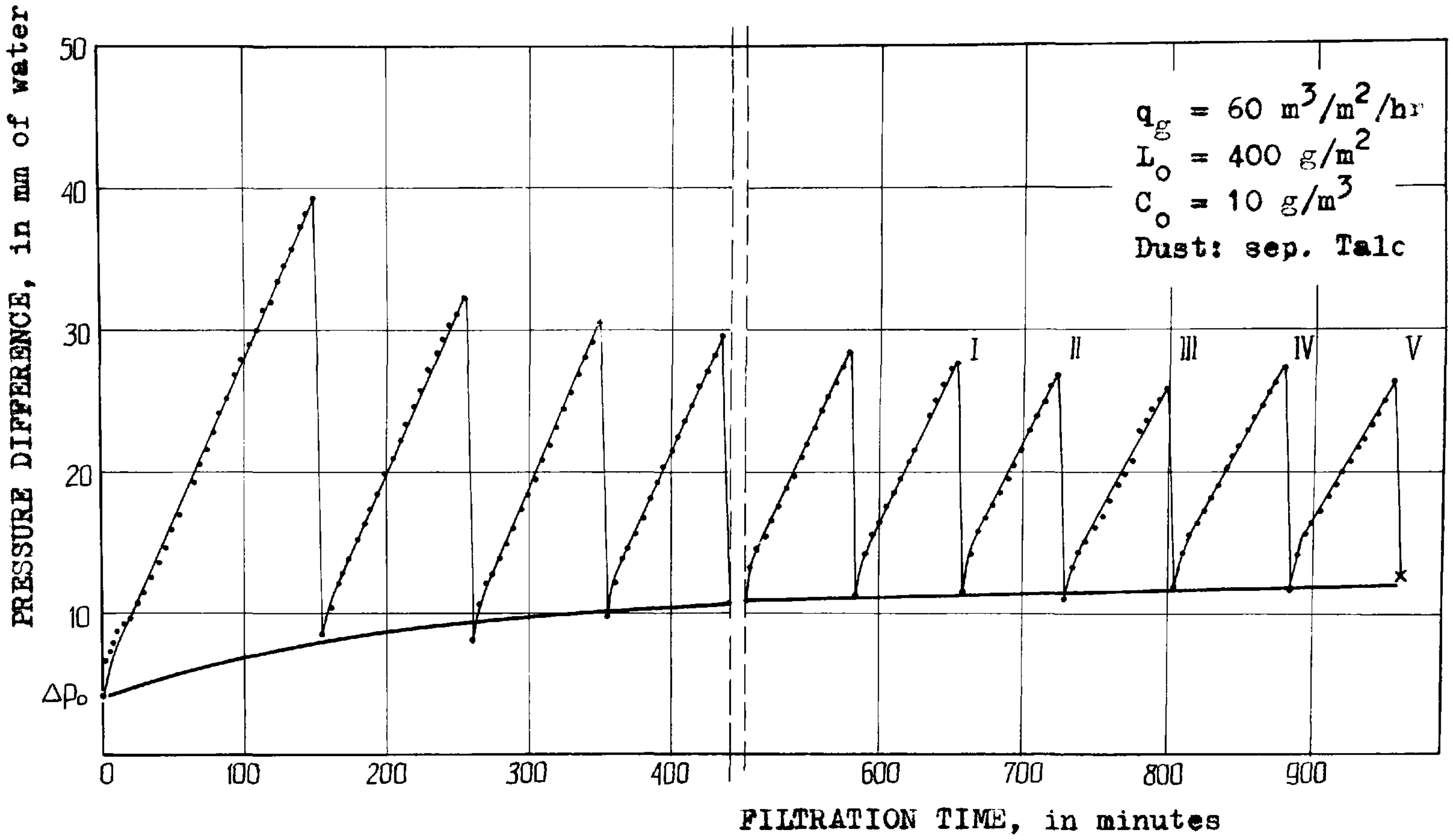


Figure A-34. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 960.

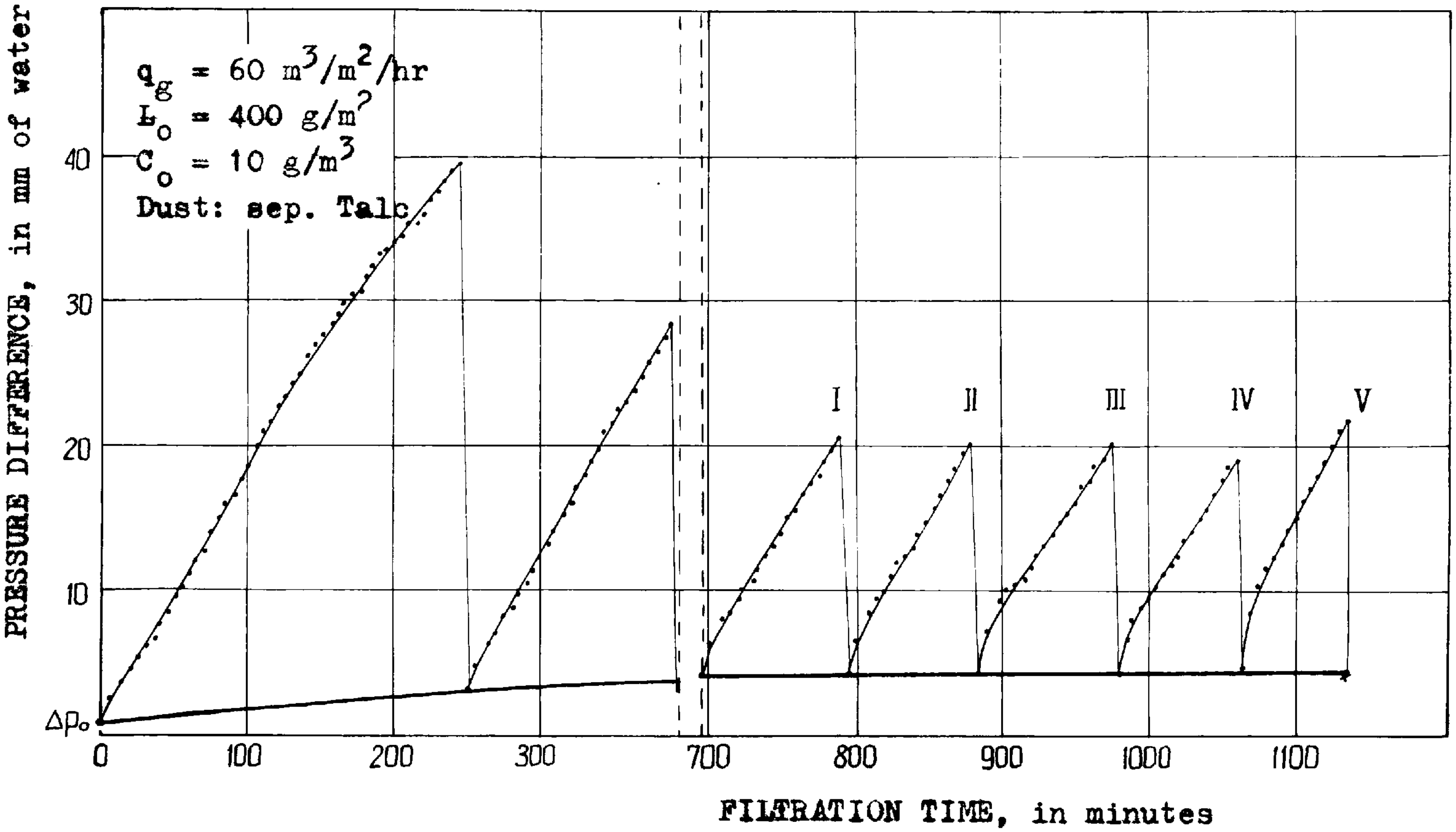


Figure A-35. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 862B

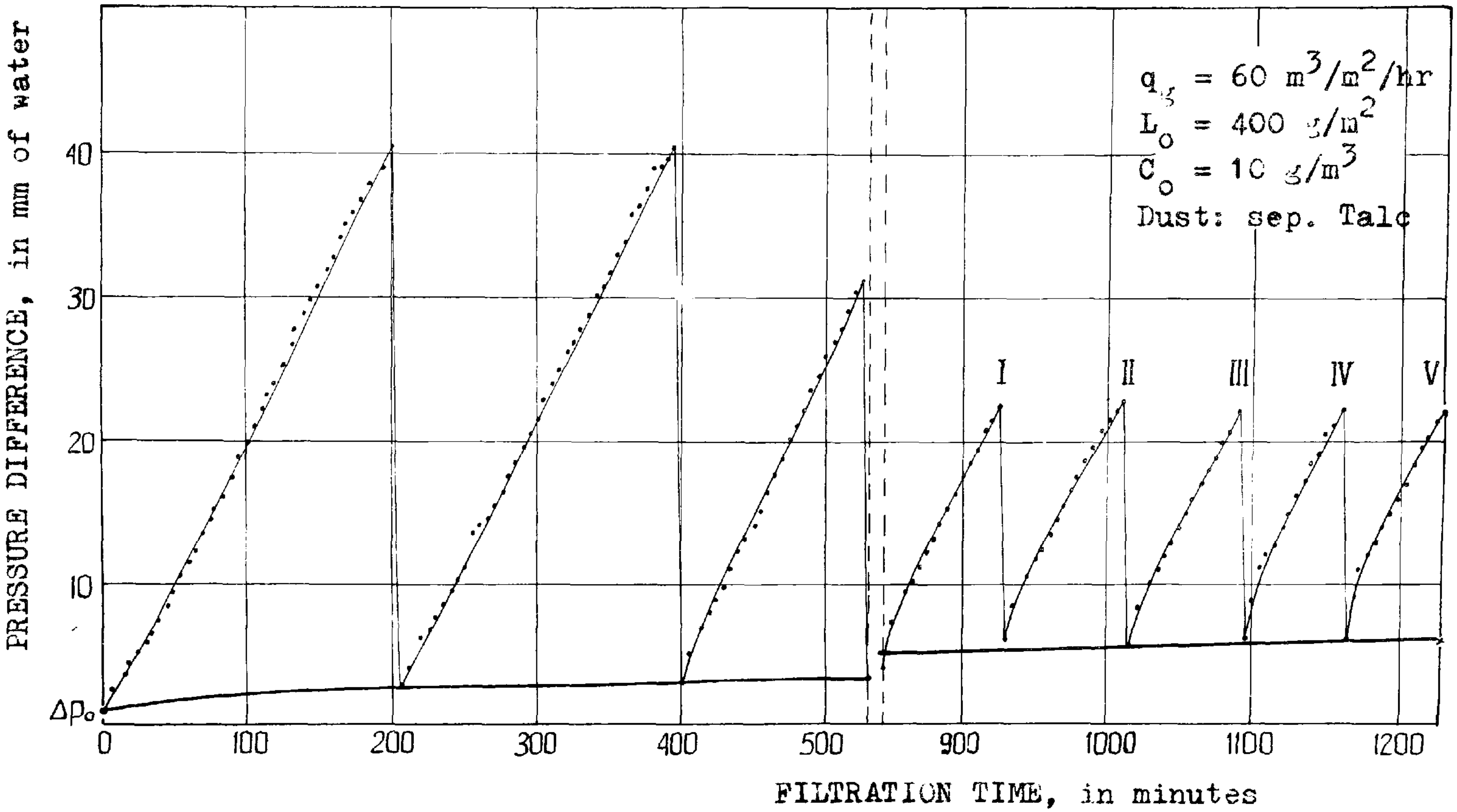


Figure A-36. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C866B.

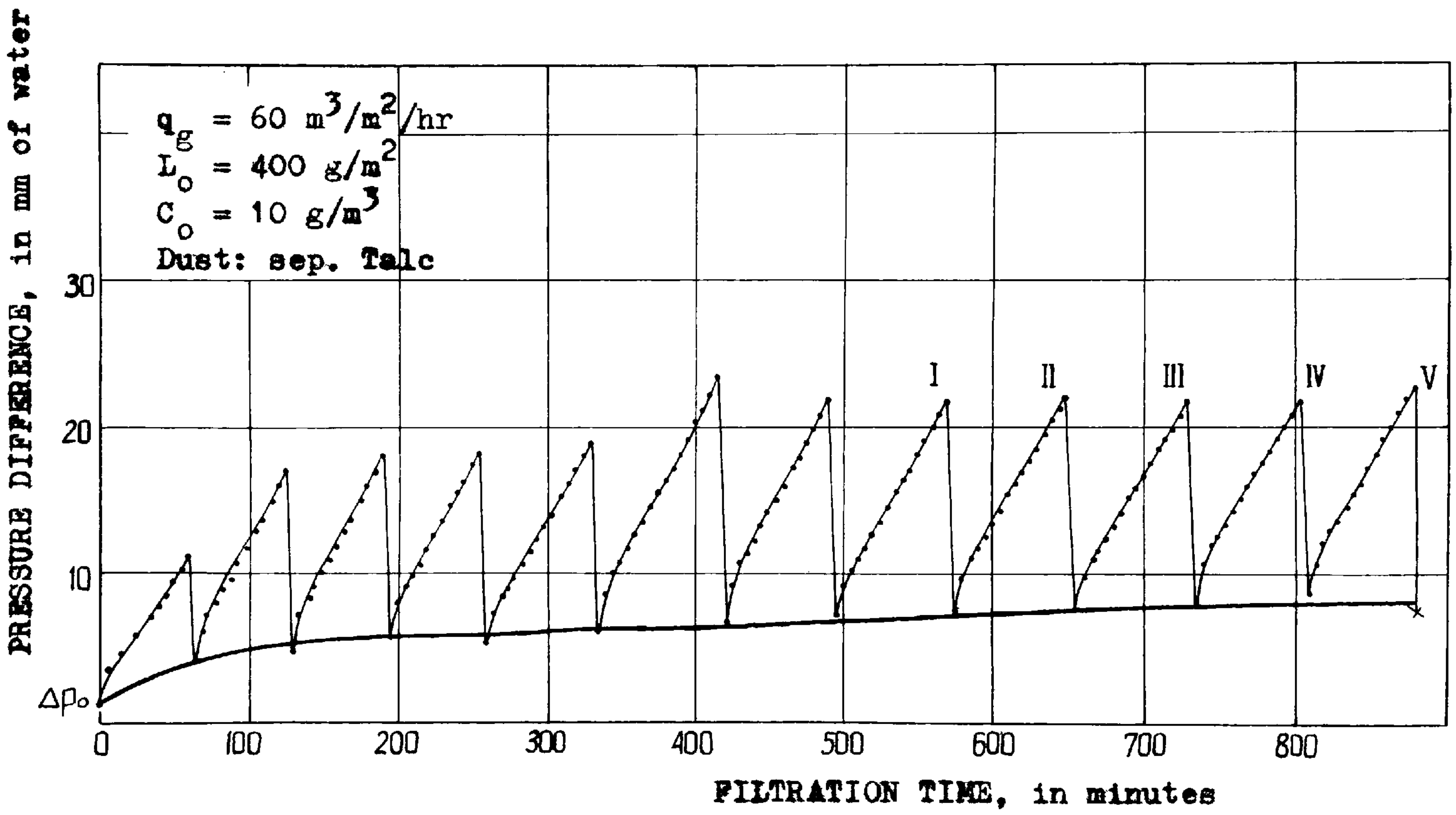


Figure A-37. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C868B.

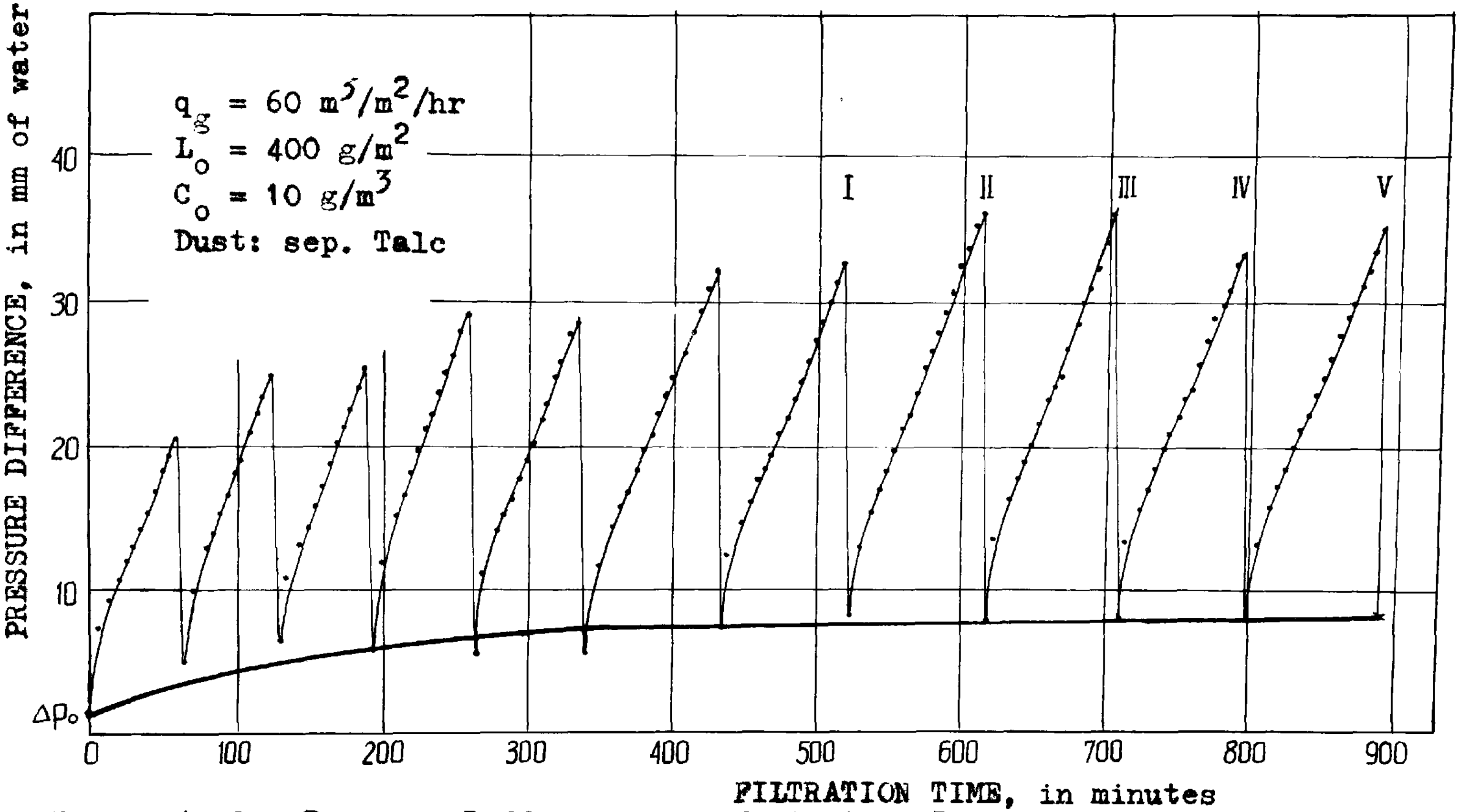


Figure A-38. Pressure Difference vs. Filtration Time for Large-Scale testing of Fabric 865B

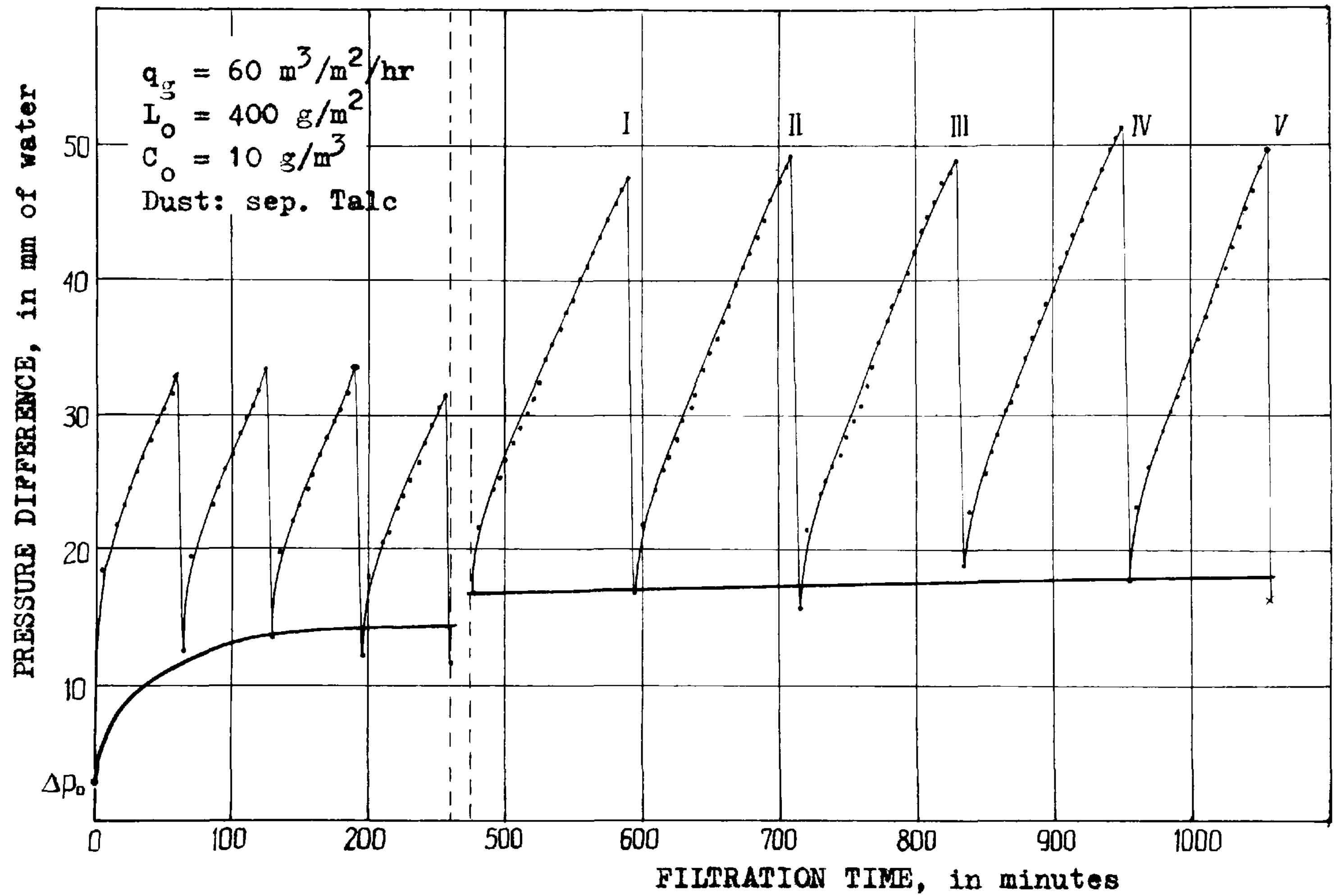


Figure A-39. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C890B.

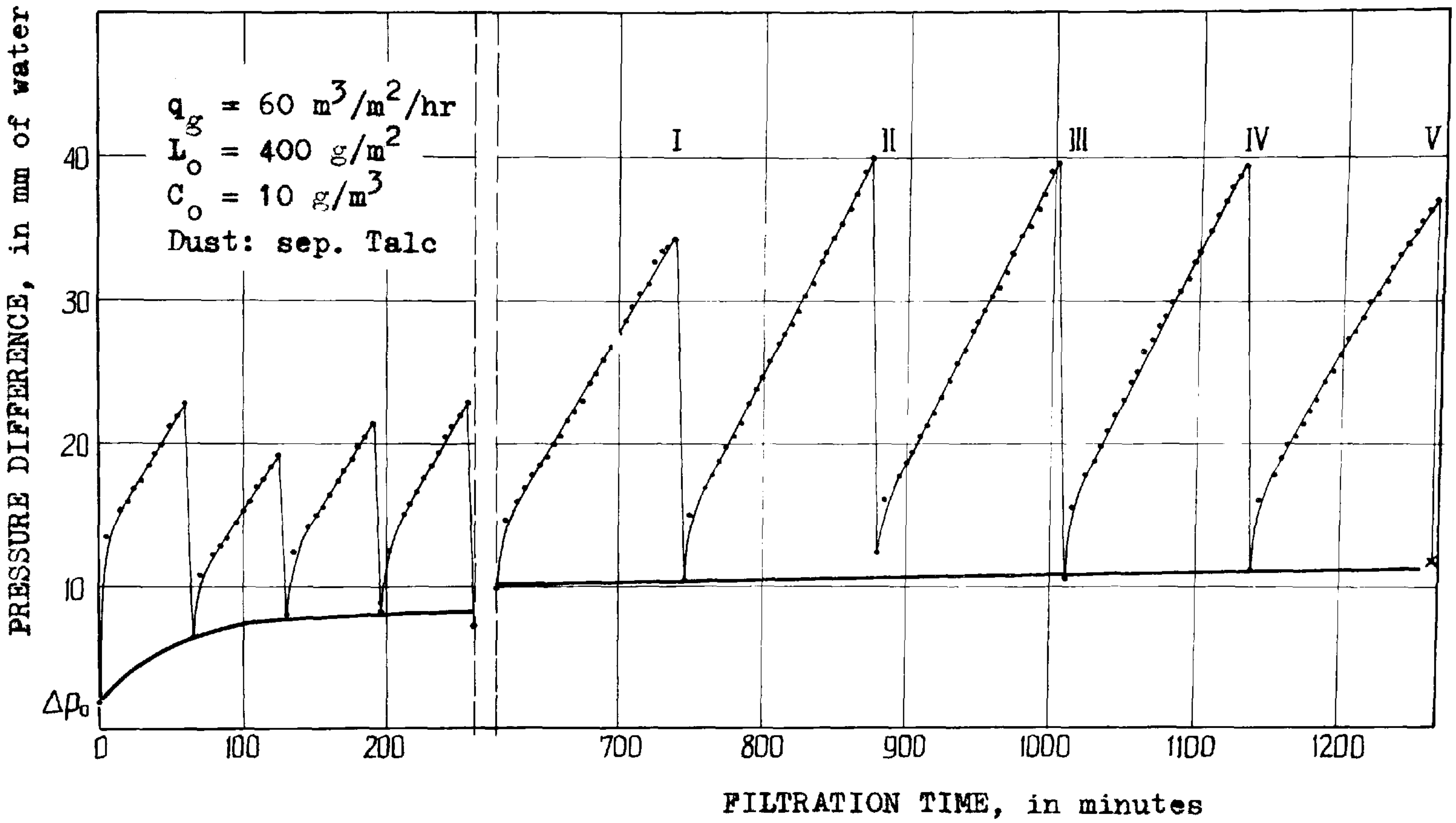


Figure A-40. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C892B.

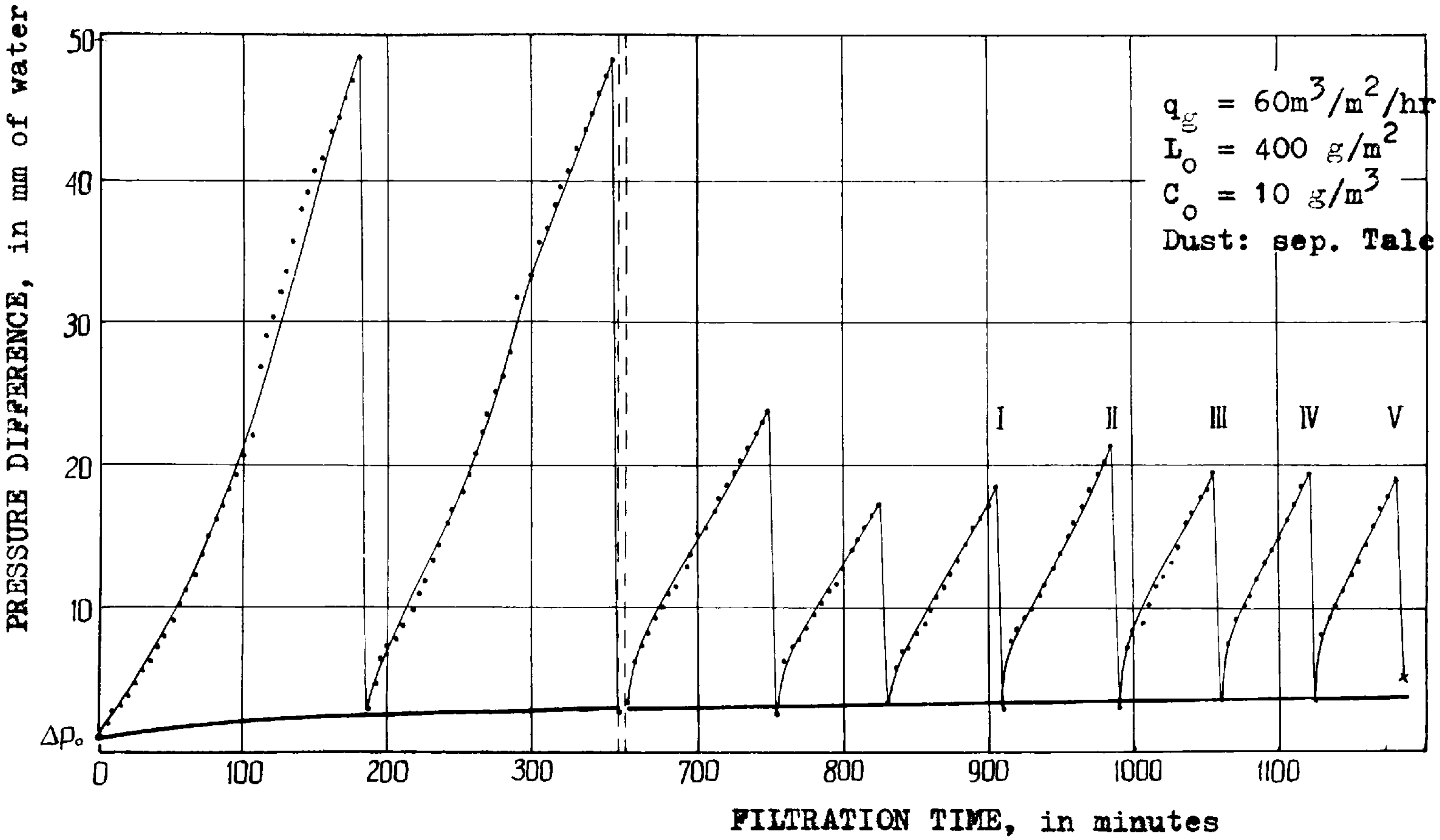


Figure A-41. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 852.

