Celite®

Celite® Brand Diatomite Filter Aids for maximum clarity at lowest cost

WORLD MINERALS®

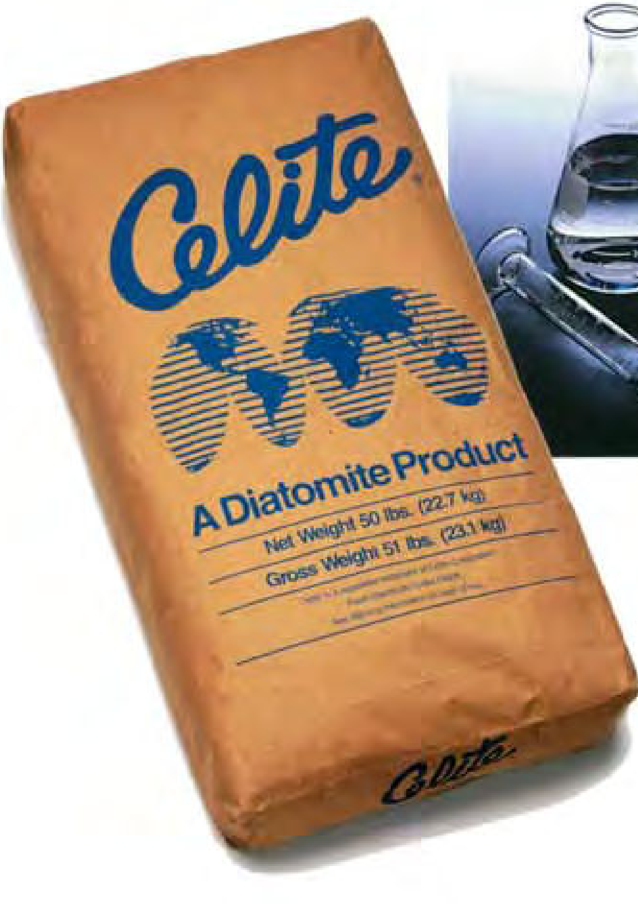
Celite®
A Diatomite Product
Net Weight 50 lbs. (22.7 kg)
Gross Weight 51 lbs. (23.1 kg)
Celite

Table of Contents

Foreword

This brochure is intended as a guide to a better understanding of the use of filter aids, both by those who currently have a filtration operation and by those who are considering filtration.

So, where you are having a problem with an existing filtration system or need assistance in setting up a new one, we invite you to call a Celite Filtration Specialist. He will determine whether you are operating at maximum efficiency. His extensive background and practical experience in this field is at your service. Address your inquiries to the Celite Sales Office nearest you, or via e-mail at info@worldminerals.com. A variety of technical bulletins, each treating a specific subject in more detail, is also available.

Celite Corporation ("Celite") produces a wide variety of diatomite filter aids at modern processing plants at Lompoc, California and Quincy, Washington. Crude diatomite is processed into Celite® and Kenite® brand products of various particle sizes which meet a wide range of industrial filtration requirements. Our operations staff's wealth of experience combines with specialized processing techniques and equipment to assure quality filter aids.

Introduction

Filtration is the process by which particles are separated from a fluid by passing the fluid through a permeable material. The filtrations discussed in this book concern the removal of suspended solids, including some semi-colloids, from liquids. Ideally, the liquid goes through and solids remain, building a permeable cake on the screen. With large, incompressible particles, this ideal can be approached. In practice however, finer solids often pass through with only larger solids remaining on the screen. If the latter are at all compressible, the liquid flow is reduced to an uneconomical level and the solids stick to the screen, making it very difficult to clean. These difficulties occur in almost all industrial liquid and food product filtrations. Celite® and Kenite® filter aids, properly used as outlined in this brochure, offer practical and economical solutions to these difficulties.

The Nature of Diatomaceous Earth

Diatomaceous earth, or D.E., is the skeletal remains of single-celled plants called diatoms. These microscopic algae have the unique capability of extracting silica from water to produce their skeletal structure. When diatoms die, their skeleta settle to form a diatomite deposit.

Celite Corporation operates ten plants around the world to process our diatomaceous earth products. Our U.S. deposit in Lompoc, California is considered the largest and purest source of marine diatomite in the world. Other Celite processing plants are in France, Spain, Mexico, Iceland*, Chile, China*, and Washington State.

Diatomite is a soft powdery mineral resembling chalk and distinguished by a variety of shapes. This raw material is processed by drying, milling, sintering and air classification to give a finished, virtually inert filter aid which is predominantly silica. When deposited on a filter septum, the filter aid forms a rigid but porous cake which sieves out the particulate matter in liquid as it passes through the filter. Celite® filter aid, properly processed, has virtually no effect on the odor and taste of any liquid filtered through it.