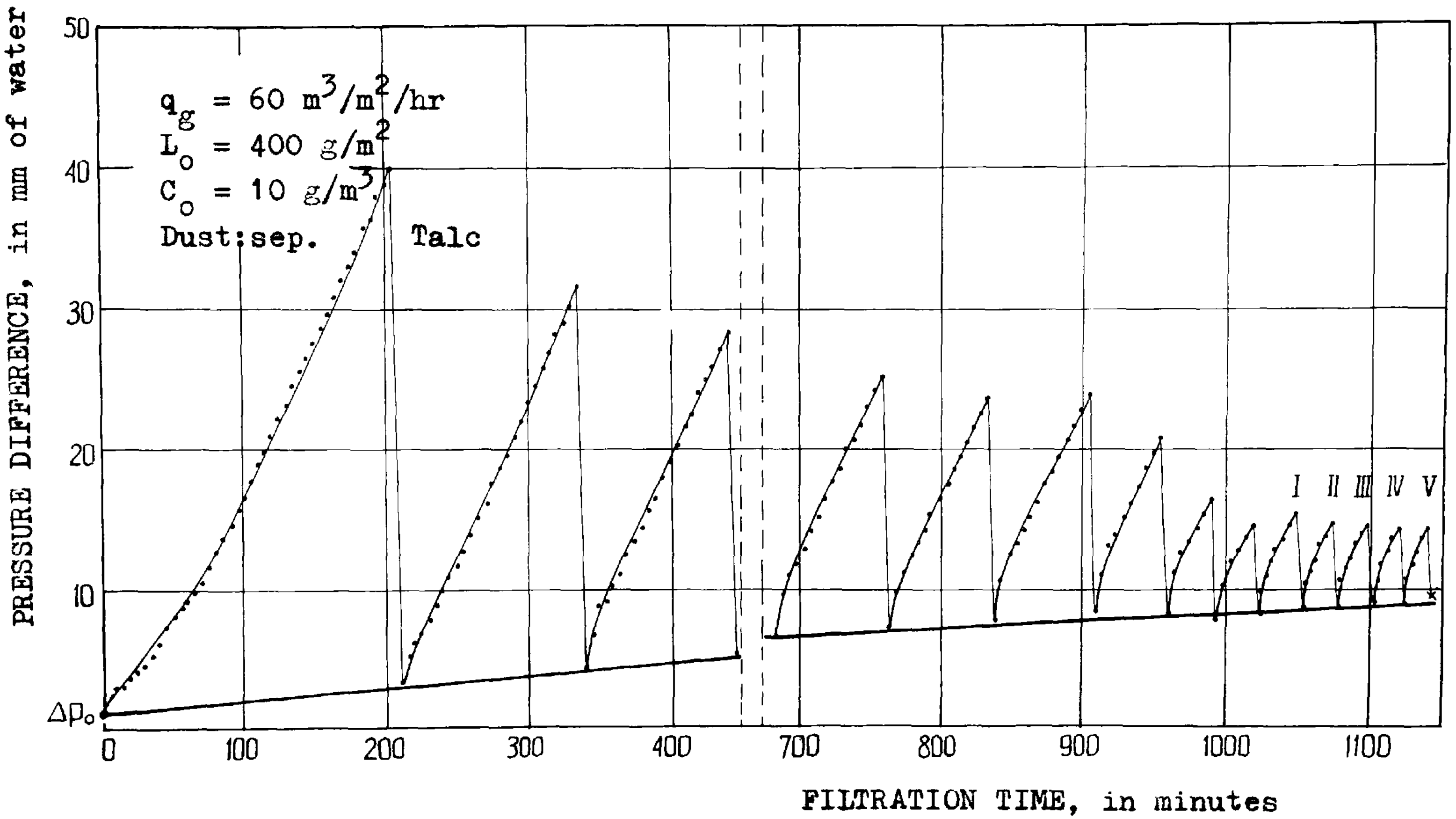


Figure A-42. Pressure Difference vs. Filtration Time for Large-Scale Testing og Fabric 853.

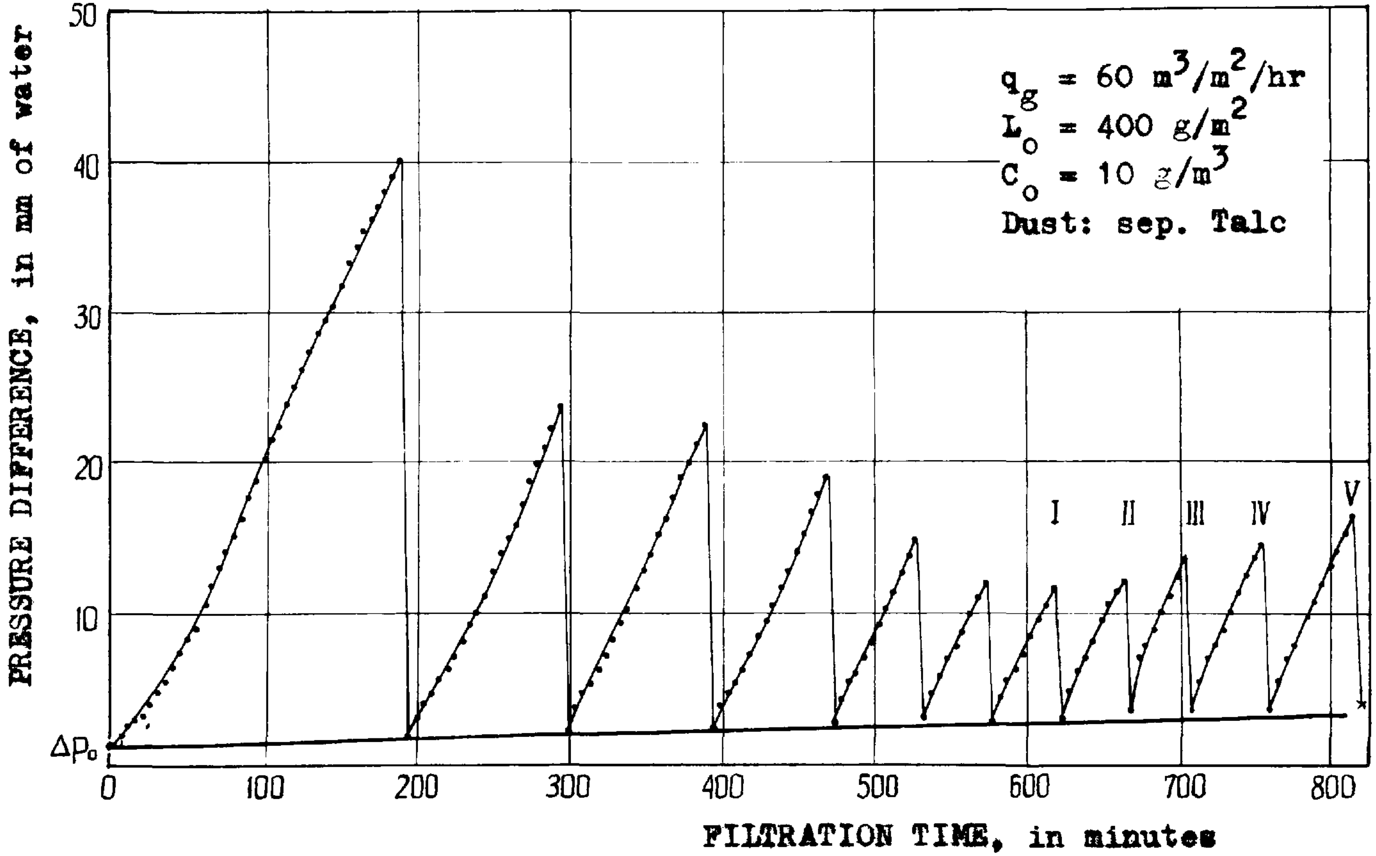


Figure A-43. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 190.

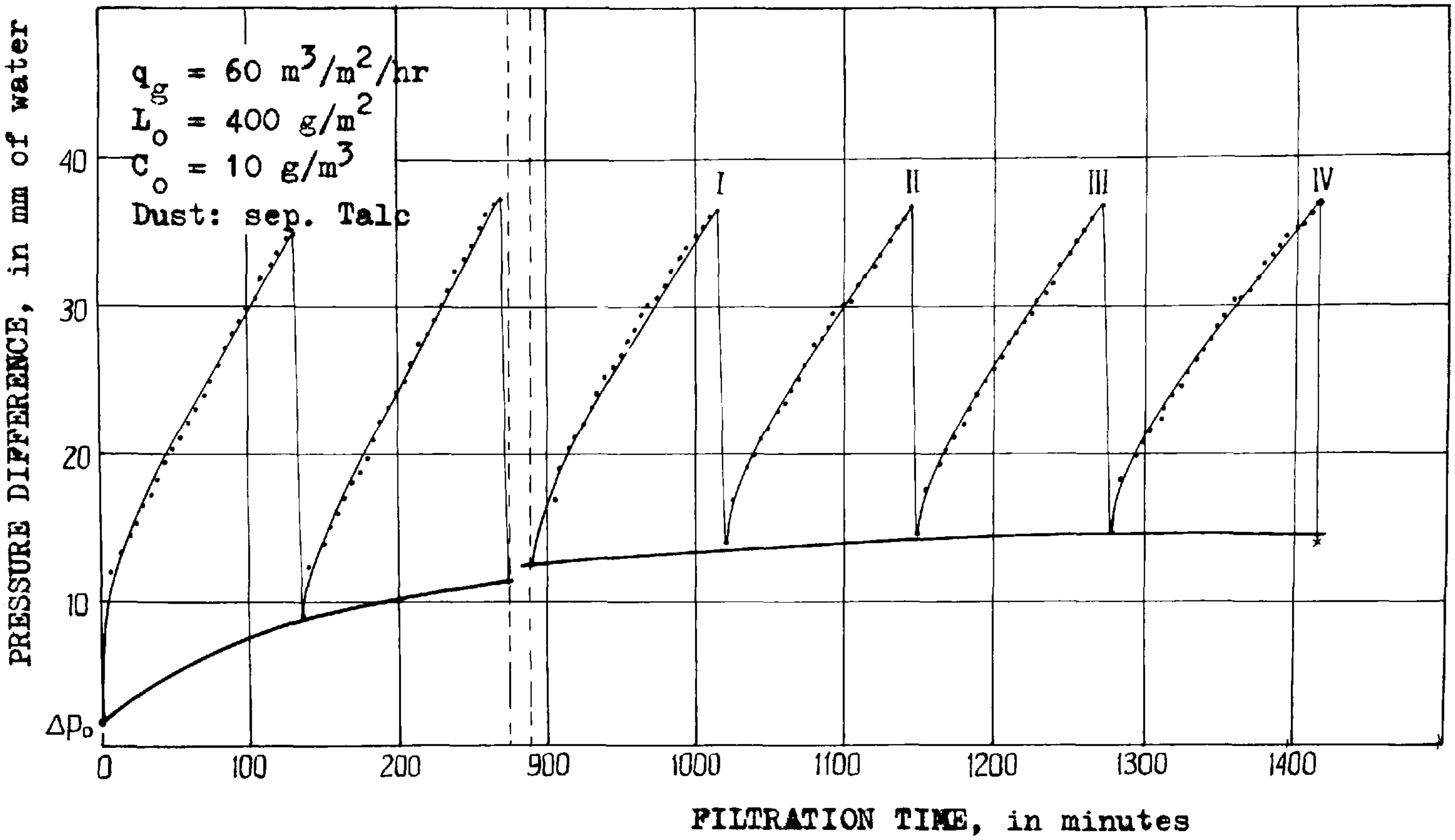


Figure A-44. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 850.

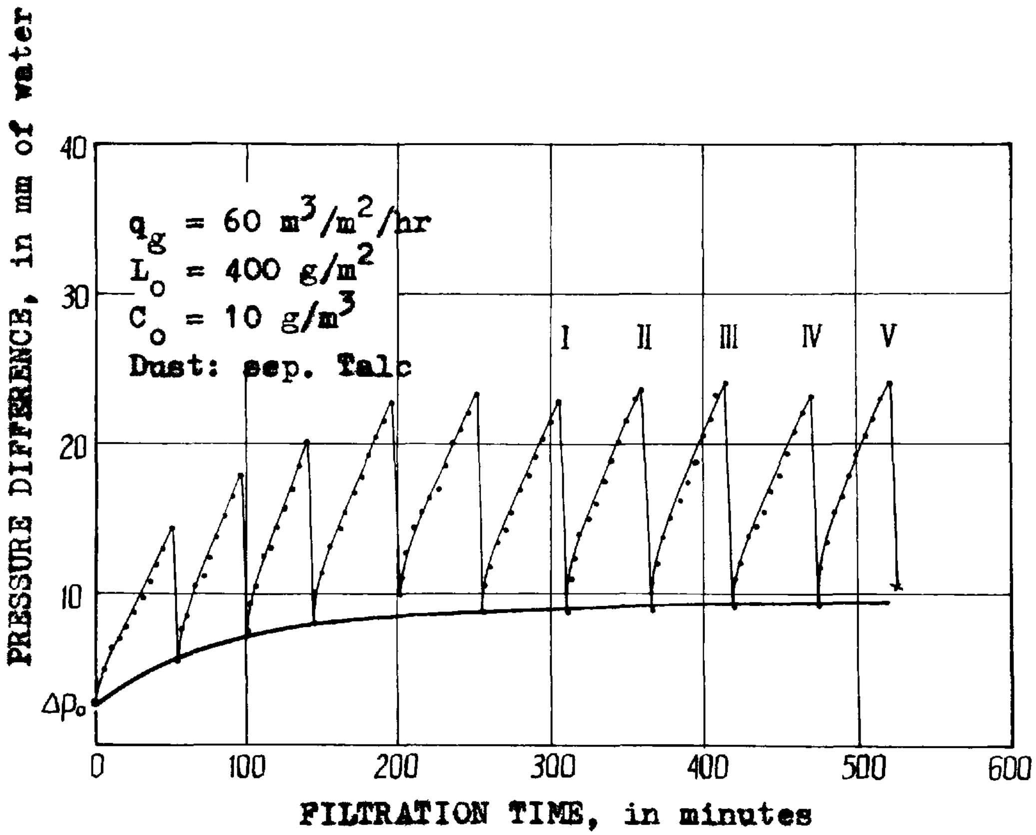


Figure A-45. **Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 802B.**

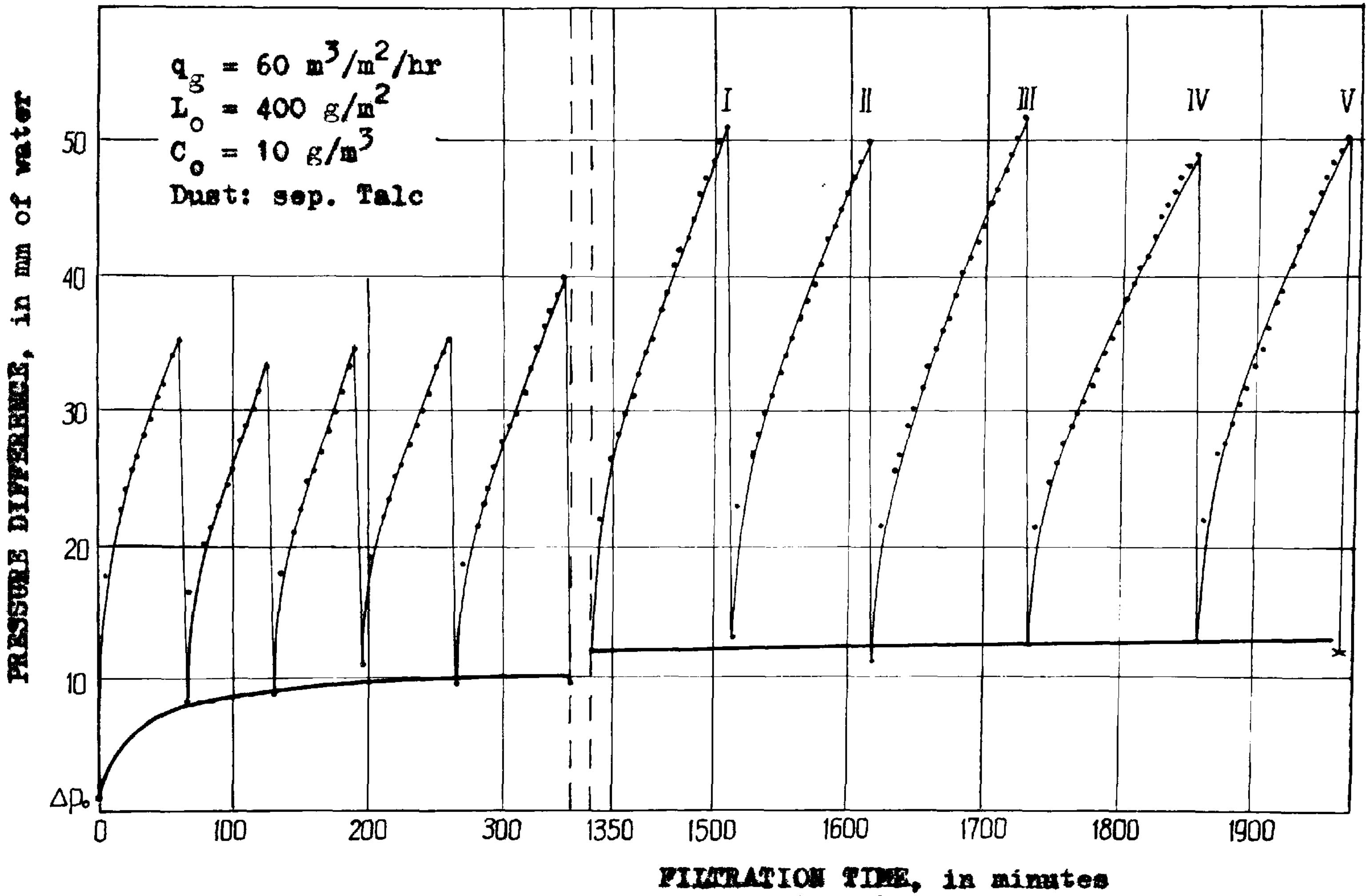


Figure A-46. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-875.

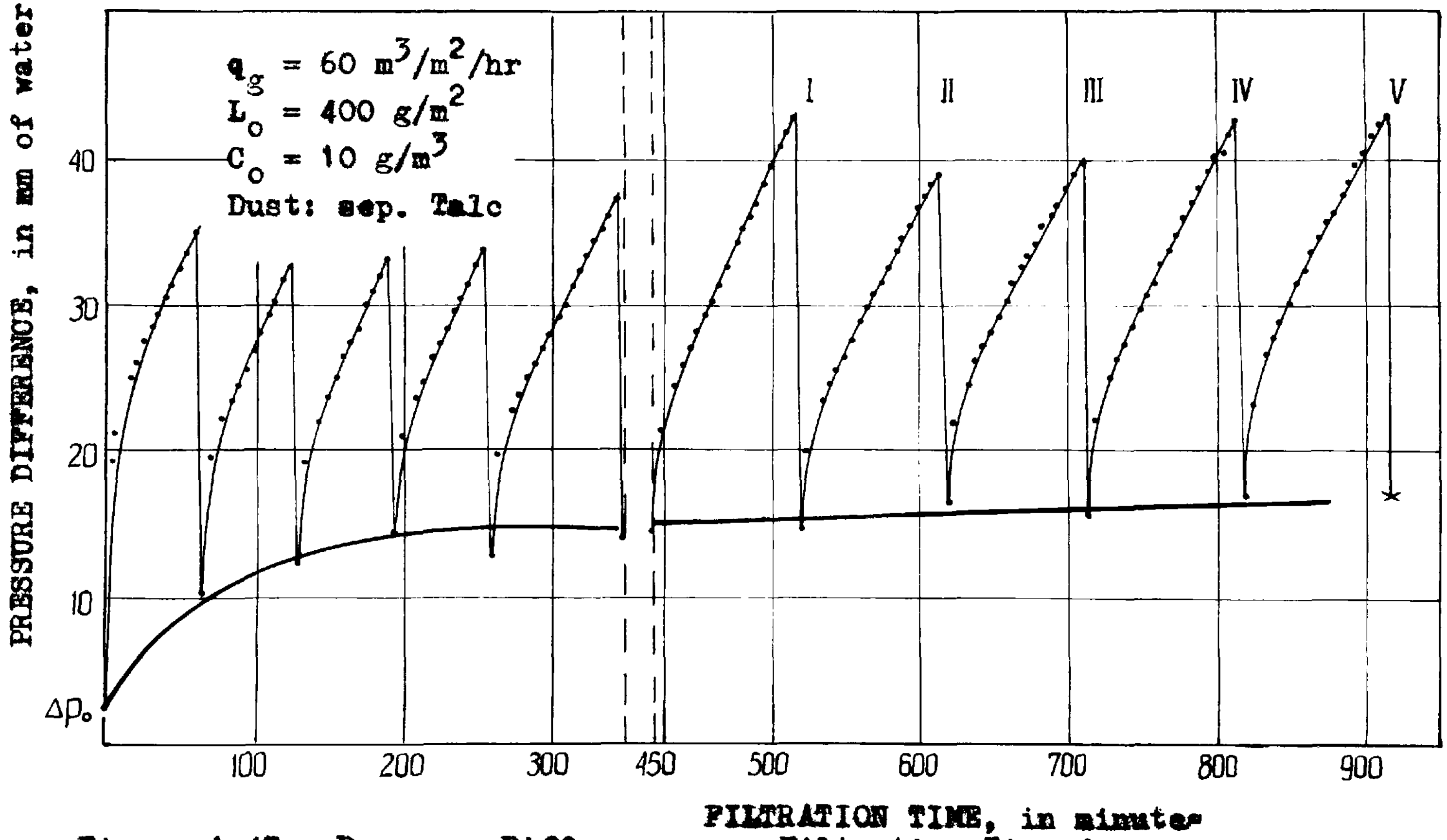


Figure A-47. Pressure Difference vs. Filtration Time for Large-Scale Testing. of Fabric Q53-870.

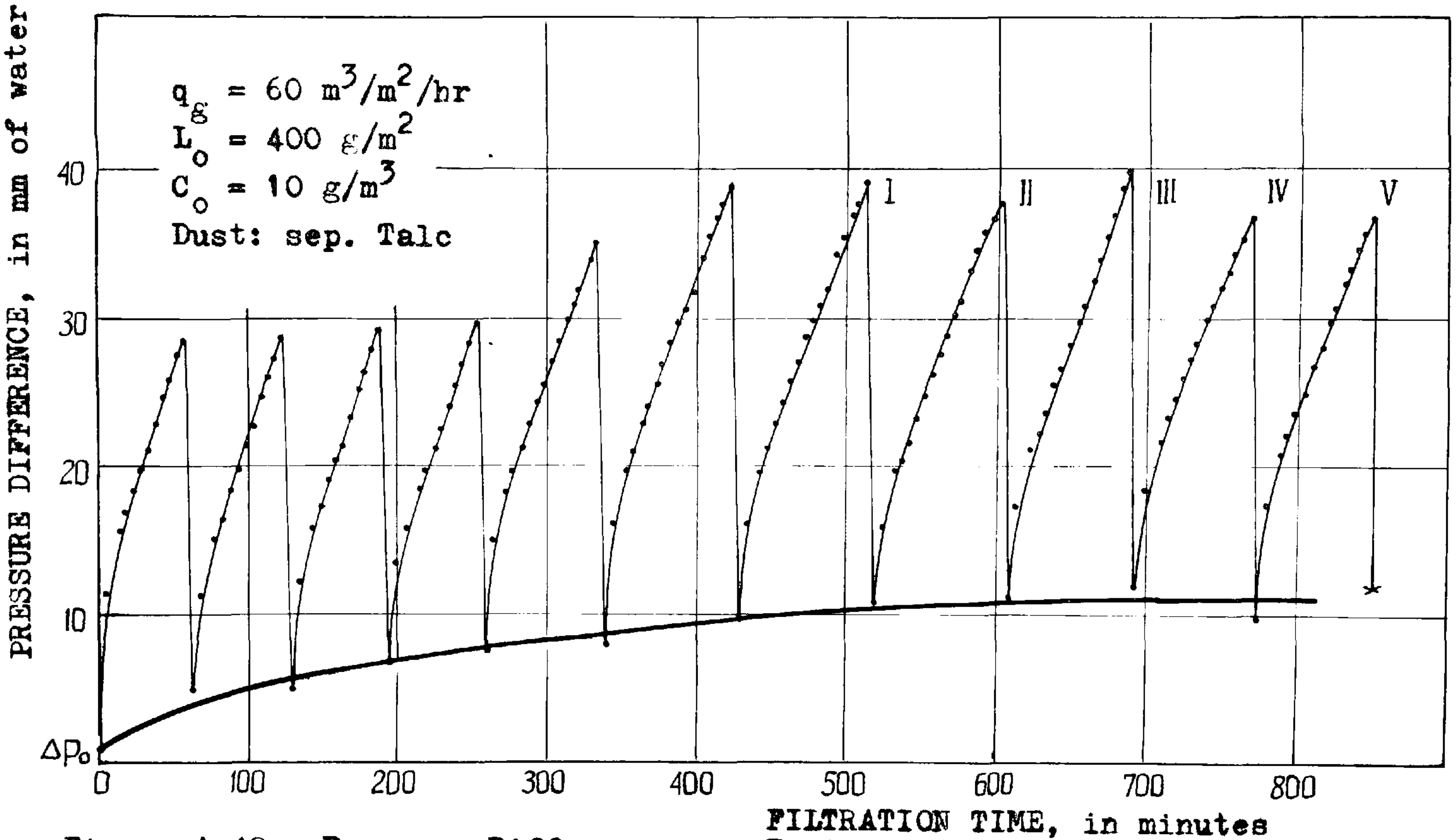


Figure A-48. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-878.

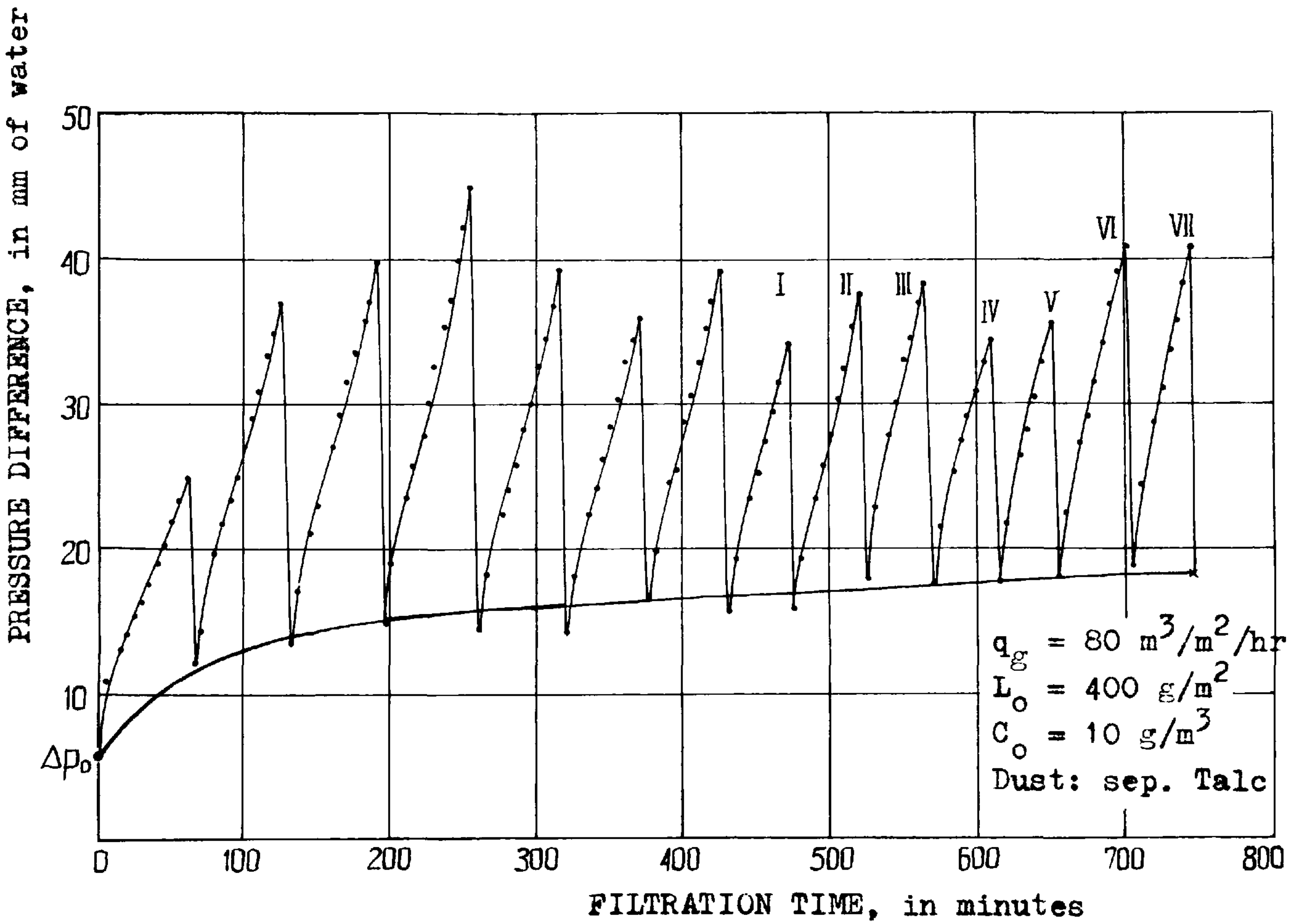


Figure A-49. Pressure Difference vs. Filtrtion Time for Large-Scale Testing of Fabric 960

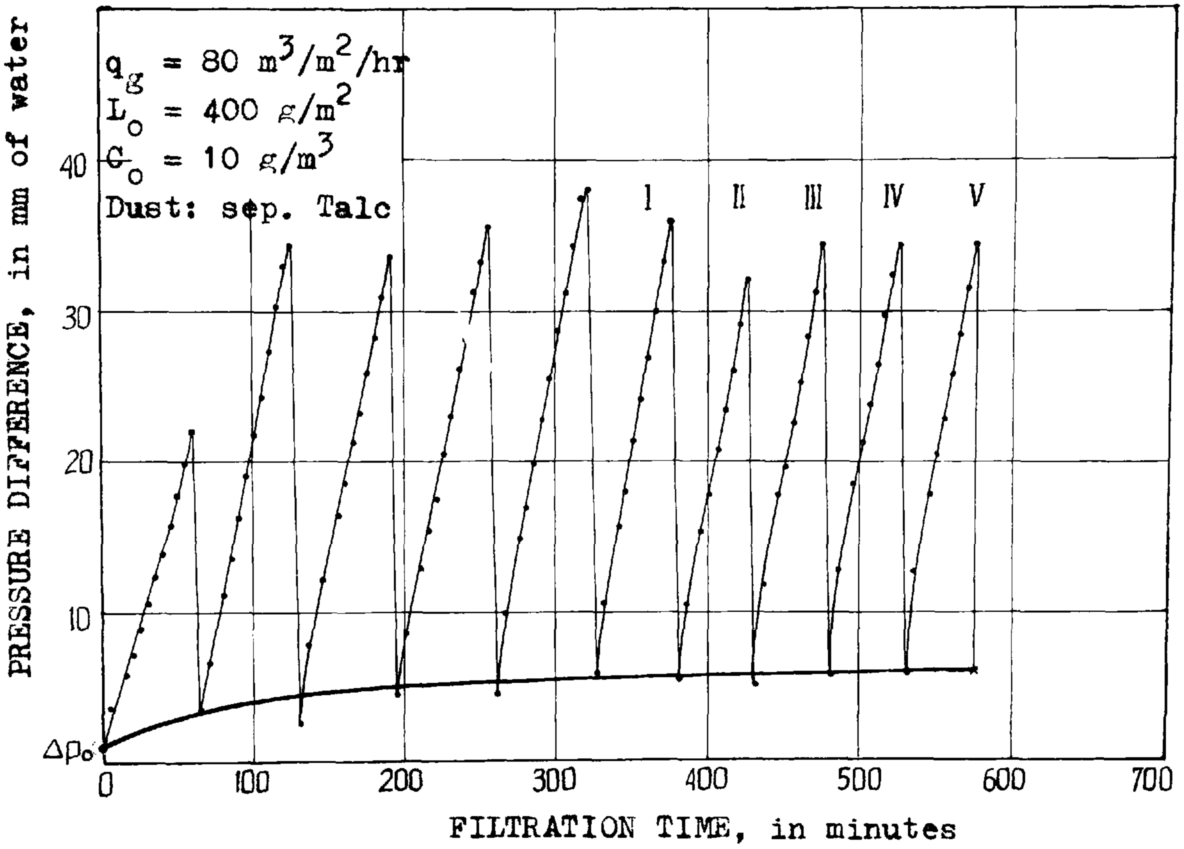


Figure A-50. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 862B.

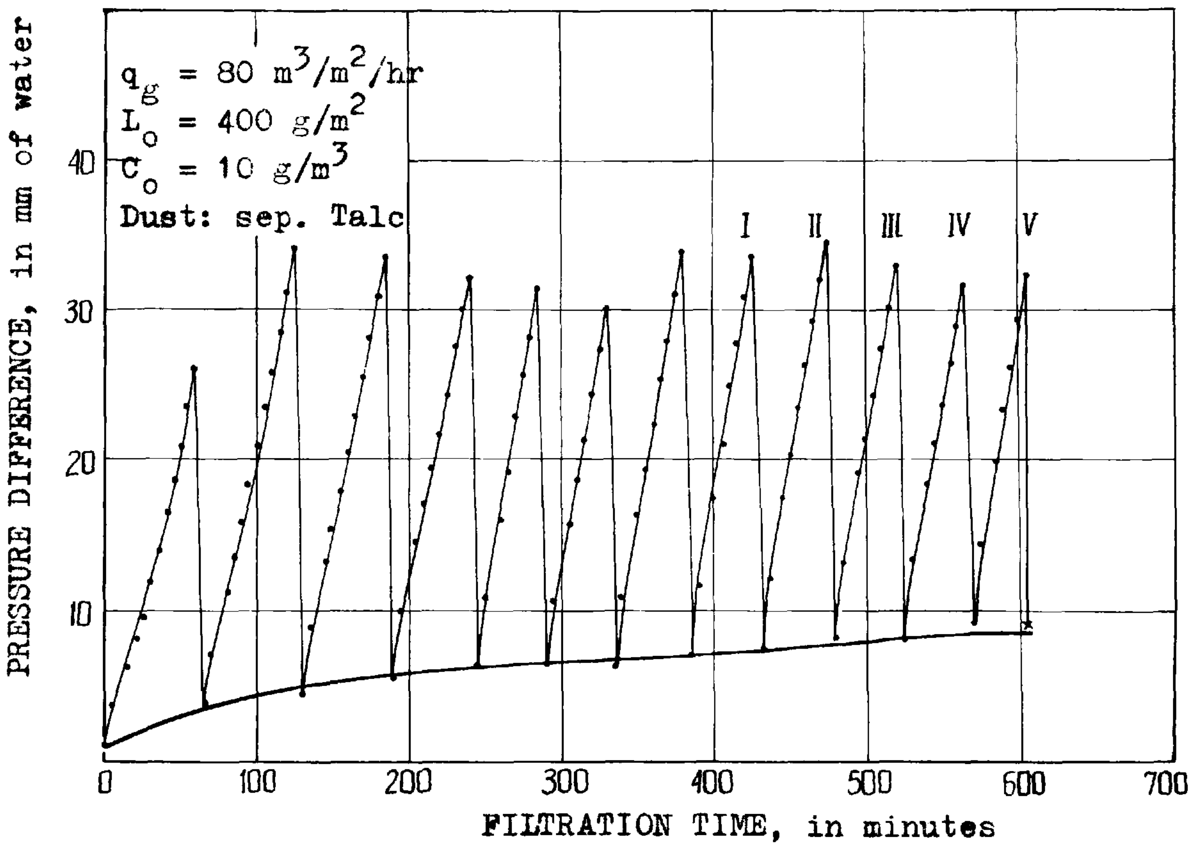


Figure A-51. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C866B.

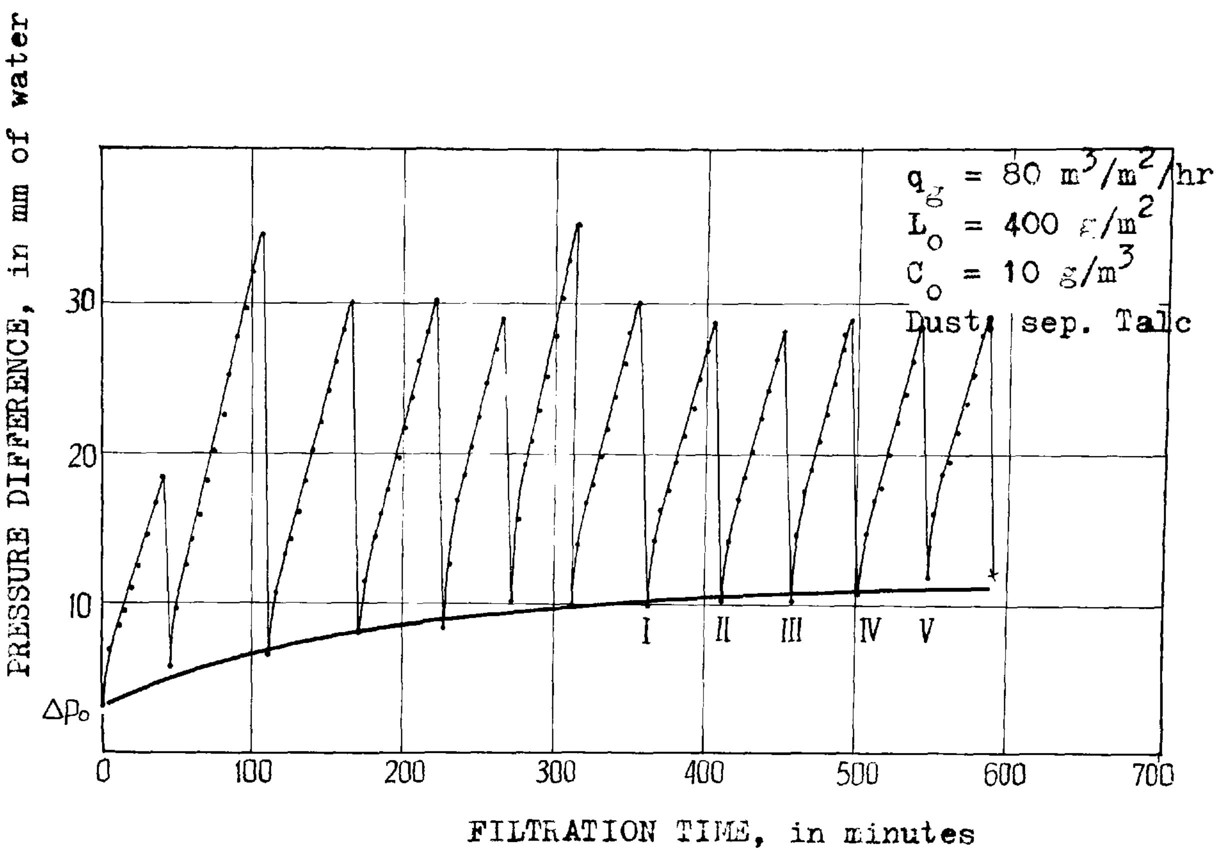


Figure A-52. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C868B.

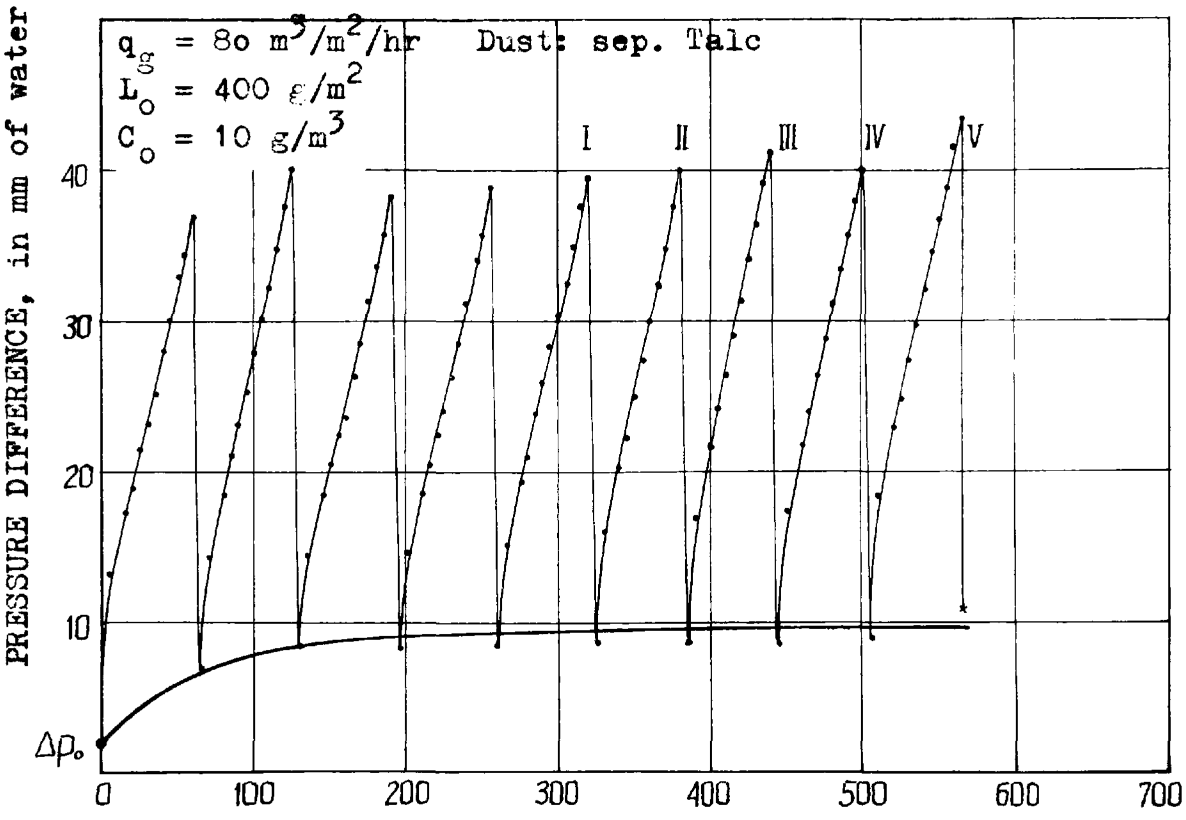


Figure A-53. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 865B.

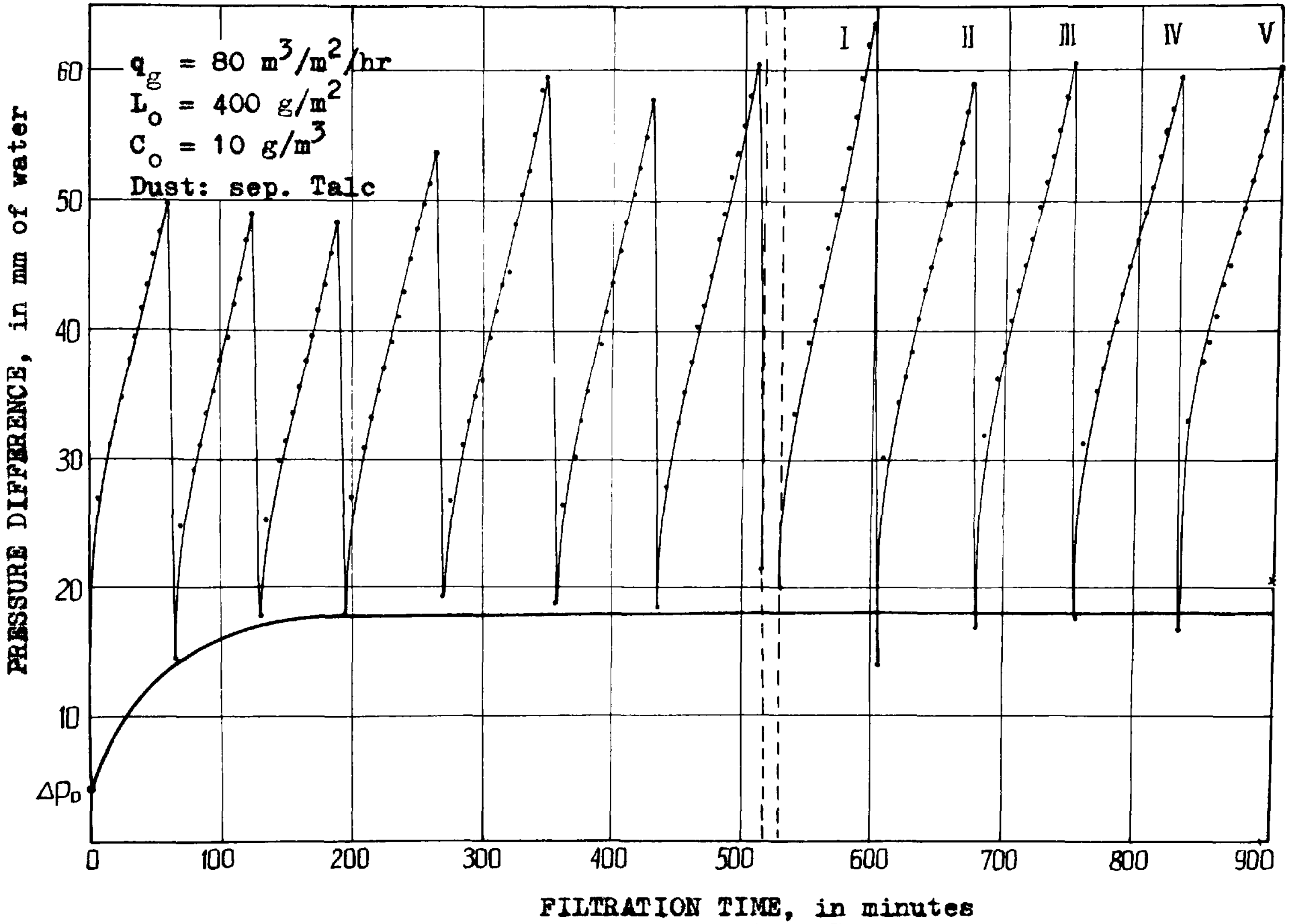


Figure A-54. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C890B.

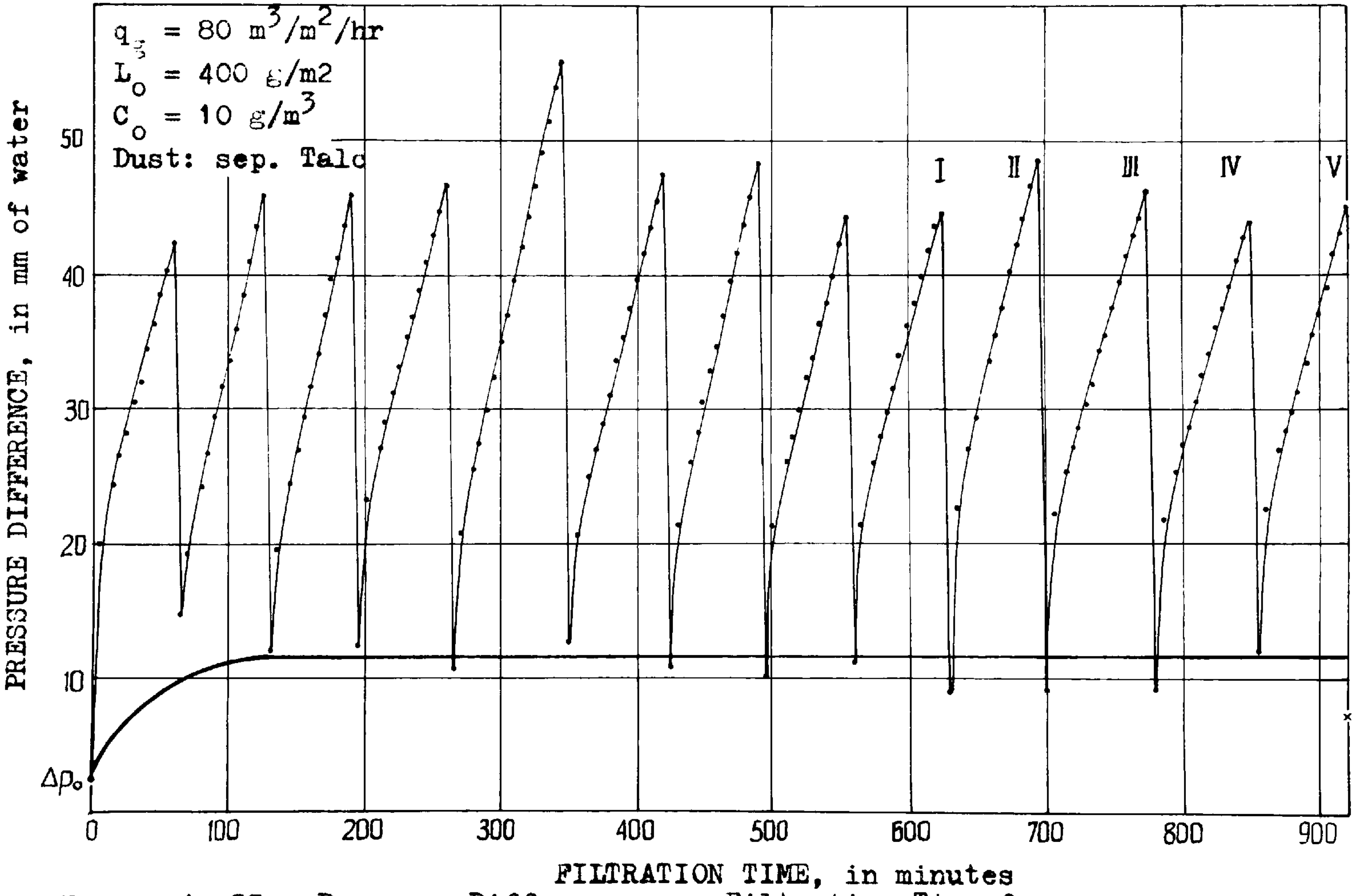


Figure A- 55. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C892B.

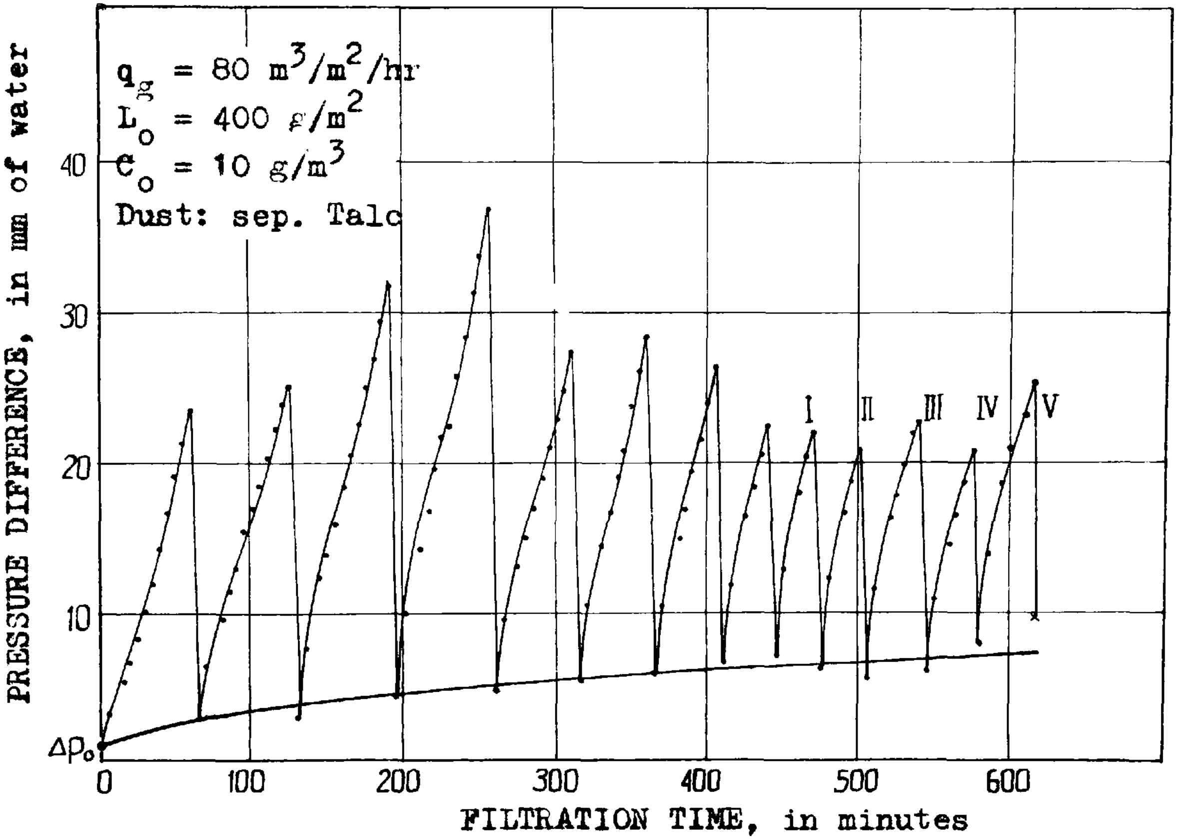


Figure A-56. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 852

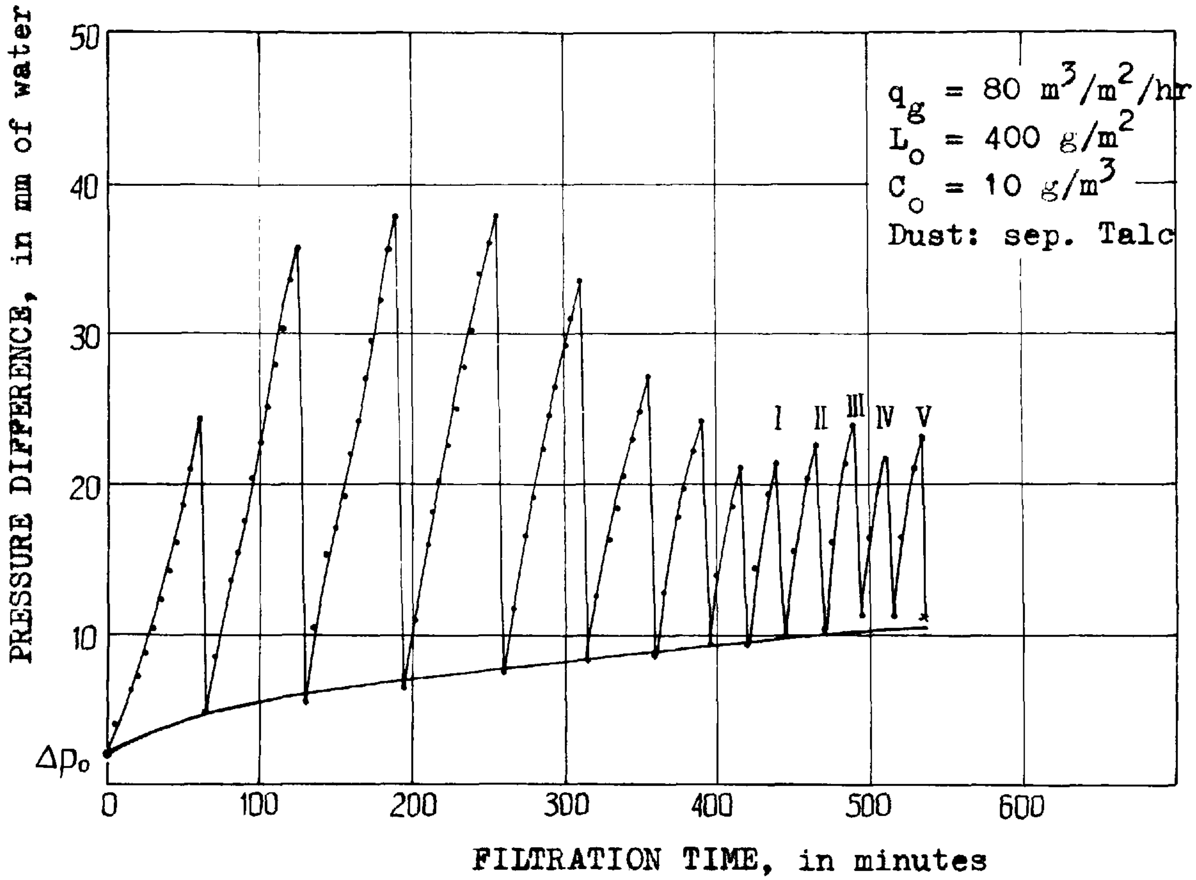


Figure A-57. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 853.

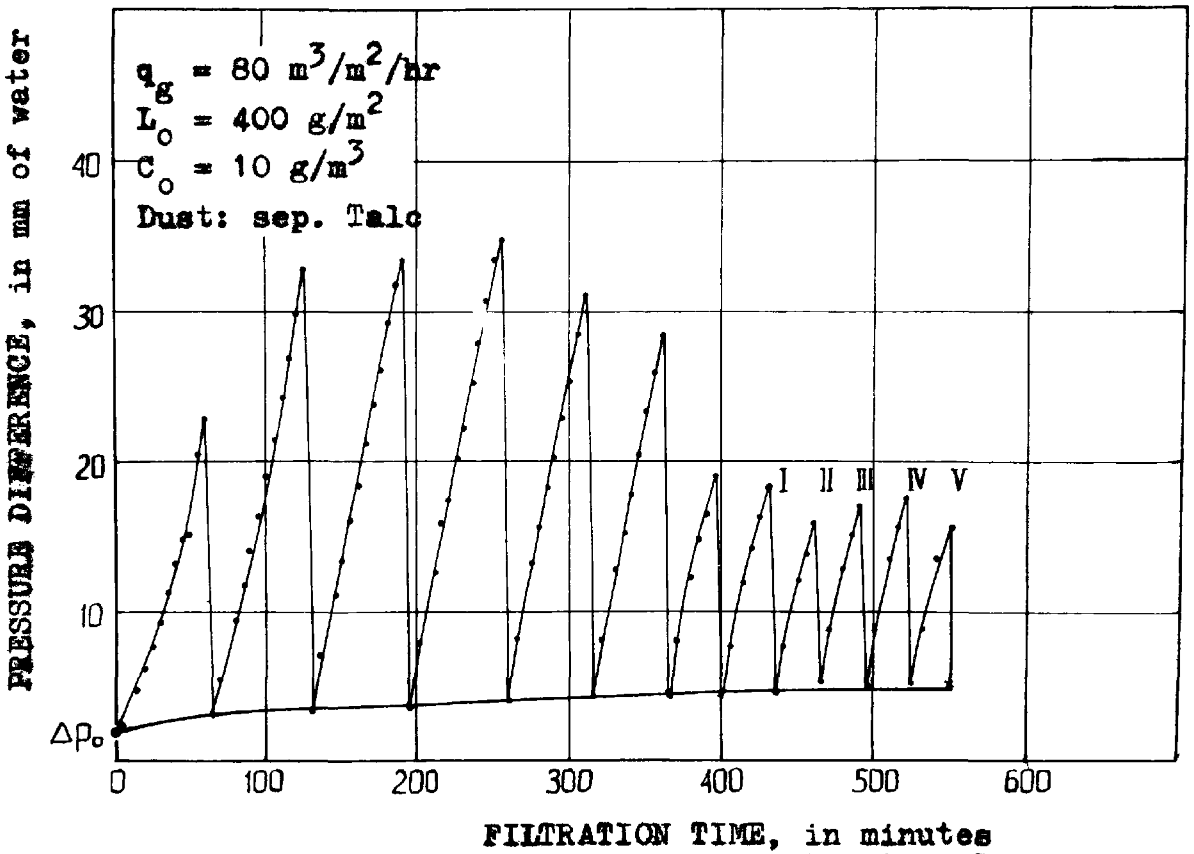


Figure A-58. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 190.

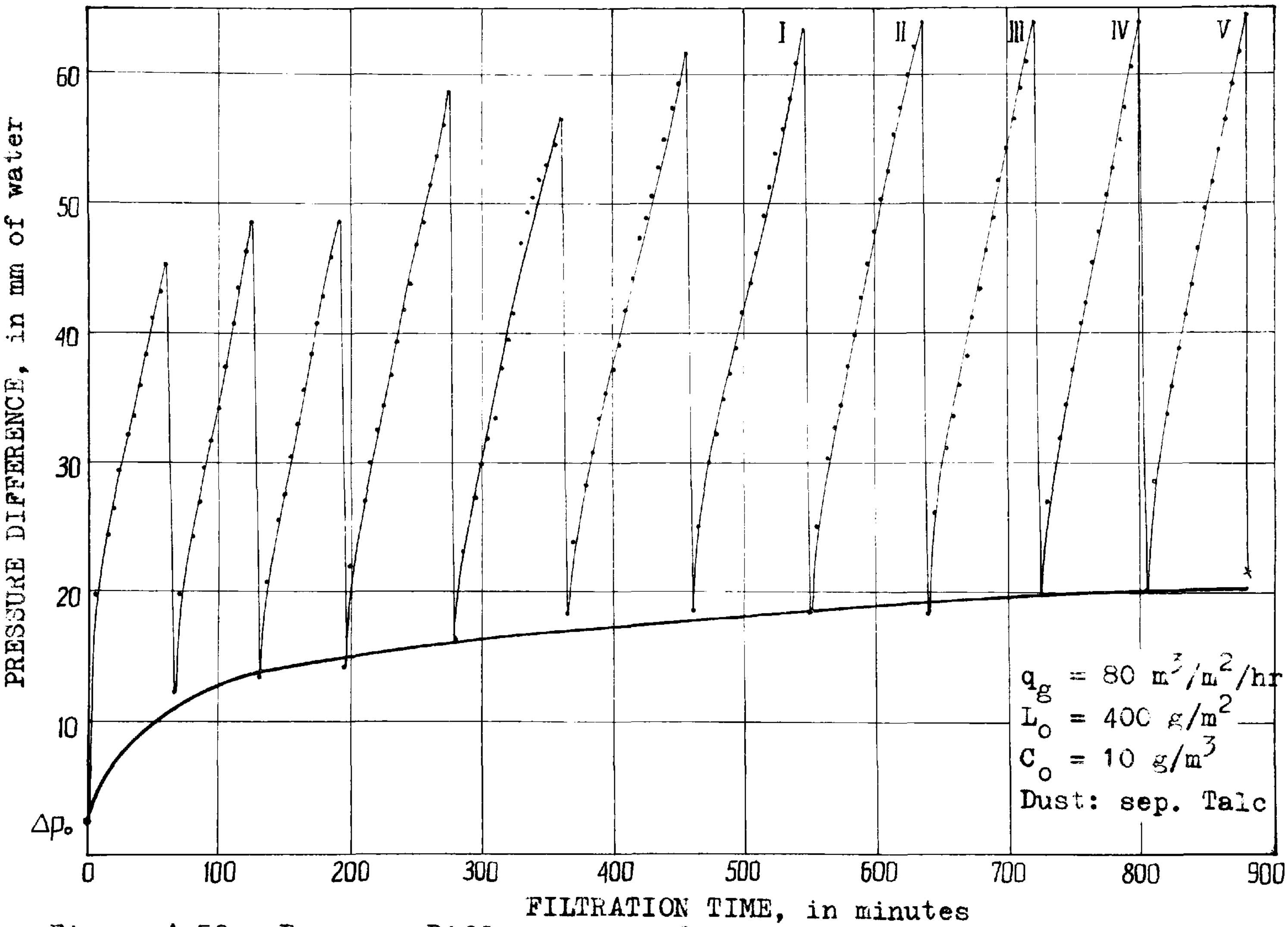


Figure A-59. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 850.

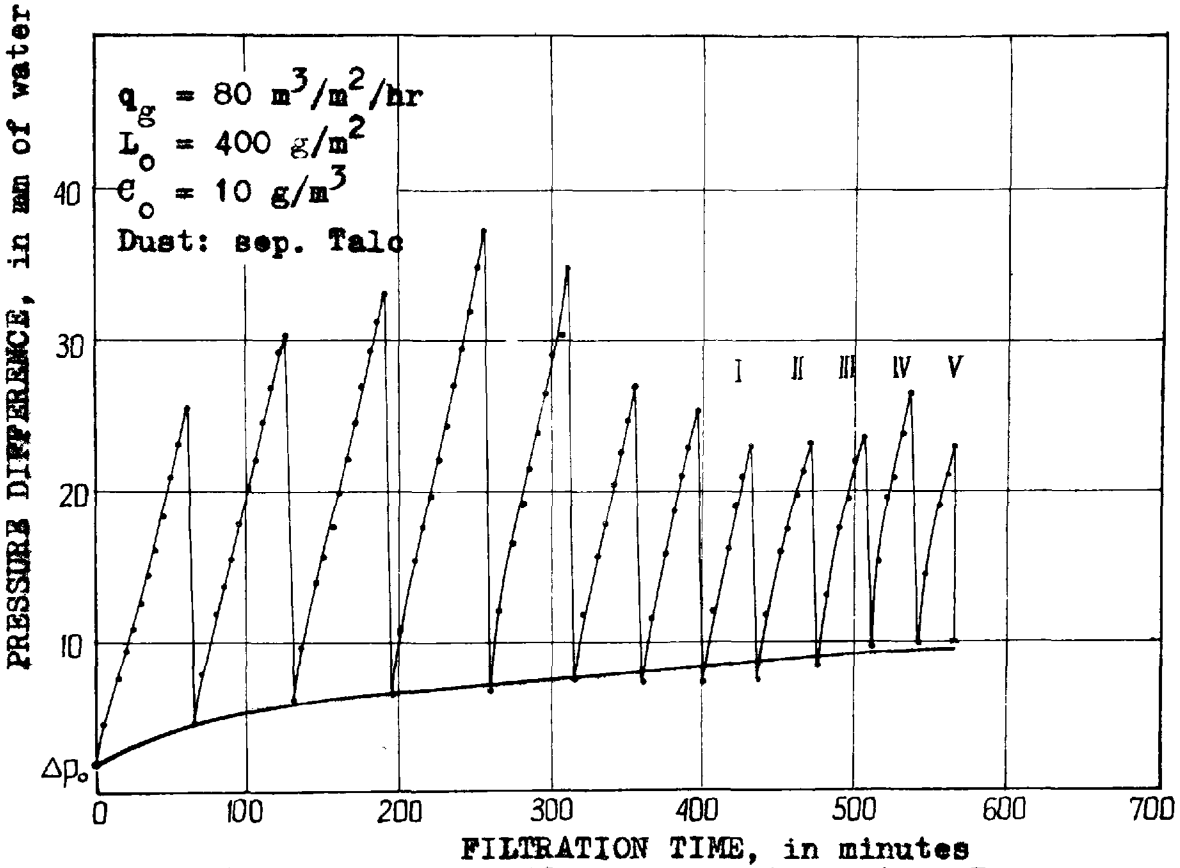


Figure A-60. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 802B.

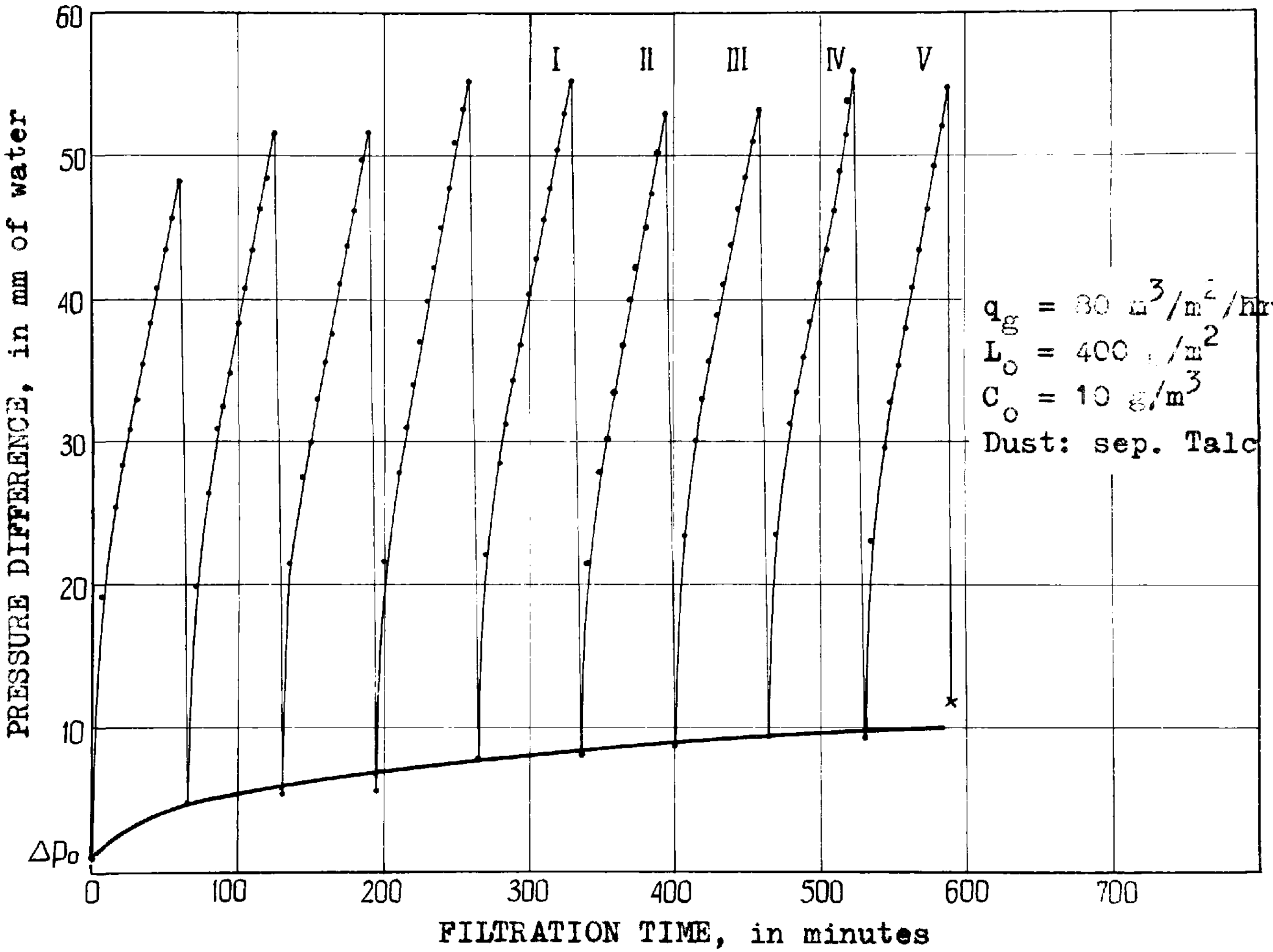


Figure A-61. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-875.

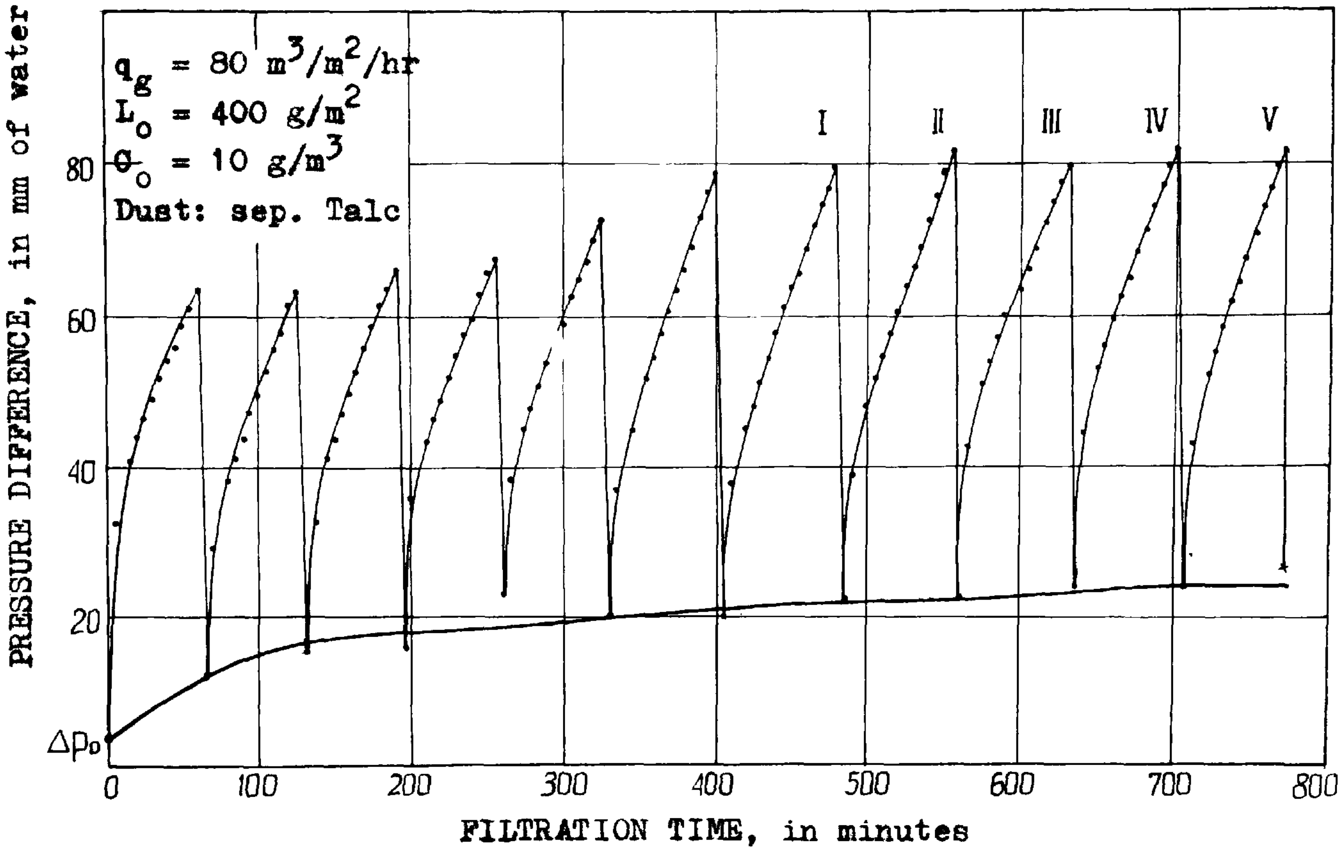


Figure A-62. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-870.

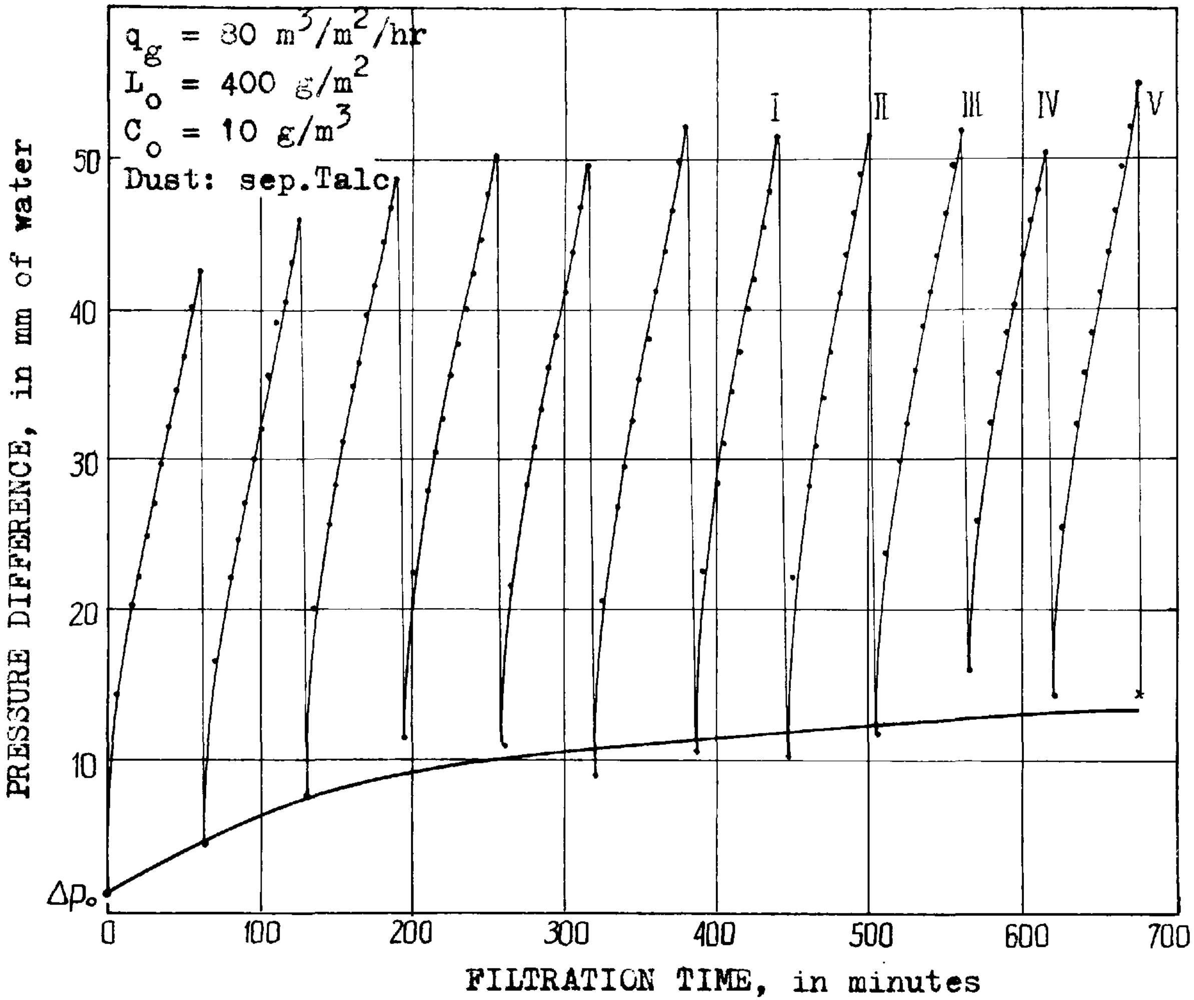


Figure A-63. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-878.

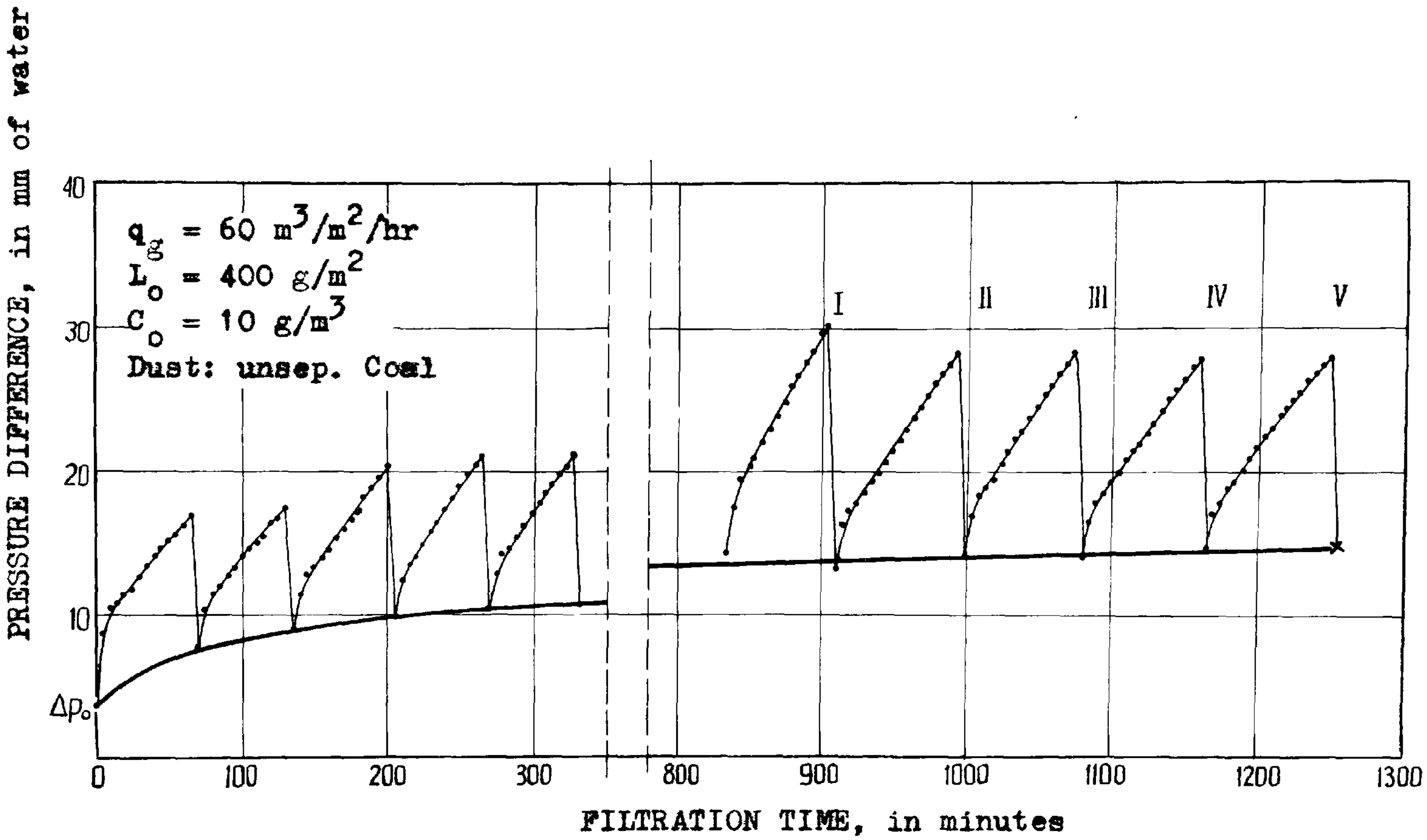


Figure A-64. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 960.

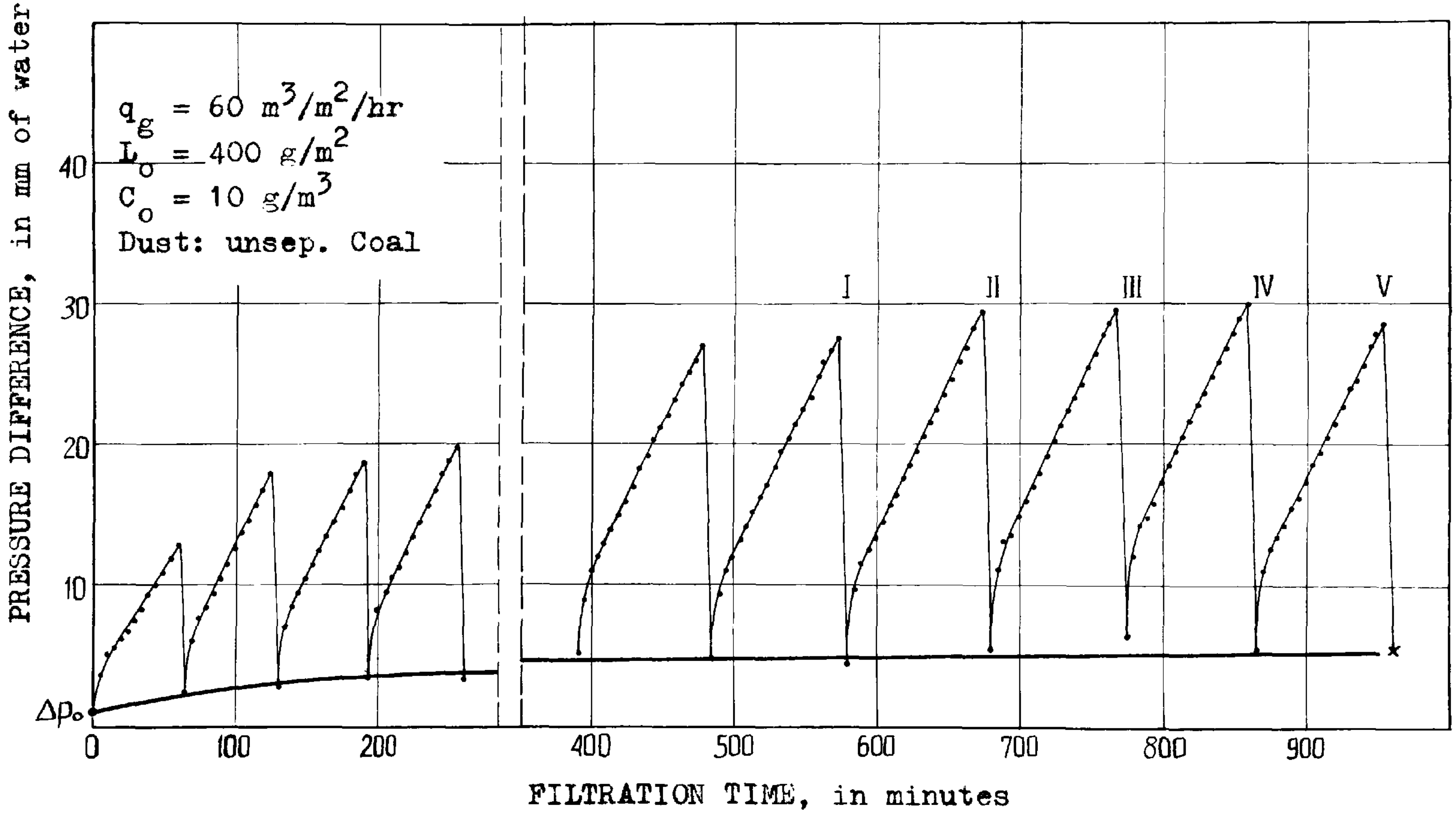


Figure A-65. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 862B.

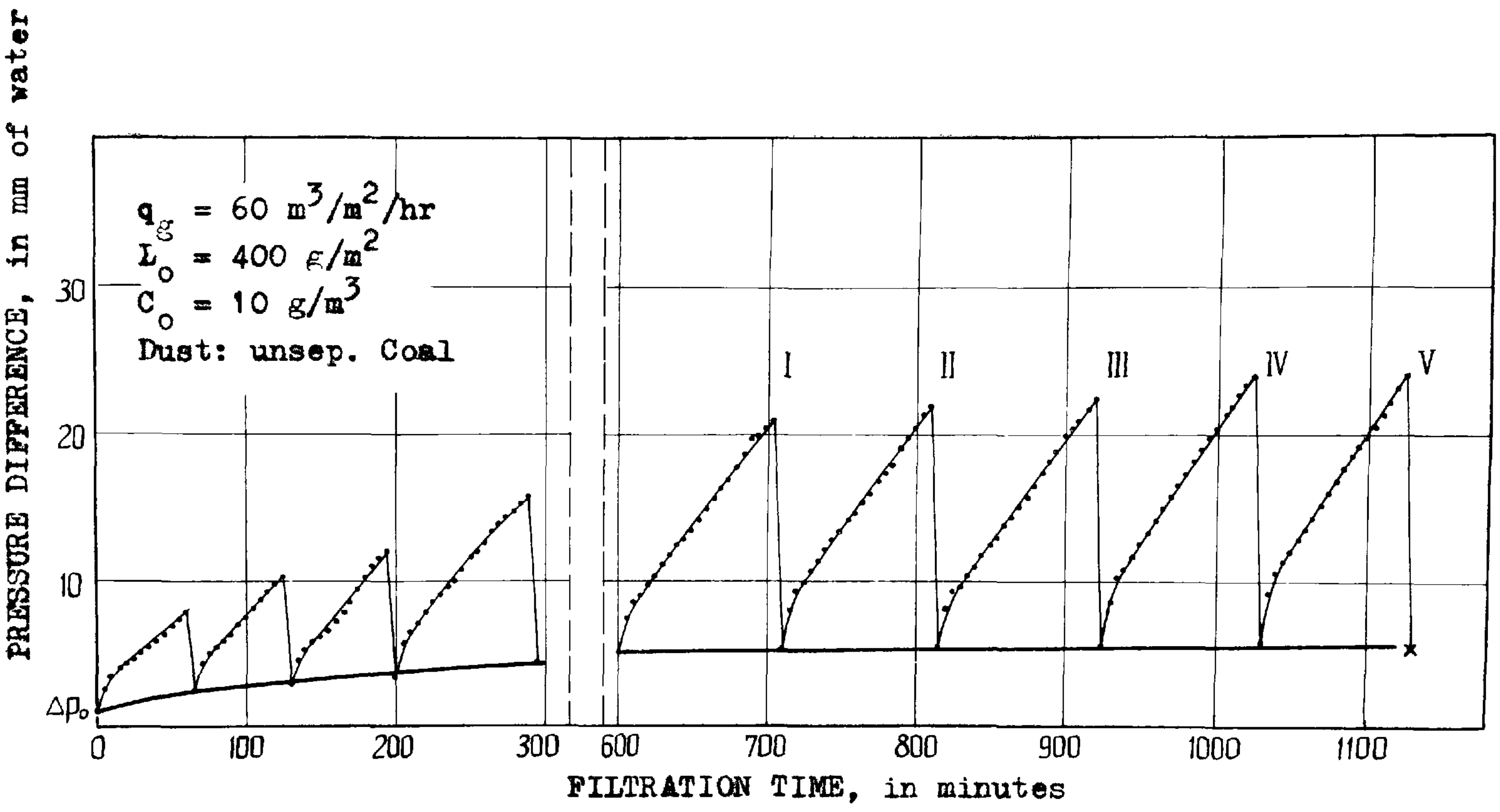


Figure A-66. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C866B.

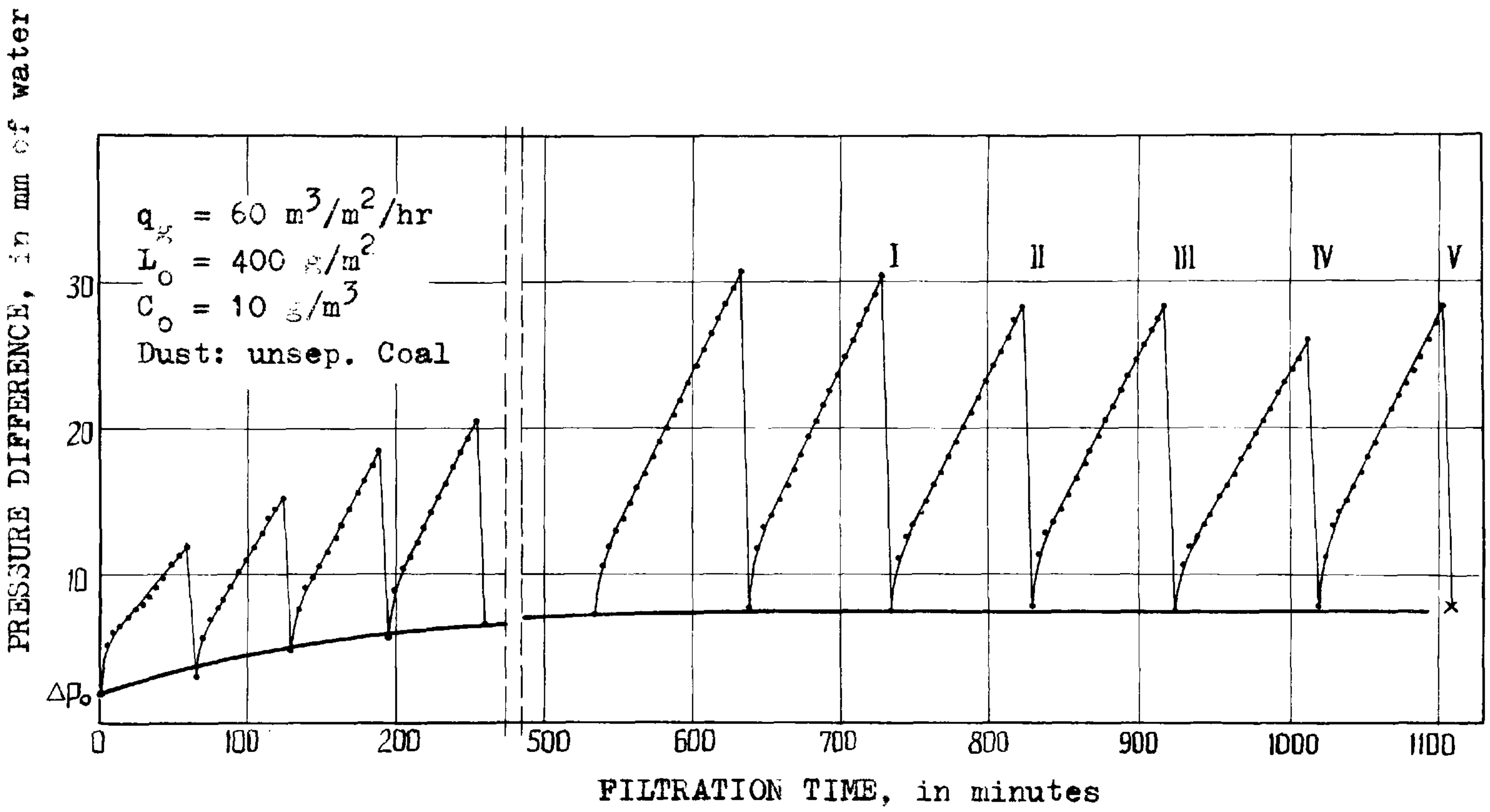


Figure A-67. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C868B.

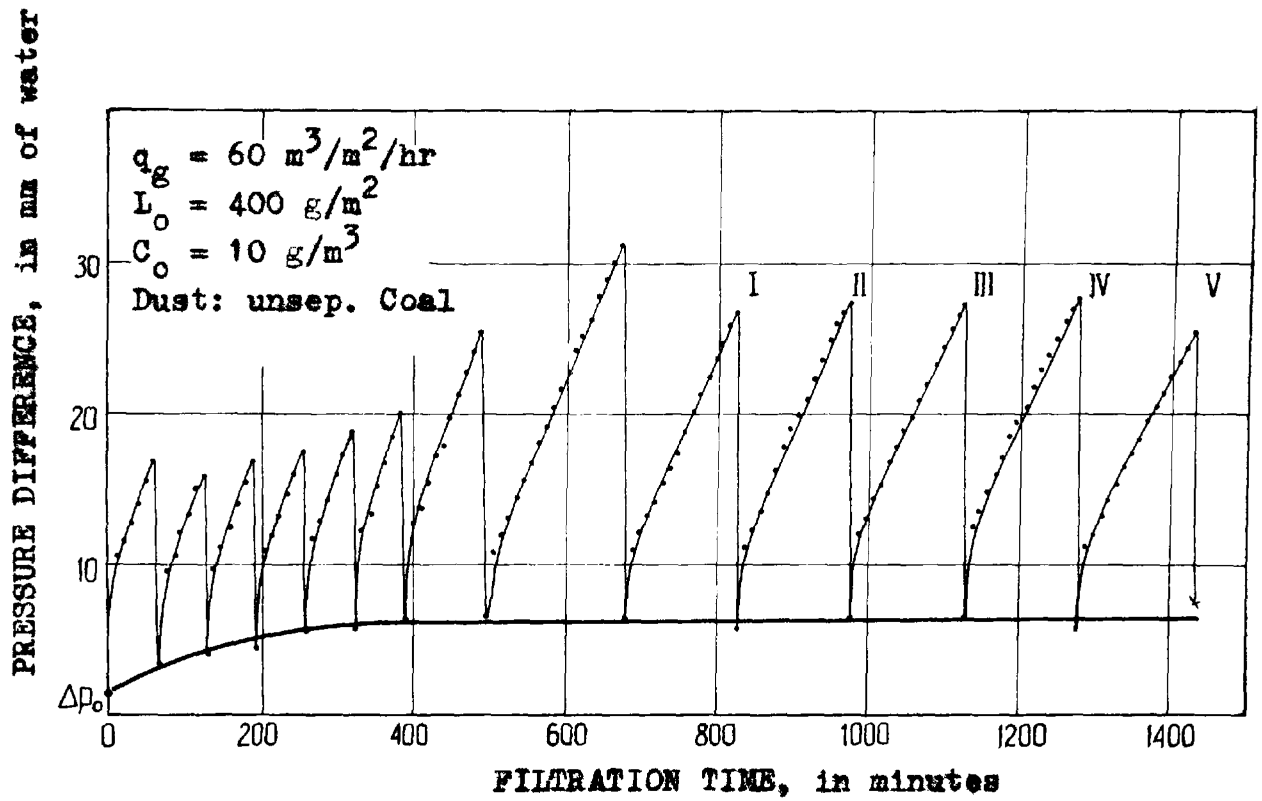


Figure A-68. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 865B.

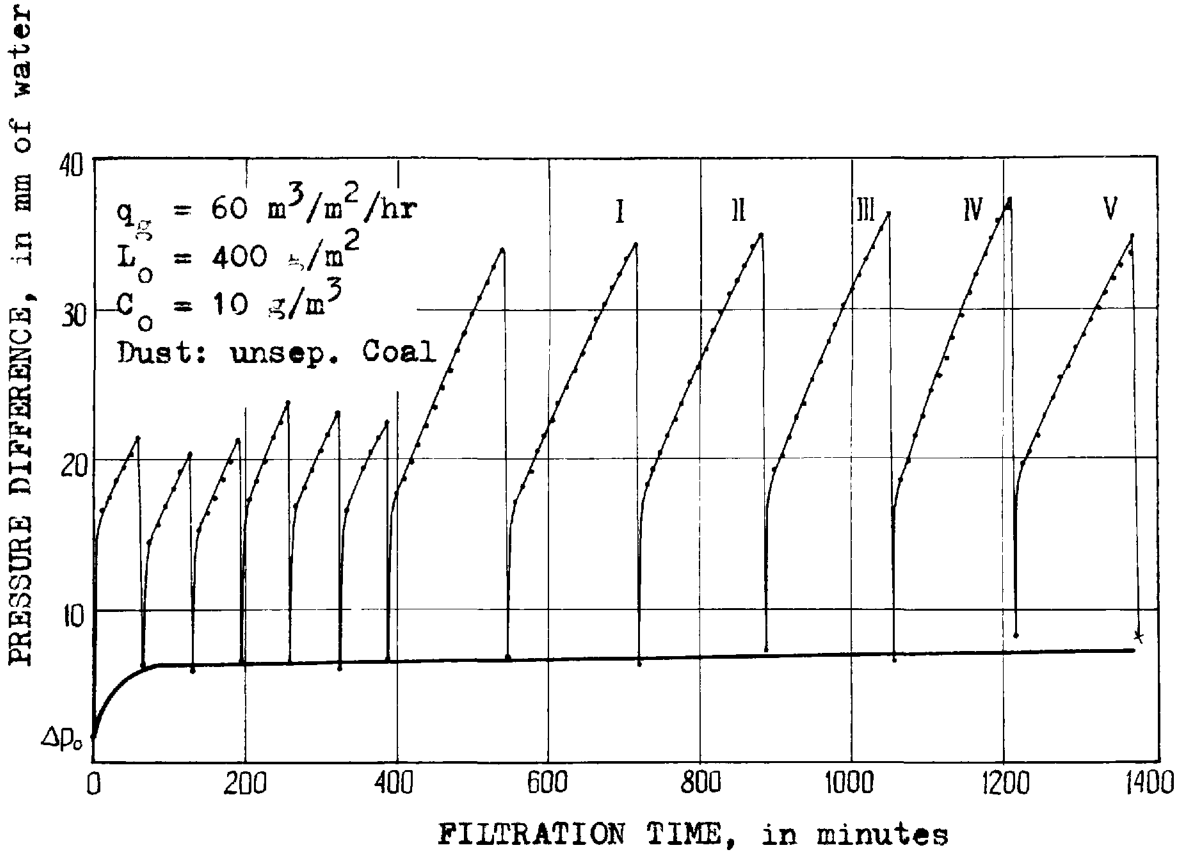


Figure A-69. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C890B.

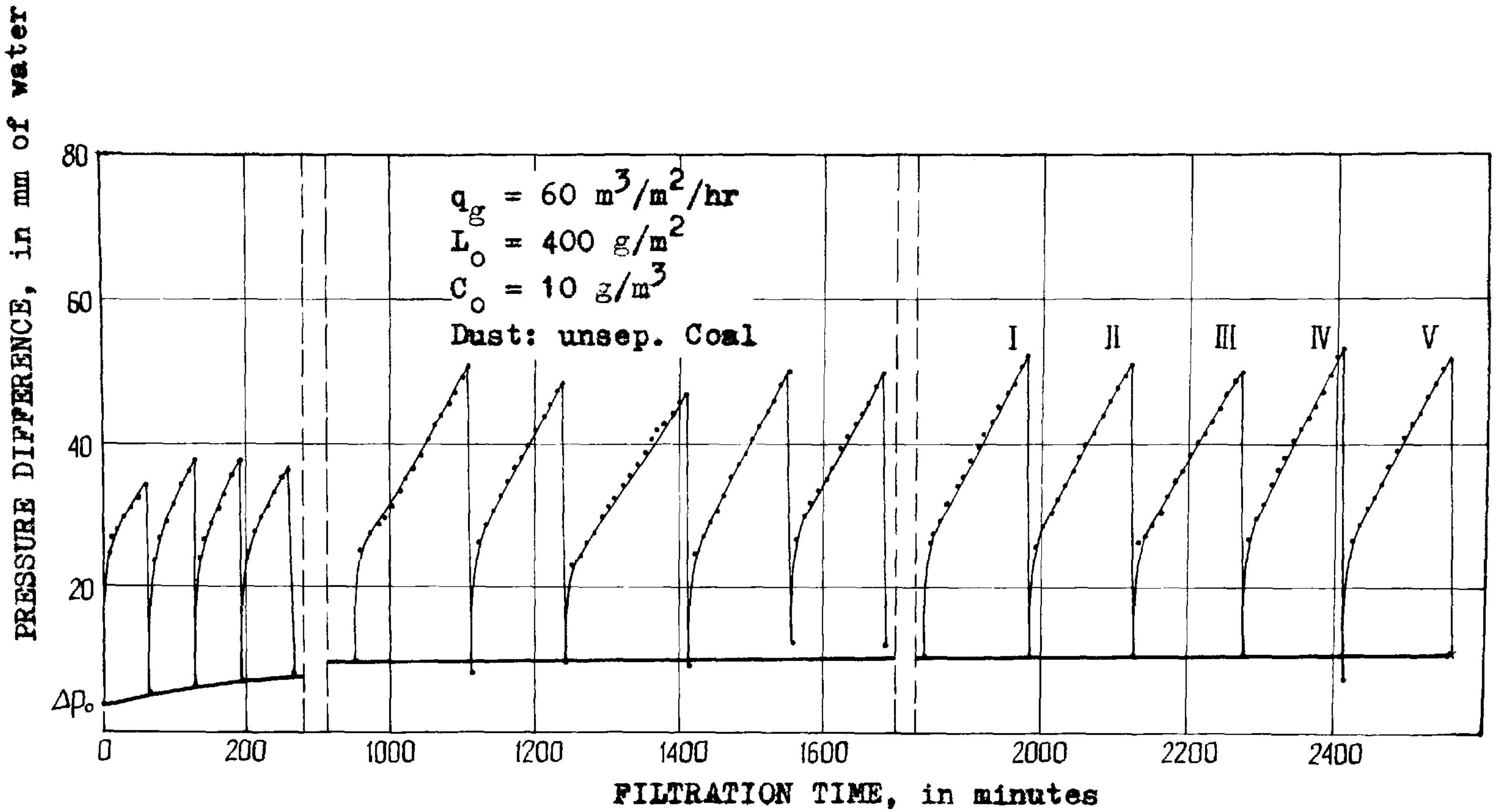


Figure A-70. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C892B.

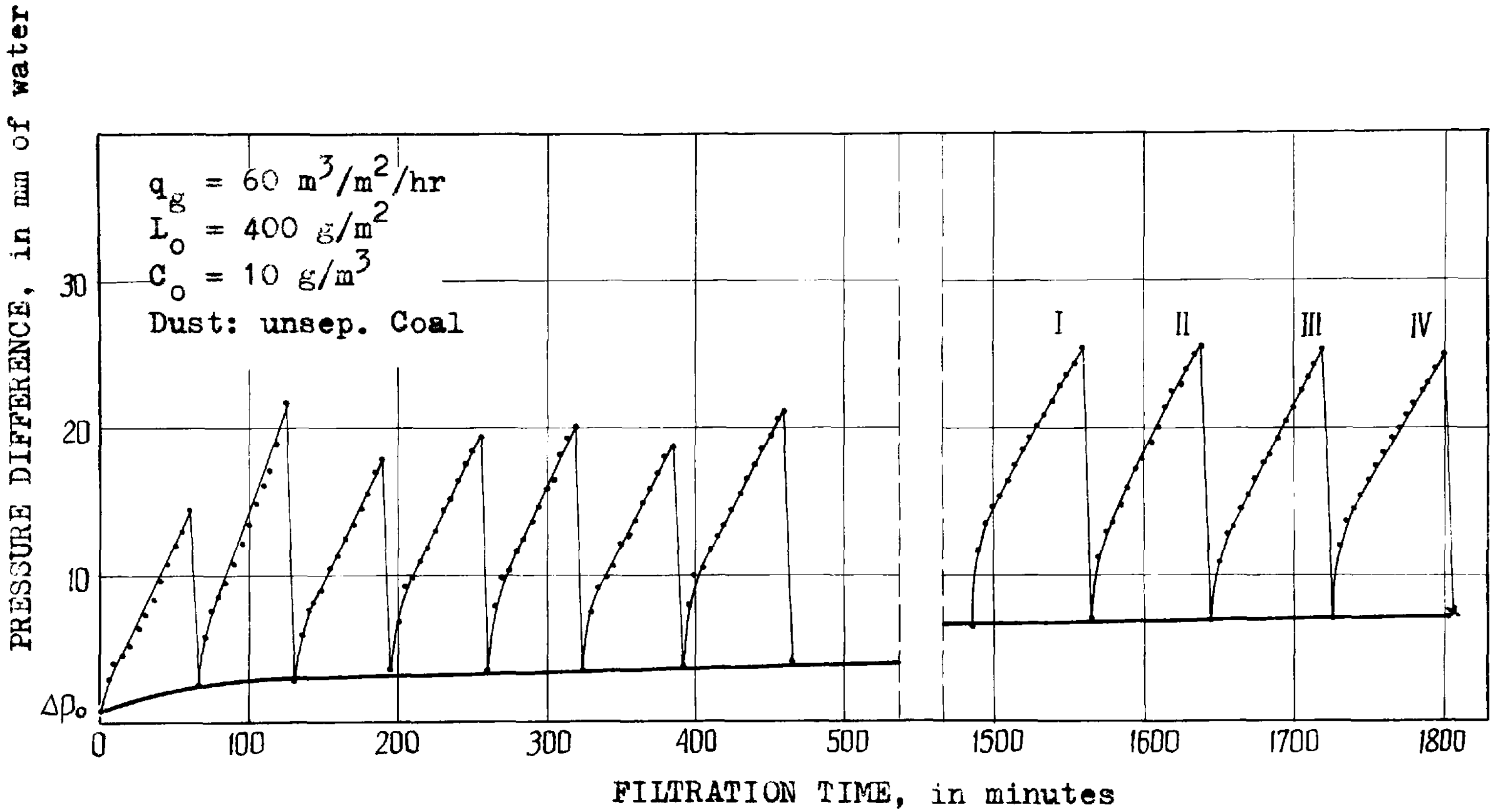


Figure A-71. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 852.

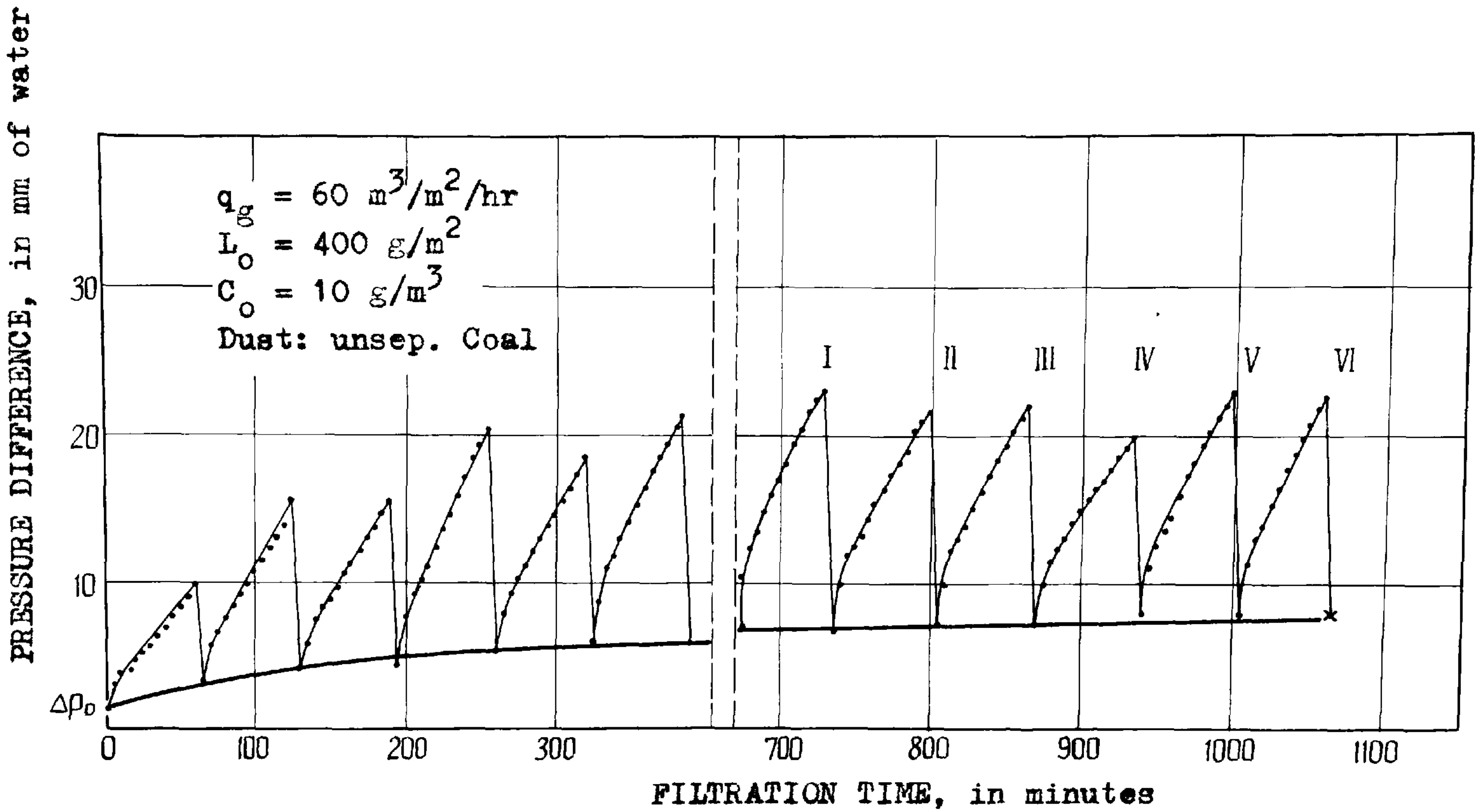


Figure A-72. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 853.

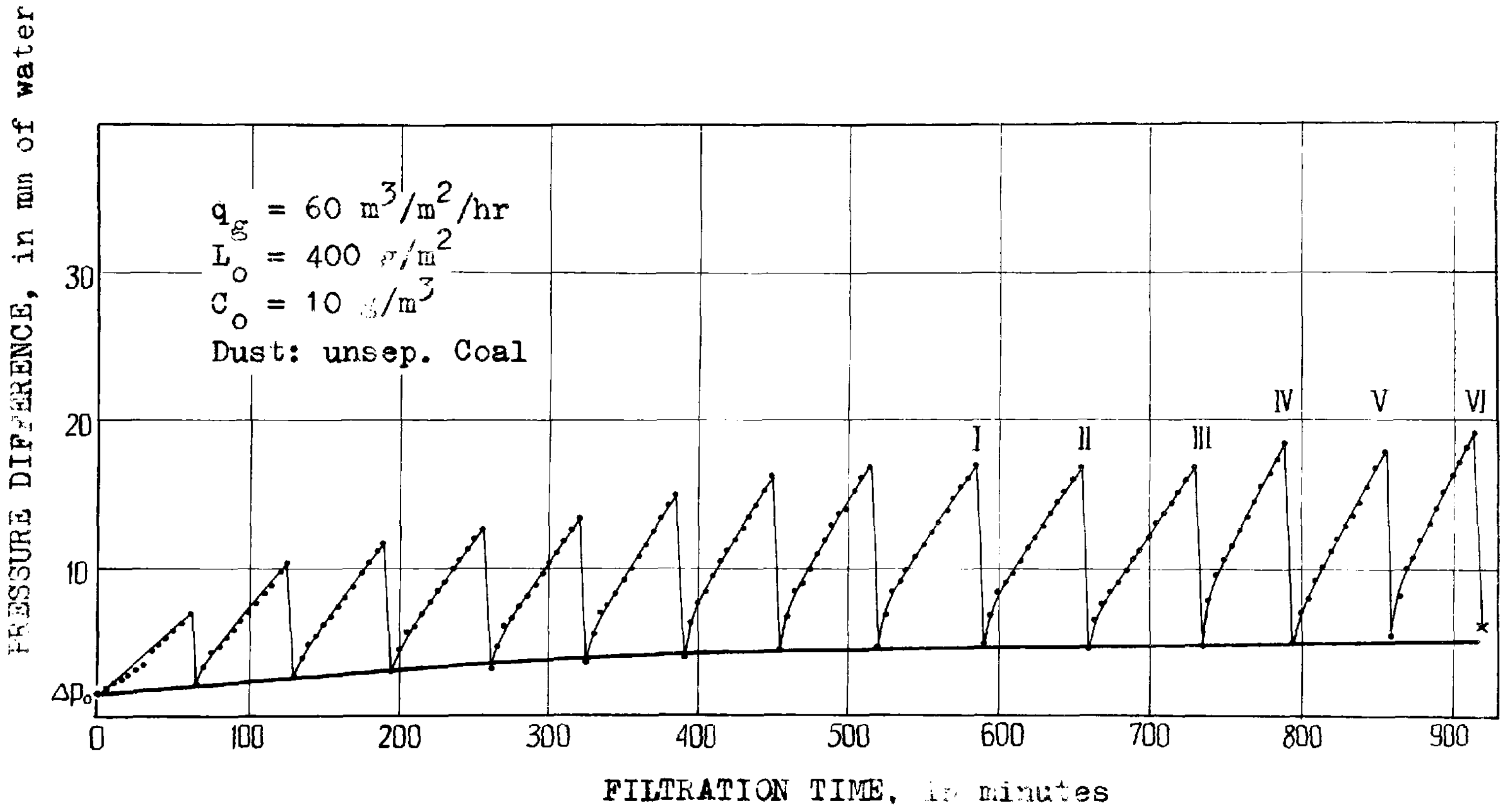


Figure A-73. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 190.

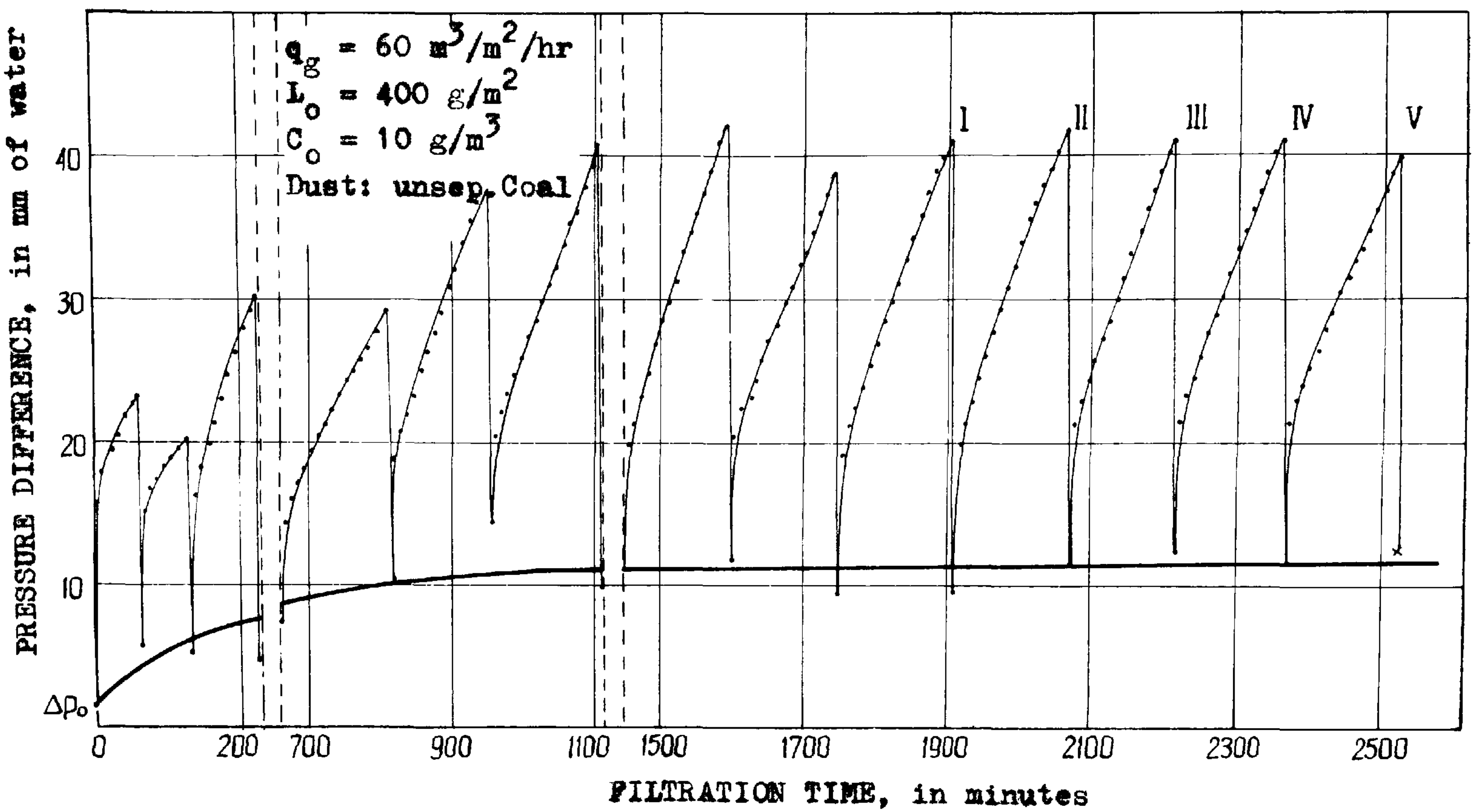


Figure A-74. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 850

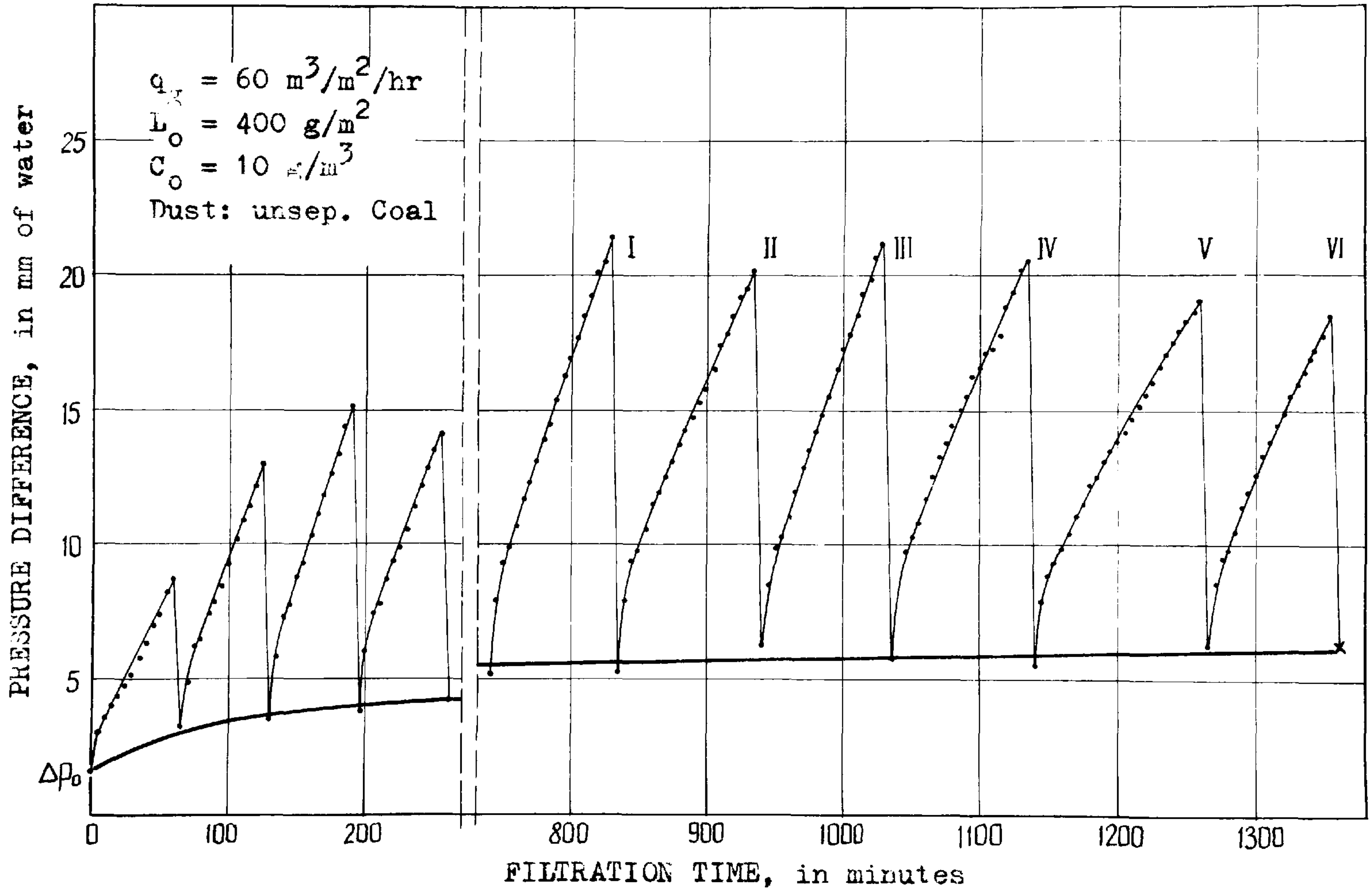


Figure A-75. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 802B.

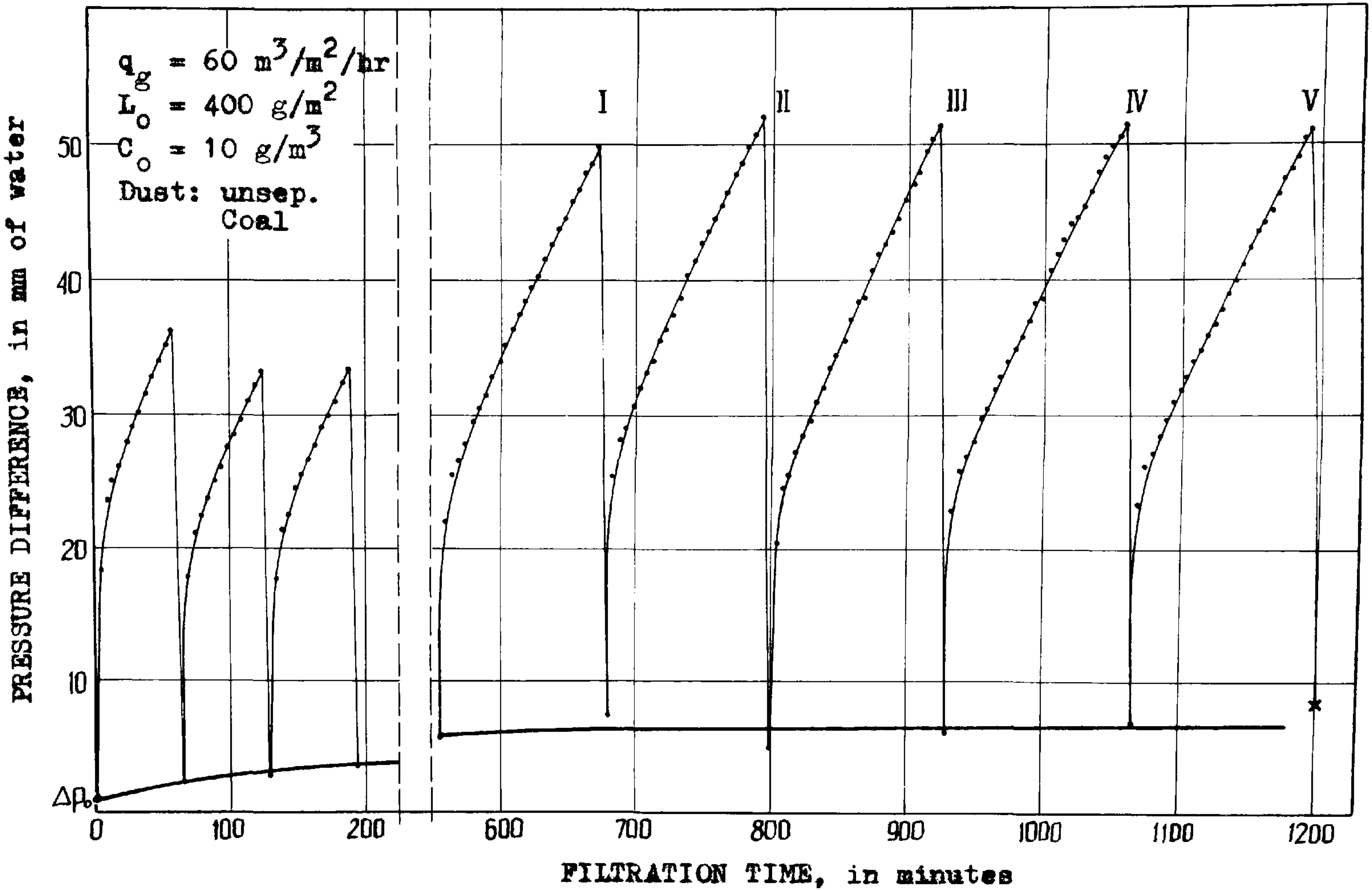


Figure A-76. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-875.

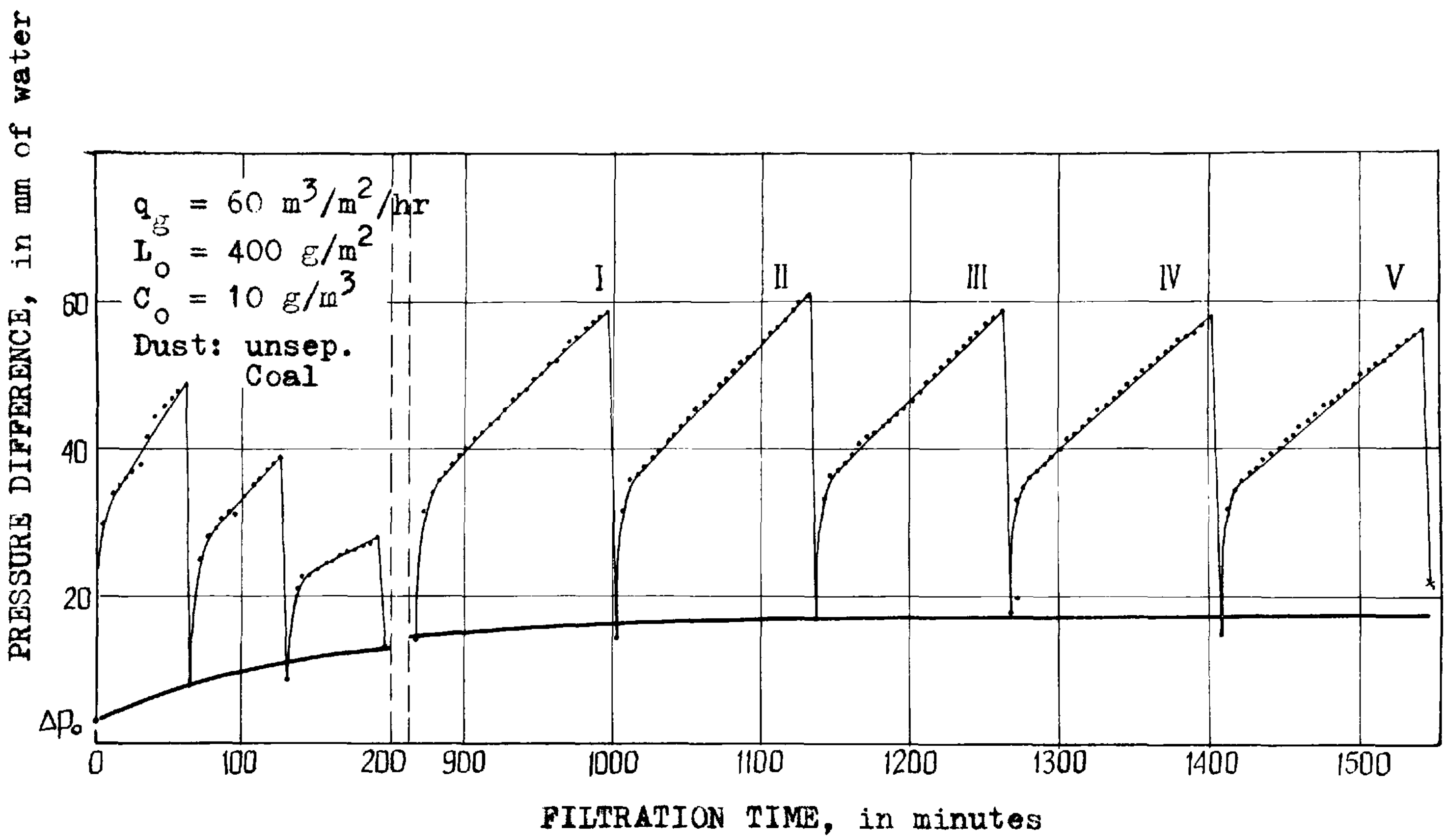


Figure A-77. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-870.

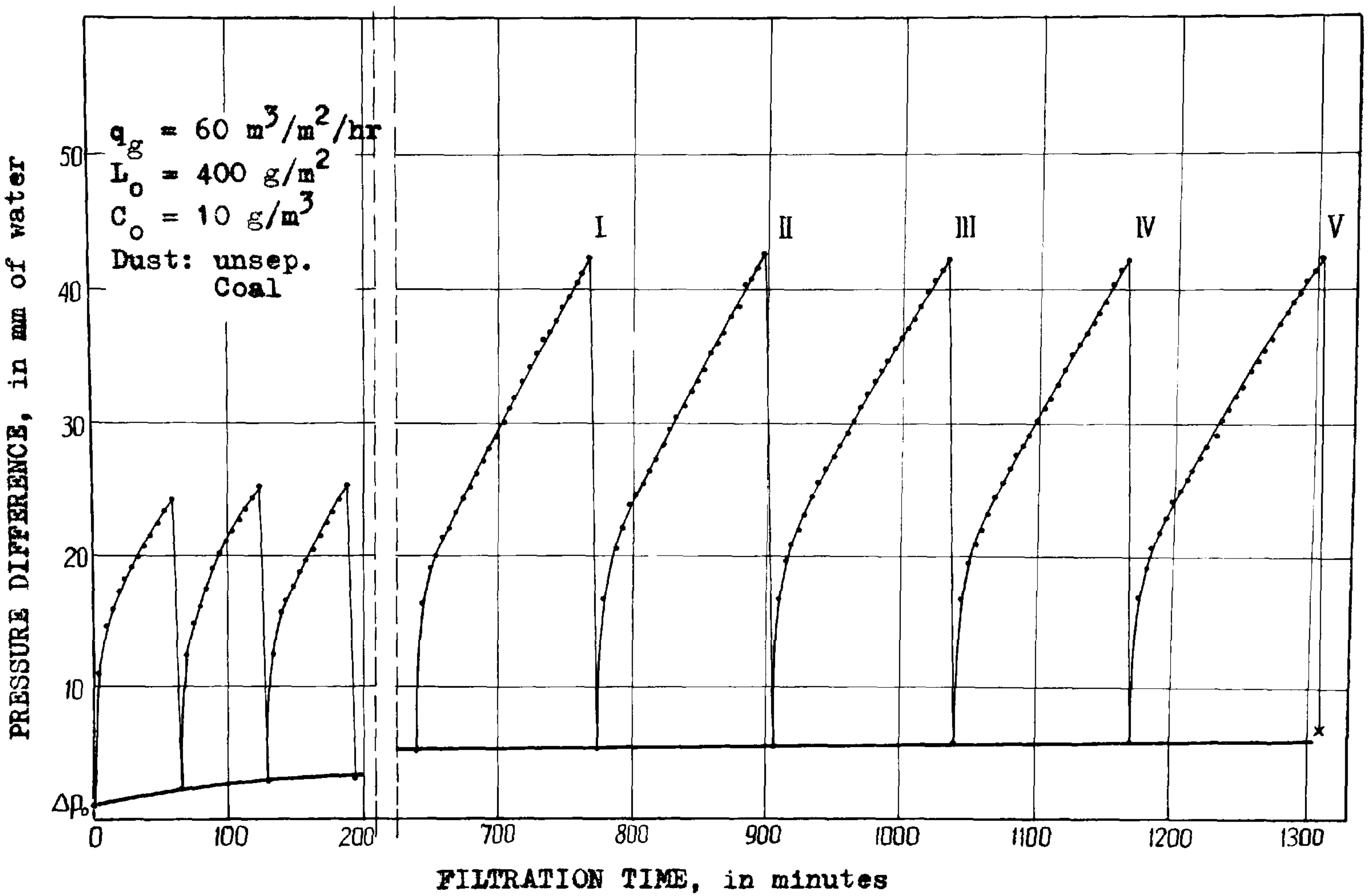


Figure A-78. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-878.

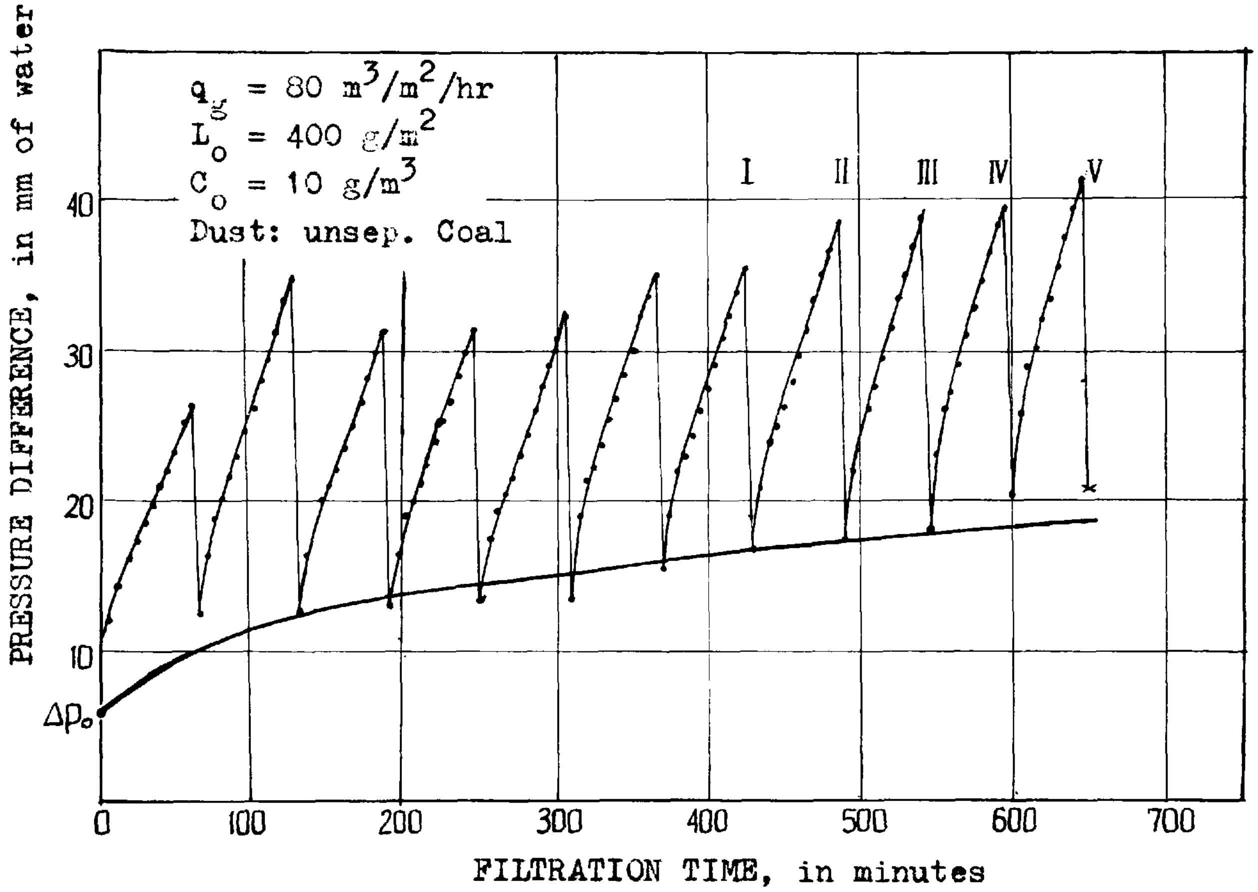


Figure A-79. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 960.

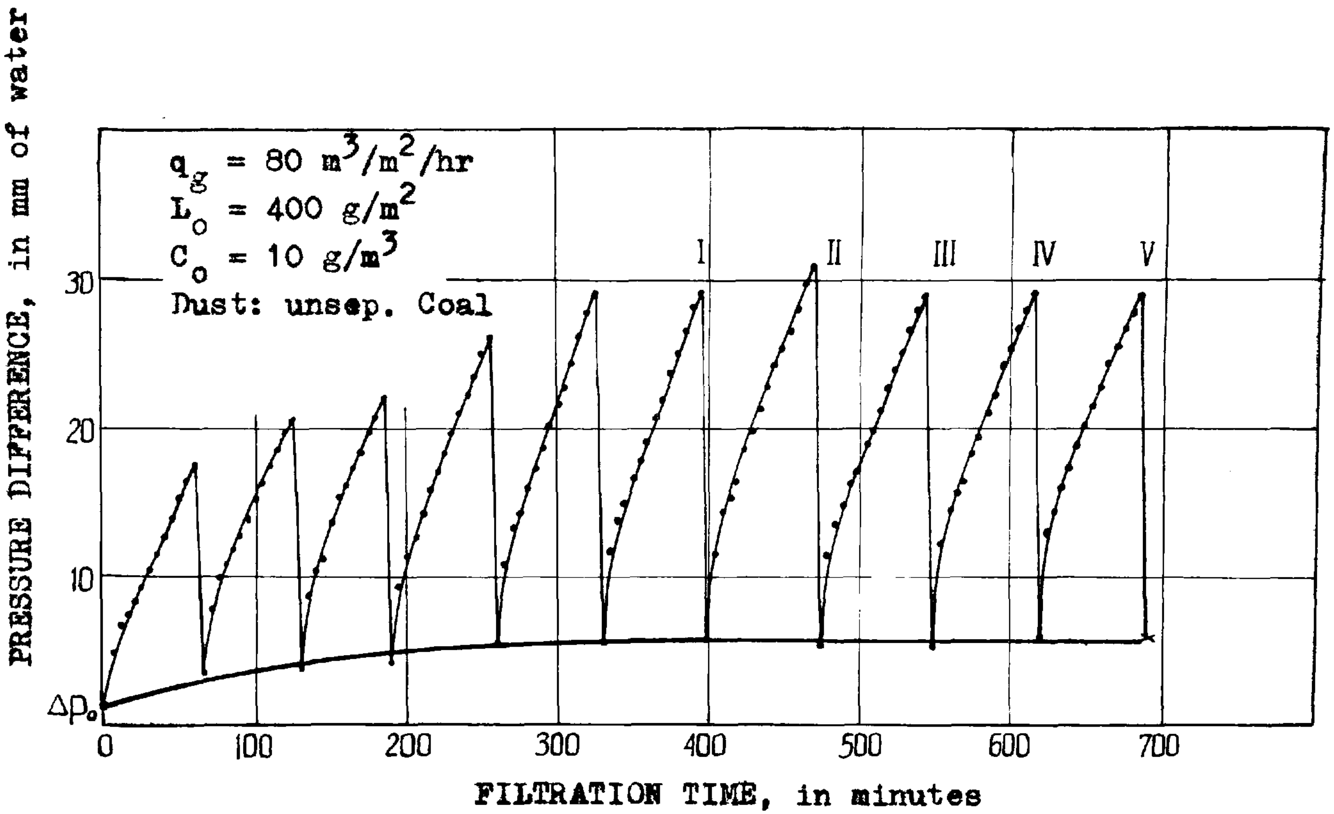


Figure A-80. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 862B.

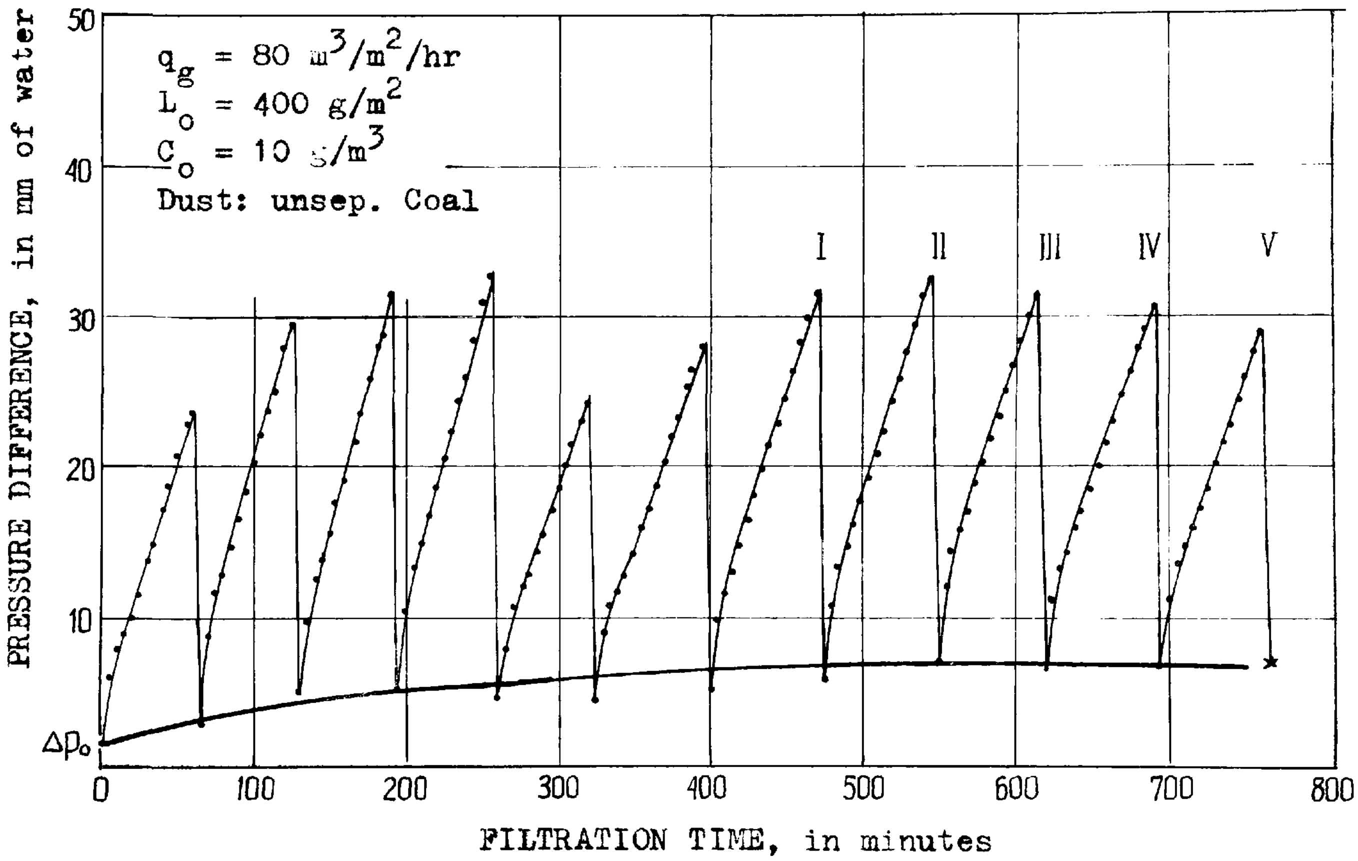


Figure A-81. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C866B.

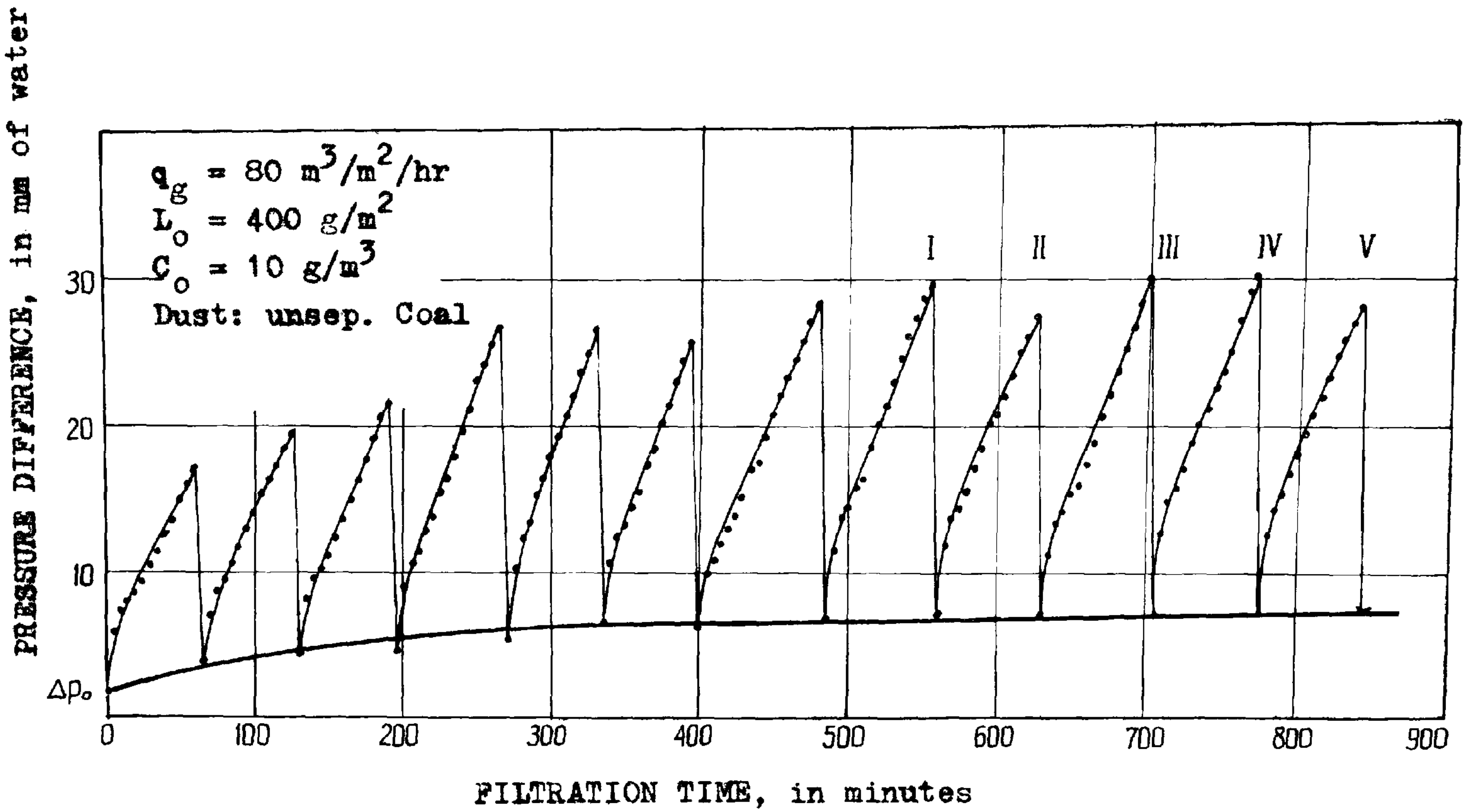


Figure A-82. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C868B.

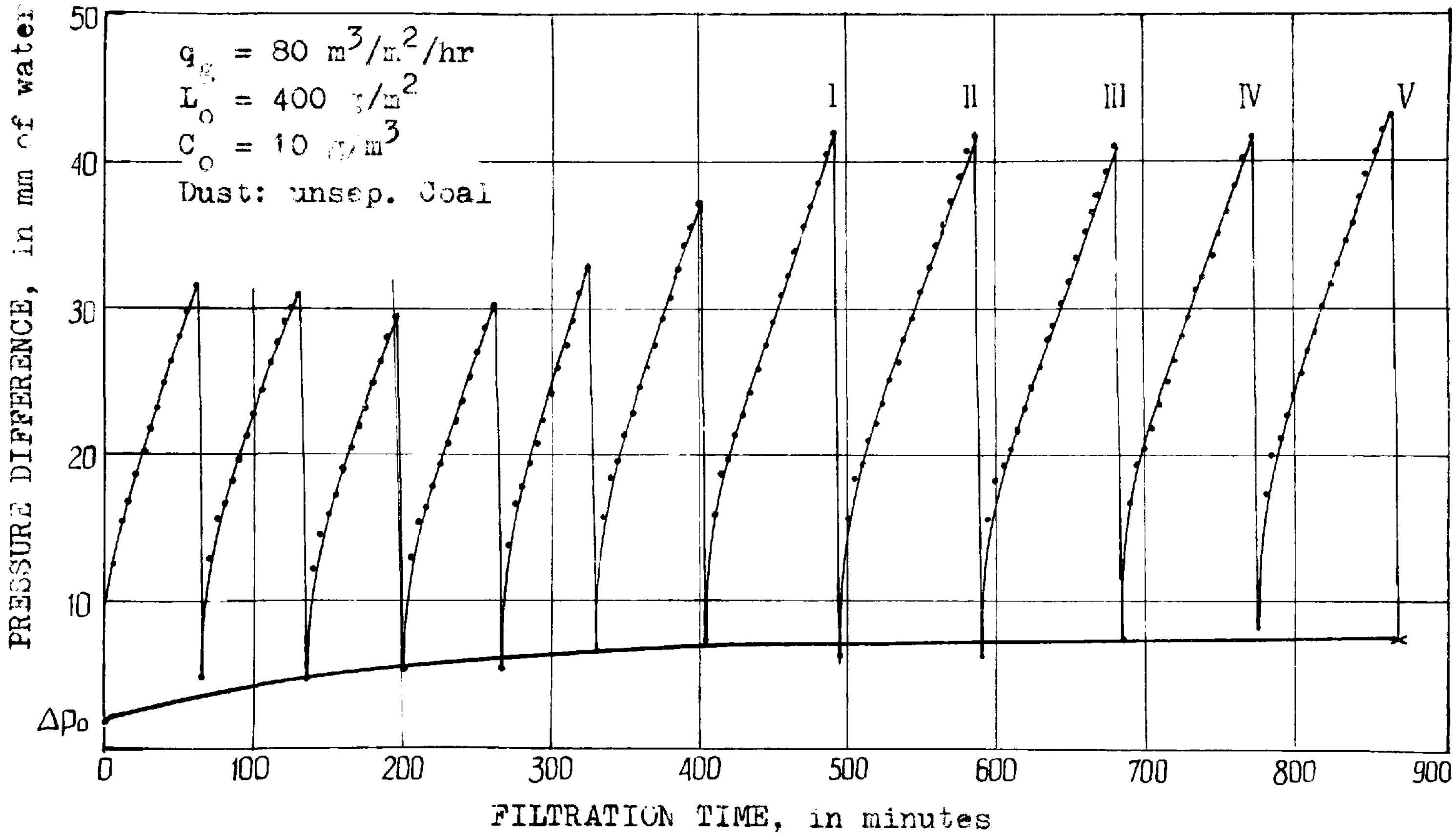


Figure A-83. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 865B.

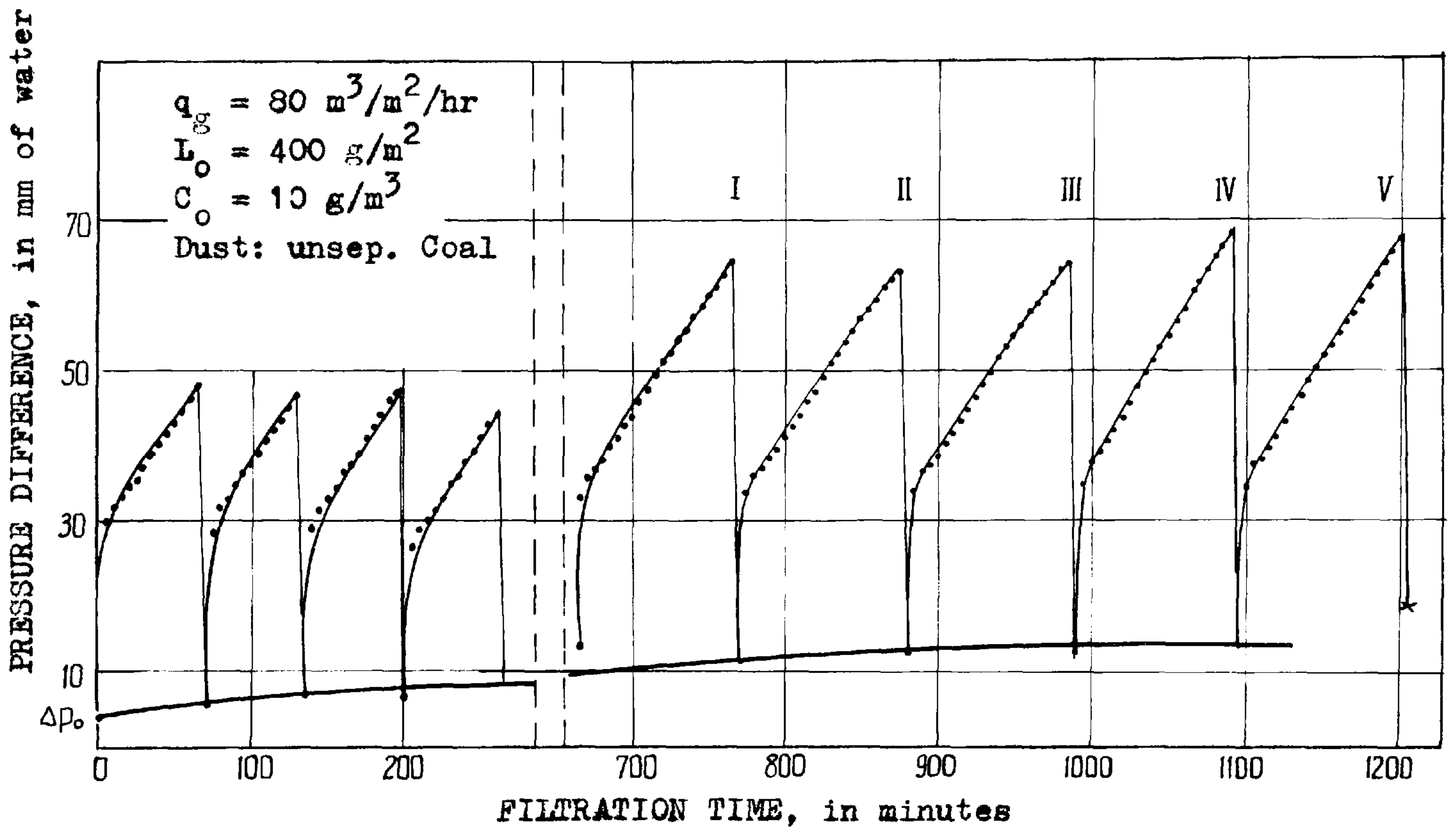


Figure A-84. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C890B.

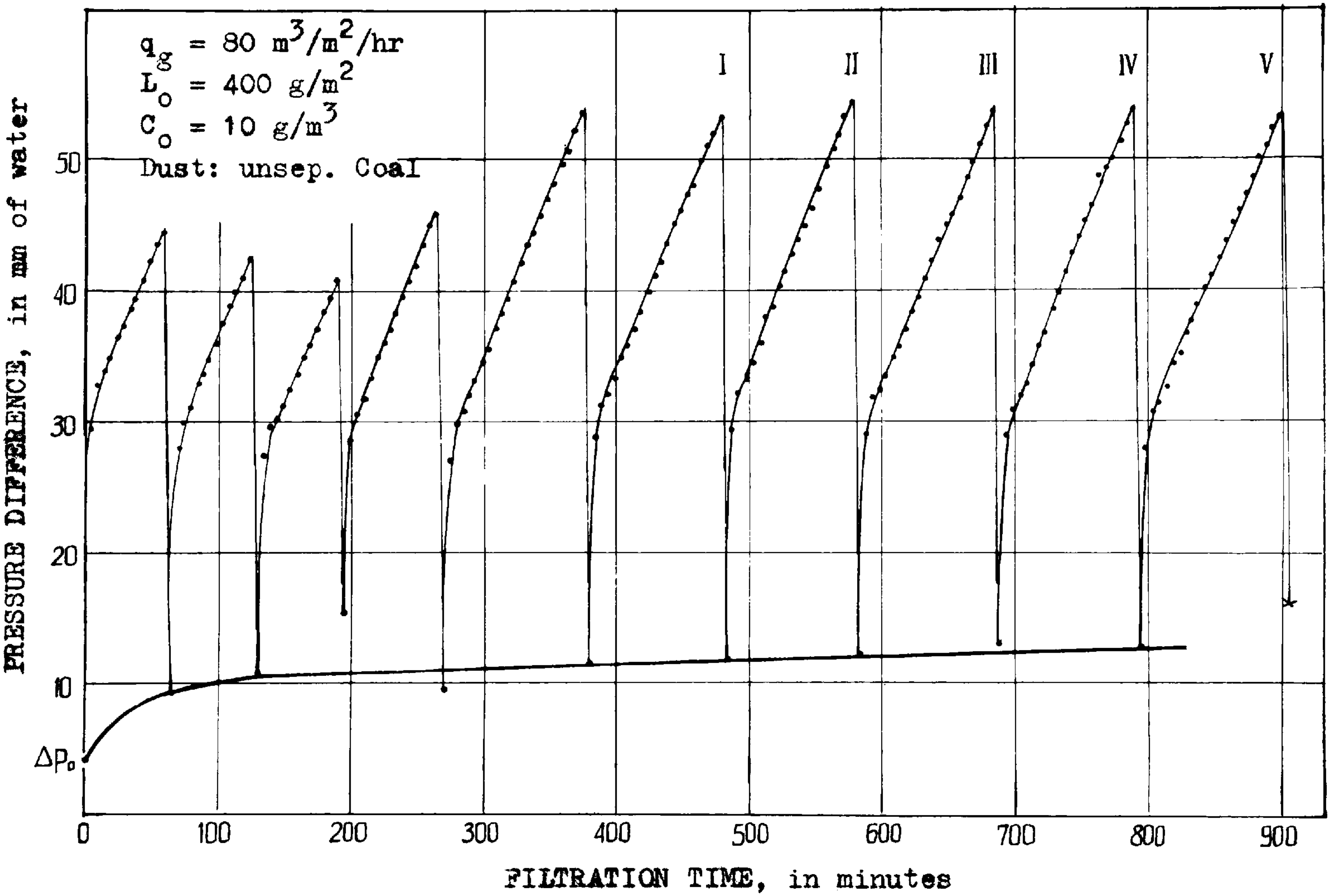


Figure A-85. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric C892B.

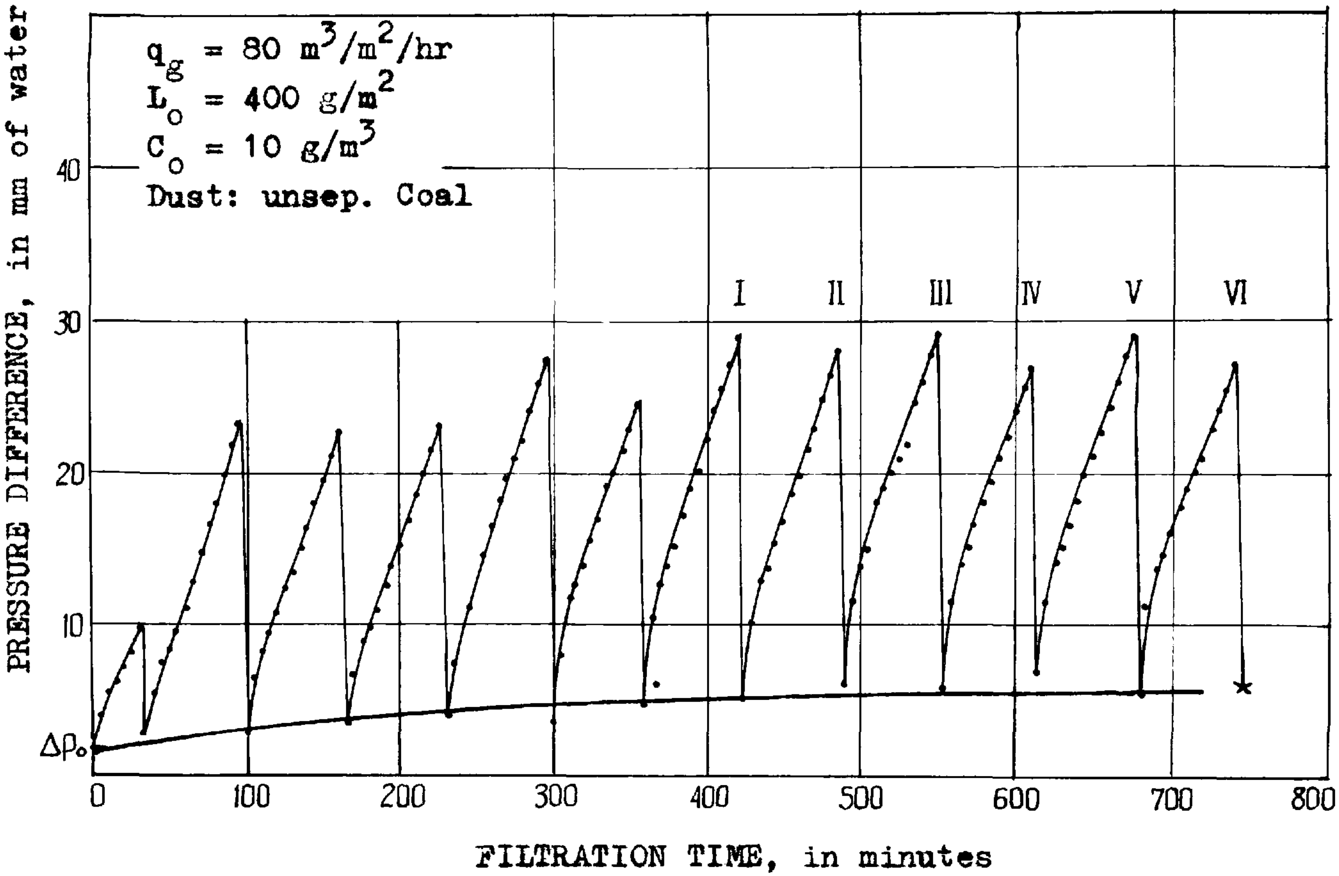


Figure A-86. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 852.

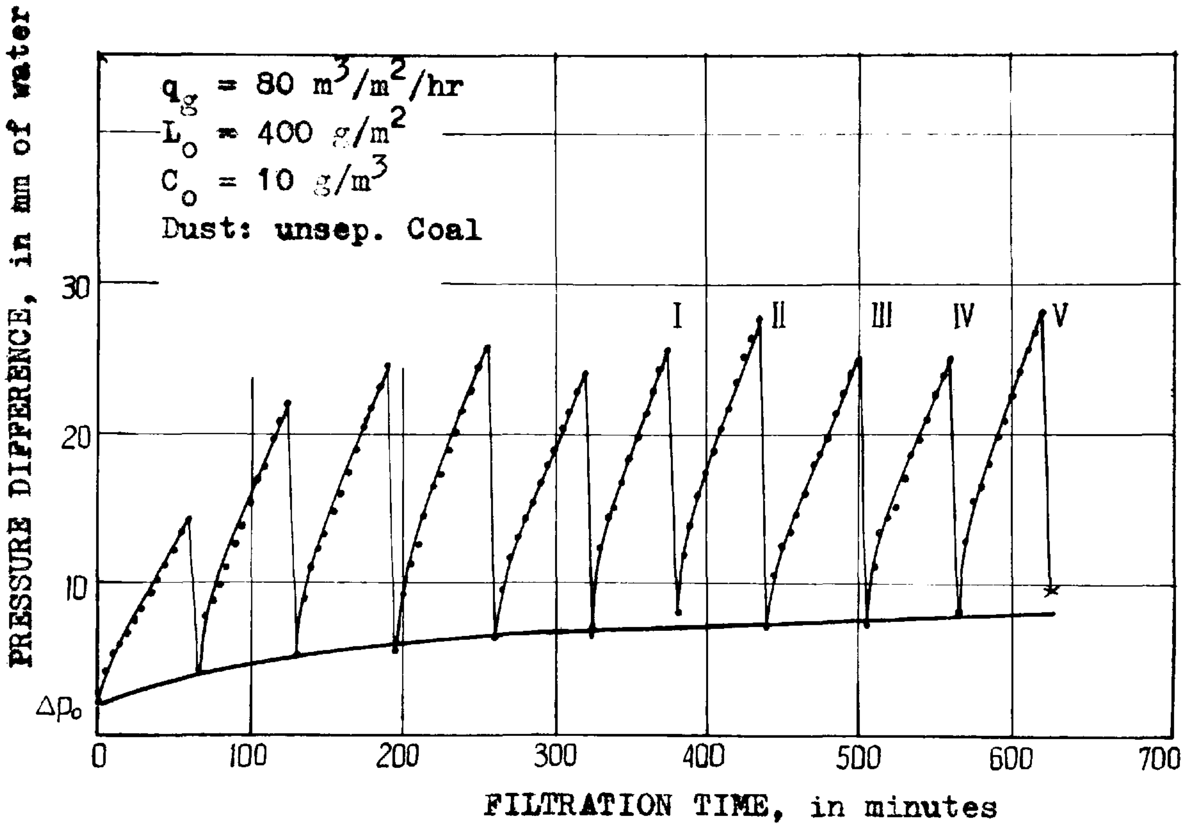


Figure A-87. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 853.

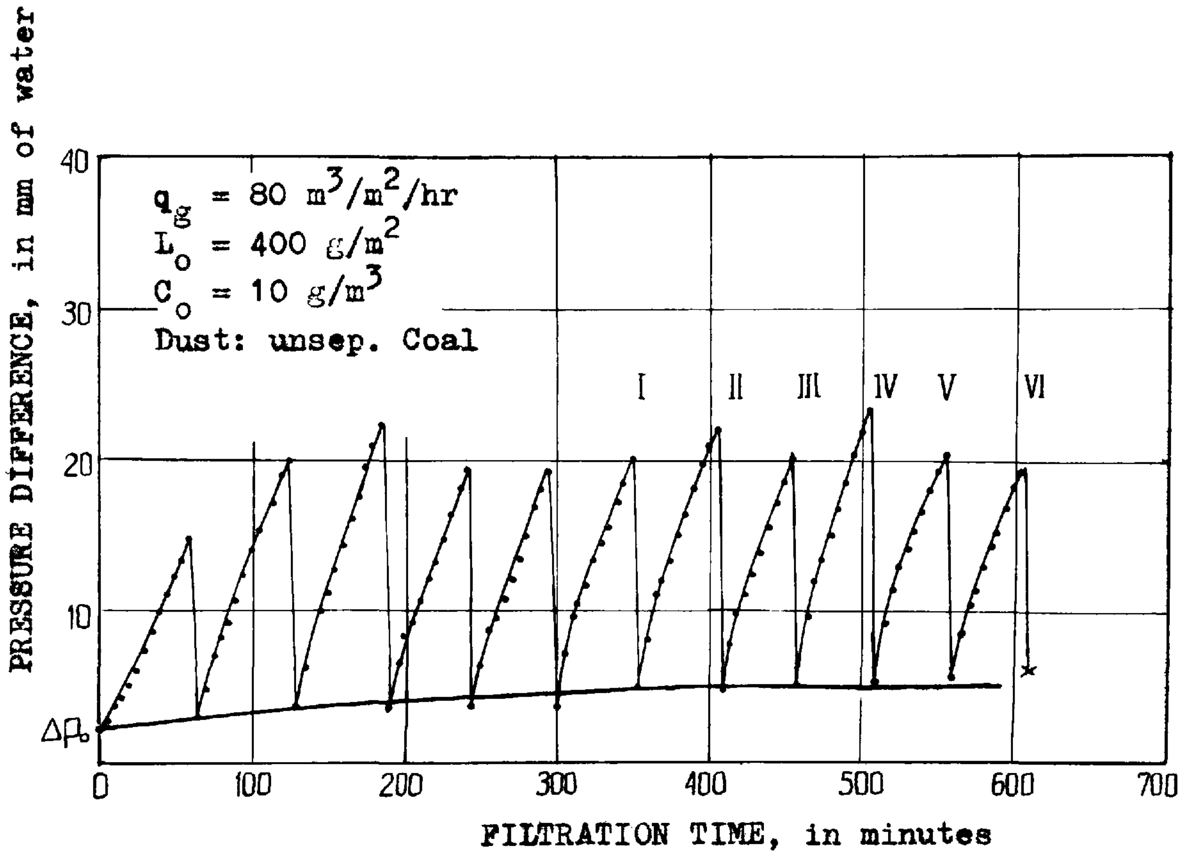


Figure A-88. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 190.

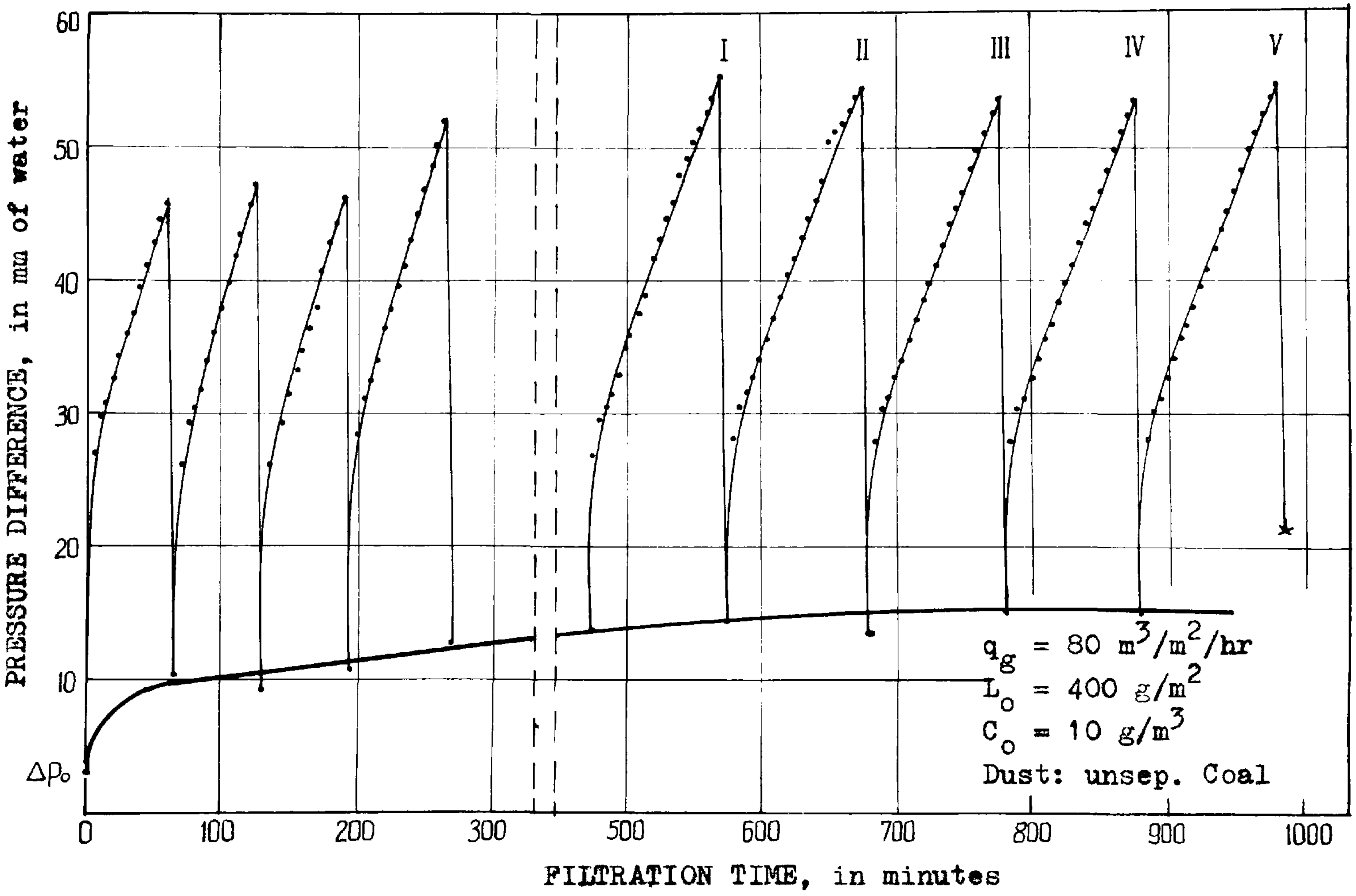


Figure A-89. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 850.

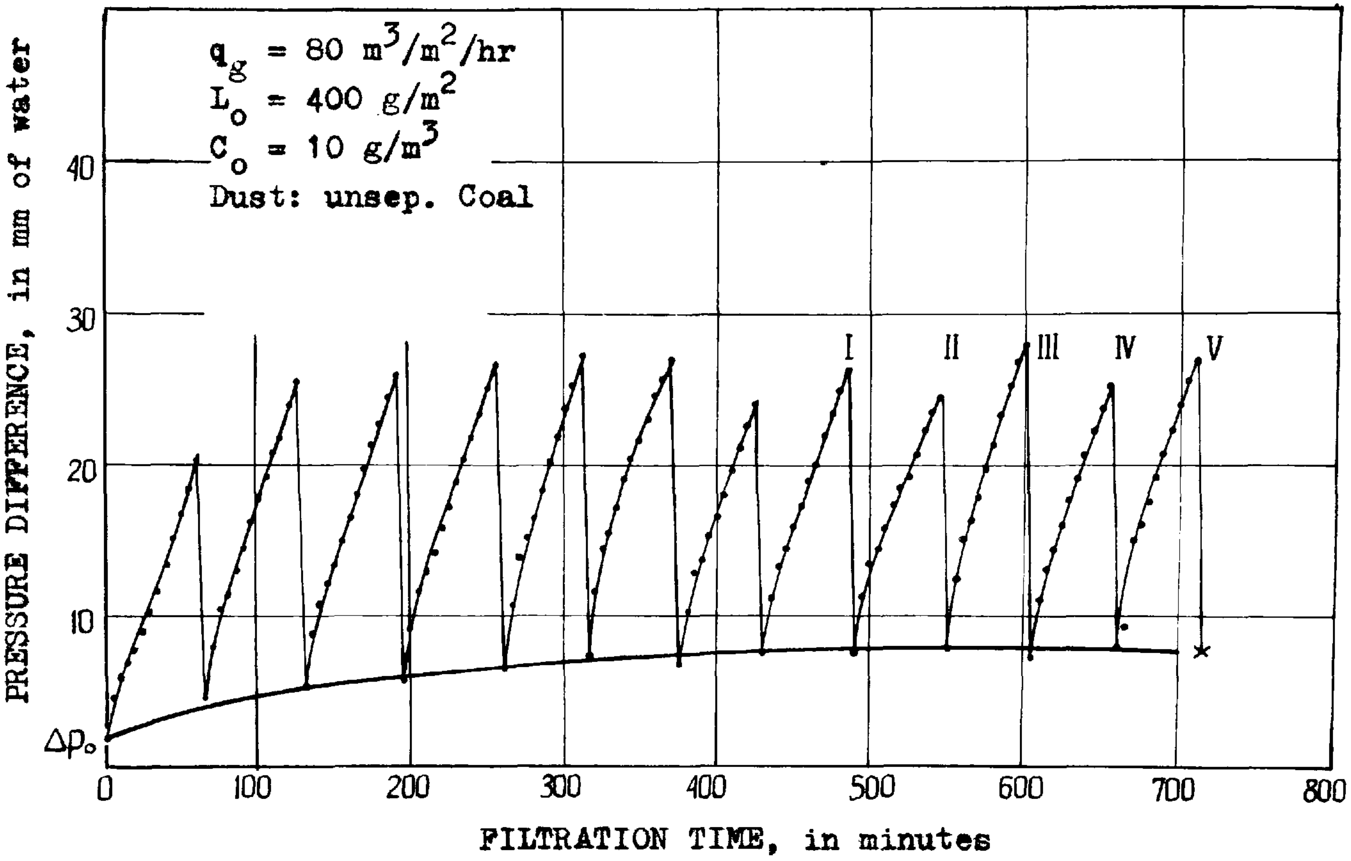


Figure A-90. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric 802B.

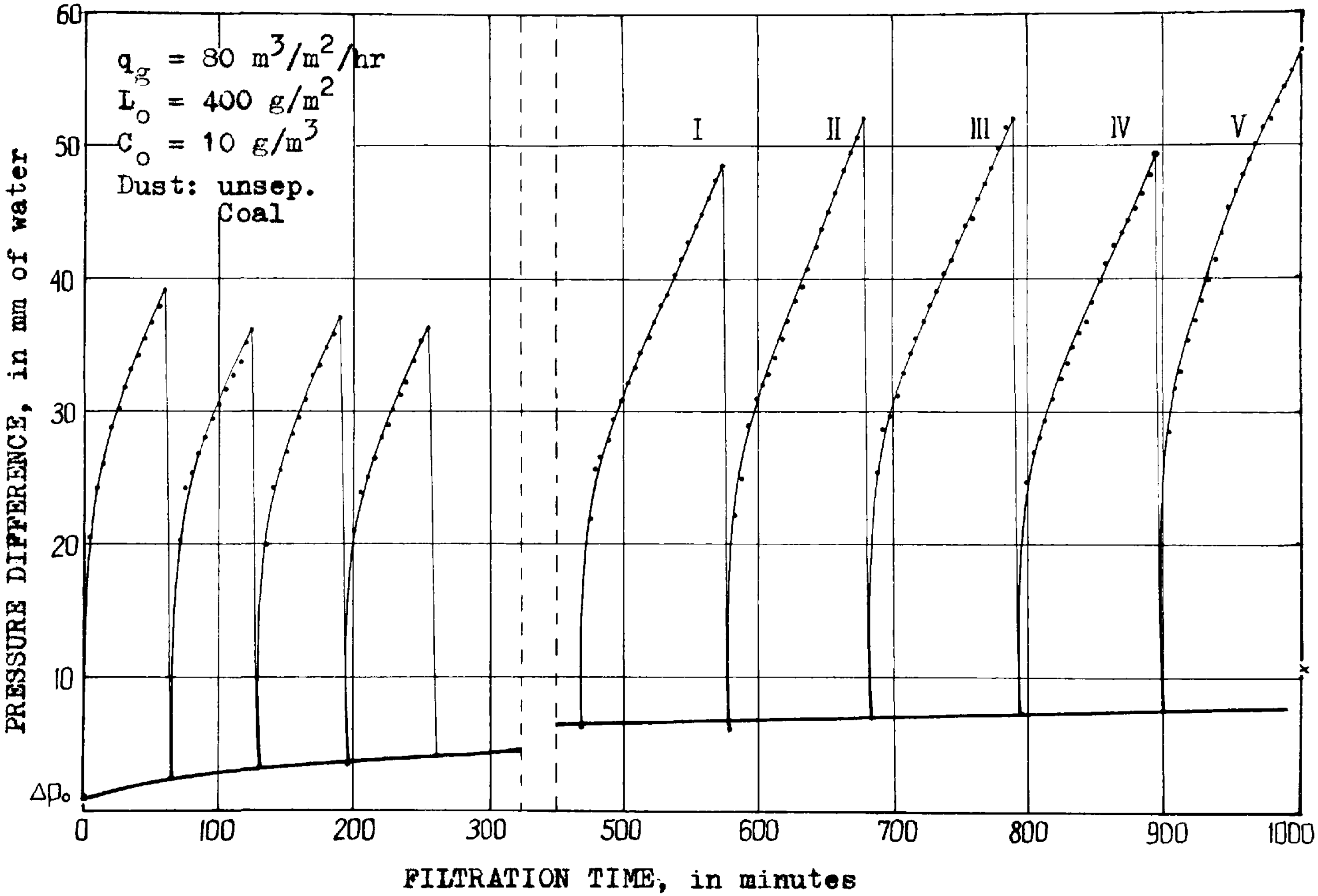


Figure A-91. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-875.

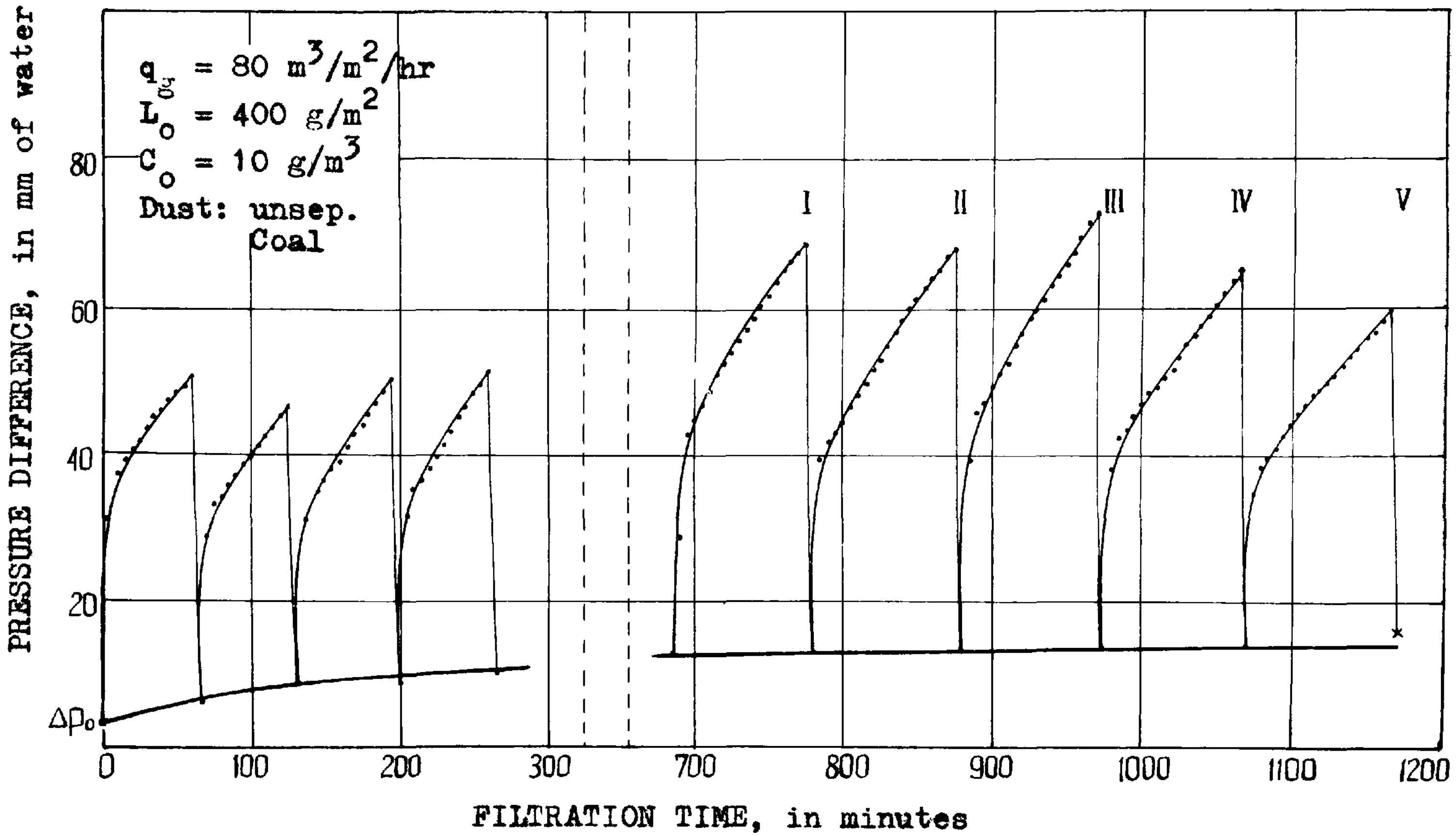


Figure A-92. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-870.

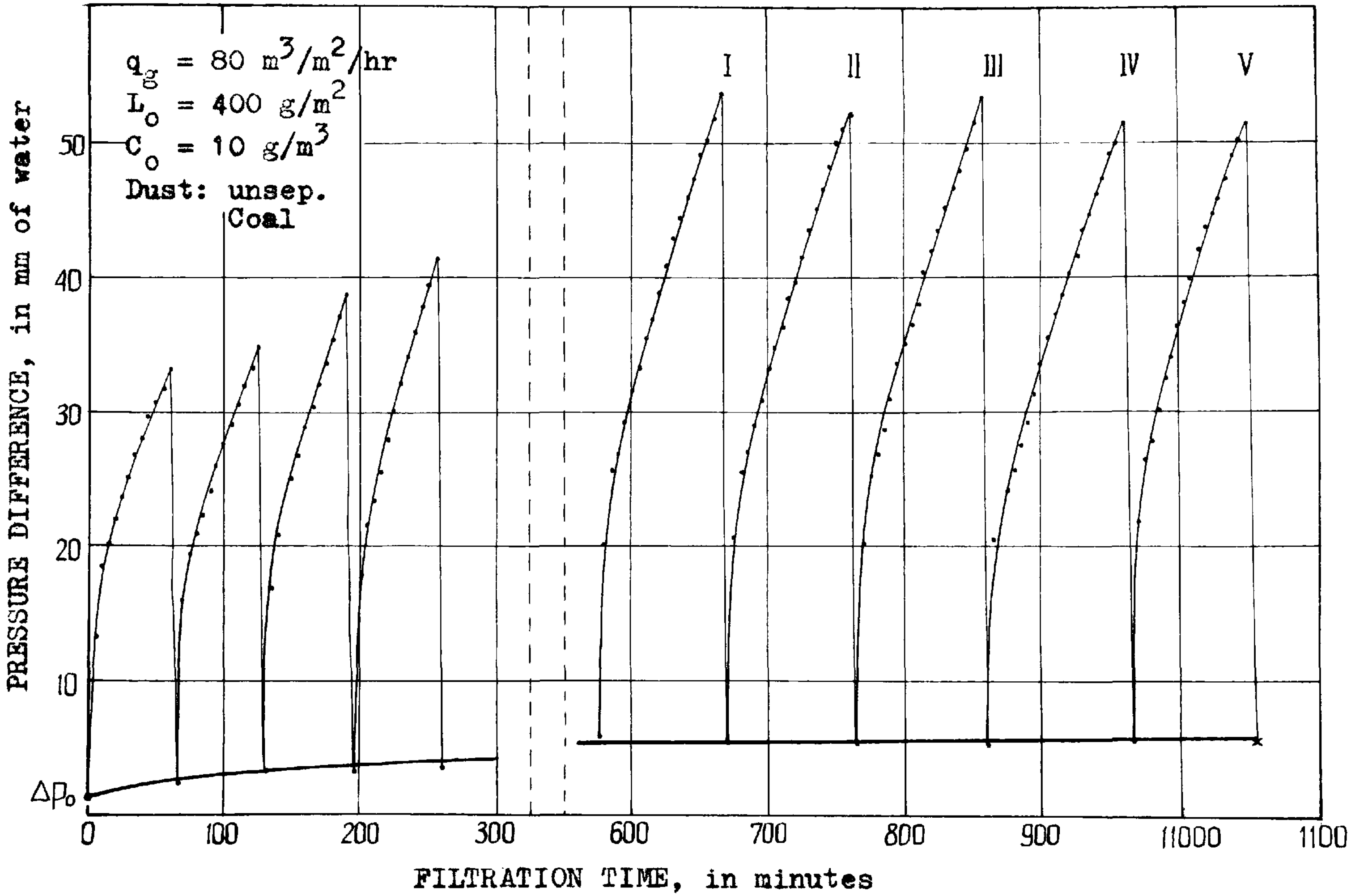


Figure A-93. Pressure Difference vs. Filtration Time for Large-Scale Testing of Fabric Q53-878.

APPENDIX B

Table B-1. Pressure Drop (in mm of water) vs. Gas Loading of Filtration Area for Pure Fabrics

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
960	2.77	3.63	5.29	7.11	8.85	10.83	12.72	14.62	20	47	745
	3.08	3.79	5.29	7.27	9.64	11.77	13.98	16.04			
	2.84	3.40	4.98	7.03	9.09	11.14	13.04	14.85			
	3.16	3.87	5.61	7.90	10.19	12.32	14.54	16.59			
	2.84	3.48	5.06	7.19	9.32	11.38	13.19	15.01			
Average	2.94	3.63	5.25	7.30	9.42	11.49	13.49	15.42			
862B	0.16	0.19	0.25	0.35	0.51	0.66	0.79	0.92	21	43	747
	0.16	0.19	0.25	0.38	0.51	0.66	0.82	0.95			
	0.16	0.19	0.28	0.38	0.51	0.66	0.82	0.95			
	0.19	0.22	0.32	0.44	0.60	0.79	0.95	1.11			
	0.16	0.19	0.28	0.38	0.54	0.70	0.82	0.98			
Average	0.17	0.20	0.28	0.39	0.53	0.69	0.84	0.98			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
C866B	0.40	0.47	0.63	0.95	1.26	1.58	1.90	2.29	20	42	748
	0.40	0.47	0.71	0.95	1.26	1.58	1.90	2.21			
	0.47	0.55	0.79	1.11	1.50	1.98	2.29	2.69			
	0.40	0.47	0.71	0.95	1.34	1.74	2.05	2.45			
	0.32	0.40	0.55	0.71	1.03	1.34	1.58	1.82			
Average	0.40	0.47	0.68	0.93	1.28	1.64	1.94	2.29			
C868B	0.79	0.87	1.26	1.74	2.29	2.92	3.56	4.11	23	47	742
	0.71	0.87	1.26	1.66	2.21	2.84	3.40	3.95			
	0.63	0.79	1.19	1.58	2.13	2.69	3.16	3.63			
	0.63	0.79	1.11	1.50	1.98	2.45	2.92	3.40			
	0.63	0.79	1.11	1.50	2.05	2.61	3.08	3.63			
Average	0.68	0.82	1.19	1.60	2.13	2.70	3.22	3.74			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
865B	0.63	0.95	1.26	1.90	2.53	3.00	3.48	3.95	20	47	745
	0.79	1.03	1.50	2.21	2.84	3.48	3.95	4.66			
	0.79	1.03	1.50	2.21	2.84	3.48	3.95	4.74			
	1.03	1.26	1.90	2.69	3.48	4.19	4.99	5.61			
	0.95	1.19	1.82	2.61	3.40	4.11	4.82	5.53			
Average	0.84	1.09	1.58	2.32	3.01	3.65	4.24	4.90			
C890B	1.19	1.42	2.05	2.69	3.48	4.19	5.06	6.00	22	35	742
	1.03	1.26	1.74	2.29	2.92	3.48	4.11	4.98			
	1.03	1.26	1.82	2.37	3.00	3.63	4.27	4.98			
	1.26	1.50	2.13	2.37	3.63	4.35	5.21	6.16			
	0.95	1.19	1.58	2.13	2.69	3.24	3.79	4.42			
Average	1.09	1.33	1.86	2.37	3.14	3.78	4.49	5.31			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
C892B	1.50	1.82	2.61	3.48	4.50	5.53	6.64	7.74	22	35	742
	1.50	1.82	2.69	3.79	4.82	5.77	6.79	7.82			
	1.66	2.13	3.00	4.03	5.21	6.32	7.66	8.77			
	1.74	2.21	3.08	4.03	5.21	6.56	7.74	8.93			
	1.90	2.37	3.32	4.58	5.77	7.19	8.53	10.03			
Average	1.66	2.07	2.94	3.98	5.10	6.27	7.47	8.63			
852	0.16	0.24	0.32	0.47	0.55	0.71	0.87	1.03	23	53	746
	0.19	0.25	0.35	0.47	0.60	0.79	0.92	1.11			
	0.22	0.25	0.38	0.51	0.66	0.85	1.01	1.14			
	0.19	0.22	0.35	0.44	0.60	0.76	0.89	1.04			
	0.19	0.25	0.35	0.47	0.63	0.79	0.95	1.07			
Average	0.19	0.24	0.35	0.47	0.61	0.78	0.93	1.08			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
853	0.63	0.79	1.11	1.50	1.98	2.37	2.84	3.24	23	48	750
	0.79	0.95	1.42	1.83	2.45	3.00	3.56	4.11			
	0.63	0.79	1.11	1.42	1.90	2.29	2.77	3.08			
	0.63	0.79	1.19	1.50	2.05	2.53	3.00	3.40			
	0.55	0.71	1.03	1.34	1.74	2.12	2.61	2.92			
Average	0.65	0.81	1.17	1.52	2.02	2.46	2.96	3.35			
190	1.11	1.34	1.90	2.53	3.32	4.03	4.74	5.37	23	54	746
	1.19	1.42	2.05	2.77	3.63	4.42	5.14	5.93			
	1.03	1.26	1.82	2.45	3.24	3.95	4.58	5.29			
	1.11	1.42	1.97	2.61	3.40	4.19	4.90	5.61			
	1.11	1.34	1.98	2.61	3.40	4.19	4.90	5.61			
Average	1.11	1.36	1.94	2.59	3.40	4.16	4.85	5.56			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
850	0.63	0.79	1.11	1.50	1.98	2.53	3.00	3.63	23	48	750
	0.63	0.79	1.11	1.50	1.98	2.45	2.92	3.32			
	0.63	0.79	1.11	1.50	1.98	2.45	2.92	3.32			
	0.63	0.79	1.19	1.58	2.13	2.61	3.00	3.48			
	0.63	0.79	1.11	1.50	2.05	2.53	2.92	3.40			
Average	0.63	0.79	1.13	1.52	2.02	2.51	2.95	3.43			
802B	0.87	1.03	1.50	1.98	2.69	3.40	4.03	4.66	23	47	742
	0.79	0.95	1.34	1.74	2.29	2.92	3.48	3.95			
	0.79	0.95	1.34	1.82	2.45	3.00	3.63	4.19			
	0.87	1.03	1.50	2.05	2.69	3.40	4.03	4.66			
	0.95	1.11	1.58	2.13	2.92	3.63	4.35	4.98			
Average	0.85	1.01	1.45	1.94	2.61	3.27	3.90	4.49			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
Q53-875	0.22	0.28	0.41	0.54	0.76	0.95	1.11	1.26	25	50	747
	0.22	0.32	0.44	0.57	0.79	0.98	1.14	1.33			
	0.22	0.25	0.38	0.51	0.73	0.89	1.07	1.26			
	0.22	0.25	0.38	0.54	0.76	0.92	1.11	1.30			
	0.22	0.28	0.41	0.57	0.79	1.01	1.17	1.33			
Average	0.22	0.28	0.40	0.55	0.77	0.95	1.12	1.30			
Q53-870	1.90	2.21	3.32	5.06	6.64	8.22	9.64	11.22	26	38	747
	1.90	2.21	3.48	5.06	6.64	8.06	9.48	11.06			
	1.90	2.21	3.32	4.74	6.32	7.90	9.32	10.74			
	1.90	2.21	3.32	4.90	6.48	7.90	9.48	10.90			
	1.90	2.21	3.48	5.06	6.64	8.06	9.64	11.06			
Average	1.90	2.21	3.38	4.96	6.54	8.03	9.51	11.00			

Table B-1 (Continued)

Kind of Fabric	Gas loading of filtration area in $m^3/m^2/hr$								Conditions		
	50	60	80	100	120	140	160	180	Tem. °C	Rel. Hum. %	Atm. Press. mmHg
Q53-878	0.35	0.44	0.66	0.92	1.26	1.61	1.92	2.24	25	50	747
	0.35	0.44	0.63	0.89	1.20	1.55	1.83	2.17			
	0.38	0.47	0.70	0.95	1.30	1.65	1.98	2.34			
	0.35	0.44	0.60	0.95	1.26	1.61	1.96	2.28			
	0.38	0.44	0.69	0.98	1.33	1.65	1.98	2.31			
Average	0.36	0.45	0.66	0.94	1.27	1.61	1.93	2.27			

Table B-2. Characteristic Pressure Drop (in mm water) For Reverse Air Flow Regeneration (dust: separated talc, $q_g = 60\ m^3/m^2/hr$, $C_0 = 10g/m^3$).

Kind Of Fabric	ΔP_K	ΔP_0	ΔP_{NK}
Style 960	26.80	4.00	11.45
Sytle 862B	20.20	0.60	4.28
Style C866B	22.20	0.80	5.70
Style C868B	22.00	1.40	7.83
Style 865B	34.40	1.30	8.15
Style C890B	49.10	2.80	16.60
Style C892B	38.10	1.70	10.73
Style 852	19.64	0.60	3.15
Style 853	14.70	1.10	8.80
Style 190	14.10	1.40	3.95
Style 850	36.60	1.40	13.97
Style 802B	23.60	2.70	8.90
Style Q53-875	50.60	0.80	11.98
Style Q53-870	41.40	2.50	15.63
Style Q53-878	38.30	1.10	10.83

Table B-3. Characteristic Pressure Drop (in mm water) For Mechanical Regeneration (dust: separated talc, $q_g = 60\ m^3/m^2/hr$, $C_0 = 10\ g/m^3$).

Kind Of Fabric	ΔP_{RM1}	ΔP_{RM2}	ΔP_{RM3}
Style 960	12.3	12.8	12.8
Sytle 862B	4.3	4.0	3.8
Style C866B	5.5	6.2	6.2
Style C868B	7.4	7.7	7.6
Style 865B	8.1	8.1	7.9
Style C890B	17.1	16.1	15.6
Style C892B	12.3	11.2	10.9
Style 852	5.1	5.5	5.4
Style 853	9.2	9.5	9.5
Style 190	4.0	4.1	4.1
Style 850	13.6	13.7	13.9
Style 802B	10.3	10.4	10.4
Style Q53-875	14.4	11.2	10.3
Style Q53-870	16.9	16.9	17.1
Style Q53-878	12.0	12.0	11.7

Table B-4. Characteristic Pressure Drop (in mm water) For Reverse Air Flow Regeneration (dust: separated talc, q_g = 80 $m^3/m^2/hr$, C_0 = 10 g/m^3).

Kind Of Fabric	ΔP_K	ΔP_0	ΔP_{NK}
Style 960	37.50	5.70	17.35
Sytle 862B	34.20	0.80	5.50
Style C866B	33.00	1.10	8.08
Style C868B	28.60	2.40	10.60
Style 865B	40.80	2.10	8.50
Style C890B	60.50	4.30	15.45
Style C892B	45.60	2.40	9.53
Style 852	22.40	1.10	6.45
Style 853	22.50	1.90	10.65
Style 190	16.80	1.90	4.83
Style 850	63.90	2.50	19.00
Style 802B	23.80	1.90	8.70
Style Q53-875	54.50	1.10	8.50
Style Q53-870	80.60	3.20	22.70
Style Q53-878	51.90	1.10	12.63

Table B-5. Characterization Pressure Drop (in mm water) For Mechanical Regeneration (dust: separated talc, q_g = 80 $m^3/m^2/hr$, C_0 = 10 g/m^3).

Kind Of Fabric	ΔP_{RM1}	ΔP_{RM2}	ΔP_{RM3}
Style 960	18.0	18.2	18.2
Sytle 862B	6.2	6.0	5.8
Style C866B	9.6	9.0	8.4
Style C868B	12.3	12.2	11.9
Style 865B	10.7	10.6	10.4
Style C890B	20.5	20.5	20.1
Style C892B	8.8	6.6	6.0
Style 852	9.6	9.8	9.5
Style 853	10.7	10.7	10.7
Style 190	5.1	5.2	5.1
Style 850	21.2	21.8	21.6
Style 802B	9.6	9.8	9.6
Style Q53-875	12.2	11.7	9.9
Style Q53-870	25.4	26.7	26.5
Style Q53-878	14.2	14.4	14.2

Table B-6. Characteristic Pressure Drop (in mm water) For Reverse Air Flow Regeneration (dust: unsep. coal, q_g = 60 $m^3/m^2/hr$, C_0 = 10 g/m^3).

Kind Of Fabric	ΔP_K	ΔP_0	ΔP_{NK}
Style 960	28.6	3.5	14.0
Sytle 862B	28.9	0.9	5.4
Style C866B	22.7	1.1	5.5
Style C868B	28.3	1.9	7.6
Style 865B	26.9	1.6	6.1
Style C890B	35.5	1.4	7.1
Style C892B	51.5	3.3	10.1
Style 852	25.4	0.8	6.9
Style 853	22.0	1.4	7.4
Style 190	17.6	1.6	4.7
Style 850	41.0	1.4	10.4
Style 802B	20.2	1.6	5.8
Style Q53-875	51.1	0.8	6.3
Style Q53-870	58.0	2.8	15.7
Style Q53-878	42.4	0.9	5.5

Table B-7. Characteristic Pressure Drop (in mm water) For Mechanical Regeneration (dust: unsep. coal, q_g = 60 $m^3/m^2/hr$, C_0 = 10 g/m^3).

Kind Of Fabric	ΔP_{RM1}	ΔP_{RM2}	ΔP_{RM3}
Style 960	14.7	14.7	14.7
Sytle 862B	5.4	5.2	5.1
Style C866B	5.7	5.4	5.1
Style C868B	7.7	7.9	7.9
Style 865B	7.7	7.4	7.1
Style C890B	7.1	8.4	8.7
Style C892B	10.3	10.7	10.7
Style 852	7.4	7.6	7.4
Style 853	7.9	7.7	7.7
Style 190	5.2	5.2	5.2
Style 850	11.7	12.6	13.3
Style 802B	6.2	6.3	6.2
Style Q53-875	8.7	8.4	8.1
Style Q53-870	19.8	21.2	22.3
Style Q53-878	6.8	7.1	7.1

Table B-8. Characteristic Pressure Drop (in mm water) For Reverse Air Flow Regeneration (dust: unsep. coal, q_g = 80 $m^3/m^2/hr$, C_0 = 10 g/m^3).

Kind Of Fabric	ΔP_K	ΔP_0	ΔP_{NK}
Style 960	38.9	5.8	18.1
Sytle 862B	29.5	1.1	5.5
Style C866B	31.2	1.6	6.6
Style C868B	29.3	1.9	7.2
Style 865B	42.1	1.7	7.1
Style C890B	65.6	3.8	12.5
Style C892B	53.9	4.1	12.5
Style 852	28.3	1.7	5.9
Style 853	26.4	1.9	7.7
Style 190	20.9	2.1	5.1
Style 850	54.4	2.7	14.4
Style 802B	26.2	1.9	7.8
Style Q53-875	51.9	0.9	6.8
Style Q53-870	66.7	2.9	13.0
Style Q53-878	52.4	1.3	5.3

Table B-9. Characteristic Pressure Drop (in mm water) For Mechanical Regeneration (dust: unsep. coal, q_g = 80 $m^3/m^2/hr$, C_0 = 10 g/m^3).

Kind Of Fabric	ΔP_{RM1}	ΔP_{RM2}	ΔP_{RM3}
Style 960	19.8	20.2	20.7
Sytle 862B	6.2	6.0	5.7
Style C866B	7.1	7.1	6.8
Style C868B	7.7	7.3	7.1
Style 865B	7.0	7.4	7.4
Style C890B	18.2	19.0	19.6
Style C892B	15.3	17.1	15.6
Style 852	5.8	6.3	6.0
Style 853	9.3	9.6	9.8
Style 190	6.0	5.7	5.5
Style 850			
Style 802B	8.1	8.1	8.1
Style Q53-875	10.9	10.9	10.1
Style Q53-870	16.0	16.0	14.3
Style Q53-878	5.2	5.5	5.5

APPENDIX C

Glossary of Terms

Because of differences in terms used in the literature about dust filtration and filtration media and the various parameters or stages characteristic of filtration processes, we propose a uniform usage of terms for this area. The proposed terms have physical meanings in relation to the processes and phenomena occuring during dust filtration which are quite different from air filtration processes.

FILTRATION. Process of the removal of solid particles from an an aerosol stream in or on the structure of a porous medium.

AIR FILTRATION. Filtration process of atmospheric aerosols.

DUST FILTRATION. Filtration process of industrial aerosols.

DUST FILTRATION TYPE I. The initial phase of the complete dust filtration process when the fabric first begins operation as a filtration medium. This phase ends when the pressure drop reaches a predetermined level.

DUST FILTRATION TYPE II. The second phase continues until the fabric is fully filled with dust. This phase ends when the structure reaches the state of equilibrium.

DUST FILTRATION TYPE III. This phase occurs when a stable level of filling of the fabric by dust has been reached and when the pressure drop returns to a constant level after regenerations. This is a typical process for industrial dust collectors.

GAS LOADING ON FILTRATION AREA. Mean calculated value of gas, in cubic meters, passing through square meter of filtration medium per hour.

PERMEABILITY. Gas loading on the filtration area at a specific pressure drop.

(USA) 0.5 inch of water

(Poland) 20 mm of water

DUST LOADING OF FILTRATION AREA. Mean calculated value of dust quantity, in grams, removed per square meter of filtration medium.

FILTRATION VELOCITY. The true velocity of the aerosol, in meters per second, passing through filter medium (measured in true conditions).

FILLED STRUCTURE. The structure filled with dust, accumulated during filtration process, in g/m^2, which is retained after regeneration (without dust cake).

DEGREE OF FILLING. The ratio of a limited filling for a given regeneration schedule to the completely filled structure, in percent.

DUST-COVERED STRUCTURE. The structure with dust cake in g/m^2.

The full glossary of terms will be enclosed in final report.

APPENDIX D

LIST OF NOMENCLATURE

E = efficiency

G_z = weight of dust collected on the fabric

G_o = weight of dust collected on the control filter or weight of dust in cleaned gas

G_c = weight of dust fed to the testing chamber

ΔP = static pressure drop

ΔP_o = static pressure drop of pure fabric

ΔP_N = static pressure drop of filled fabric

ΔP_{NK} = static pressure drop of filled fabric at balance

ΔP_K = static pressure of covered fabric

ΔP_{KR} = limiting value of pressure drop of ducts/canals formation

ΔP_W = static pressure drop of dust cake

q_g = gas loading on filtration area

FA = free area

l = length

n_o = number of threads in warp in 10 cm

n_w = number of threads in fill in 10 cm

d_o = diameter of warp yarns

d_w = diameter of fill yarns

Nm_o = metrical number of warp yarn

Nm_w = metrical number of fill yarn

C = characteristic constant

l_o = distance between axes of yarns along fill

l_w = distance between axes of yarns along warp

L_N = fabric filling for a given regeneration cycle

L_o = dust loading of filtration area

t = time

S_R = susceptibility for regeneration of fabric

S_{RR} = susceptibility for reverse air flow regeneration

S_{RM} = susceptibility for mechanical regeneration of fabric

C_o = initial concentration

APPENDIX E

METRIC CONVERSIONS

To Convert From	To	Multiply By
ft	meters	0.305
ft^2	$meters^2$	0.0929
ft^3	$meters^3$	0.0283
ft/min	centimeters/sec	0.508
ft^3/min	$centimeters^3$/sec	471.9
in.	centimeters	2.54
$in.^2$	$centimeters^2$	6.45

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Jan R. Koscianowski, Lidia Koscianowska, and Maria Szablewicz		8. PERFORMING ORGANIZATION REPORT NO.
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16. ABSTRACT The report describes laboratory and pilot scale testing of filter fabrics. Tests were made on flat specimens and on bags. Fifteen styles of fabrics (made from cotton, polyester, aramid, or glass) were tested, using cement, coal, or talc dusts. Collection efficiencies and pressure drop data are presented for inlet dust concentrations of 10-11 g/cu m, filtration velocities of 60 and 80 cu m/sq m-hr, temperatures of 20-30 C, and relative humidities of 55-60%. Conclusions reached were: (1) fabrics which performed well on bench scale apparatus also performed well on large scale apparatus; (2) free area calculations for characterizing fabrics are useful for staple fiber fabrics, but not for continuous filament fabrics; (3) smooth fiber fabrics with low coefficients of friction may have poor collection efficiency at high filtration velocities; and (4) cleaning properties of fabrics depend on the fabric composition and structure, and on dust properties, but not on filtration velocity. Collateral tests are described.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Air Pollution	Glass Fibers	Air Pollution Control	13B	11B
Dust Filters		Stationary Sources	13K	
Tests		Fabric Filters	14B	
Fabrics		Aramid	11E	
Cotton Fabrics				
Polyester Fibers				

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 215
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