We have been processing and marketing Celite® diatomite for more than 85 years. Still, Celite® filter aid would be just another diatomite if it weren't for Celite's careful quality assurance checks made before, during and after processing.

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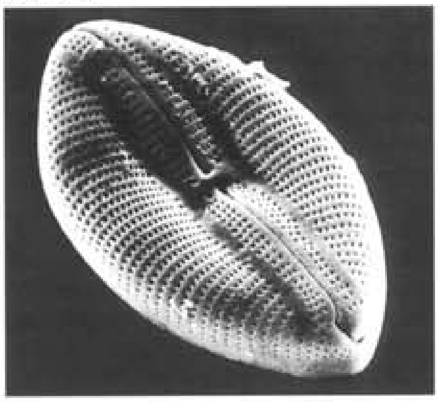

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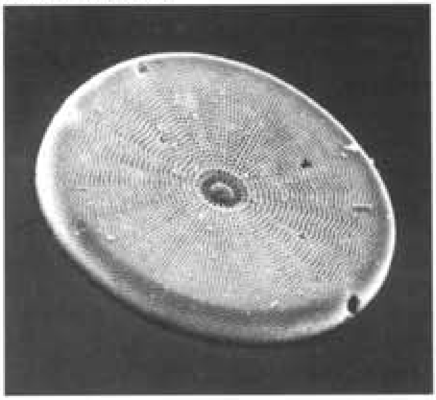

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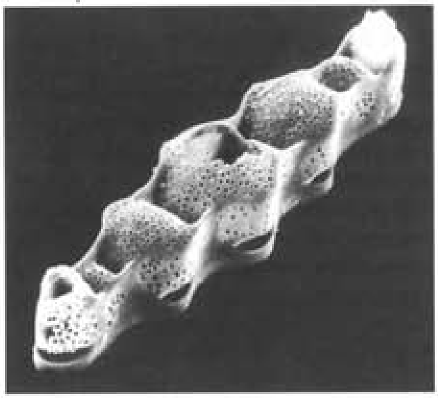

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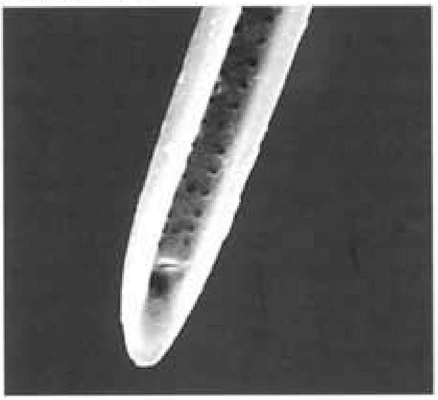

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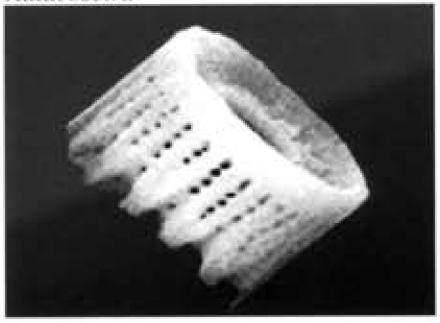

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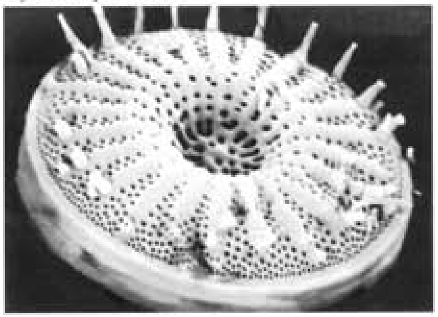


* Joint Ventures

How Filter Aids Work

Filtration using Celite® diatomite is a two-step operation. First, a thin protective layer of filter aid, called the precoat, is built up on the filter septum by recirculating a filter aid slurry. After precoating, small amounts of filter aid (body feed) are regularly added to the liquid to be filtered. As filtering progresses, the filter aid, mixed with the suspended solids from the unfiltered liquid, is deposited on the precoat. Thus, a new filtering surface is continuously formed; the minute filter aid particles provide countless microscopic channels which entrap suspended impurities, but allow clear liquid to pass through without clogging.

An efficient, economical filter aid must: 1) have rigid, intricately shaped, porous, individual particles; 2) form a highly permeable, stable, incompressible filter cake; 3) remove fine solids at high rates of flow; and 4) be chemically inert and essentially insoluble in the liquid being filtered. Celite® diatomite meets these requirements due to the wide variety of intricately shaped particles and inert composition which makes it virtually insoluble in most liquids.

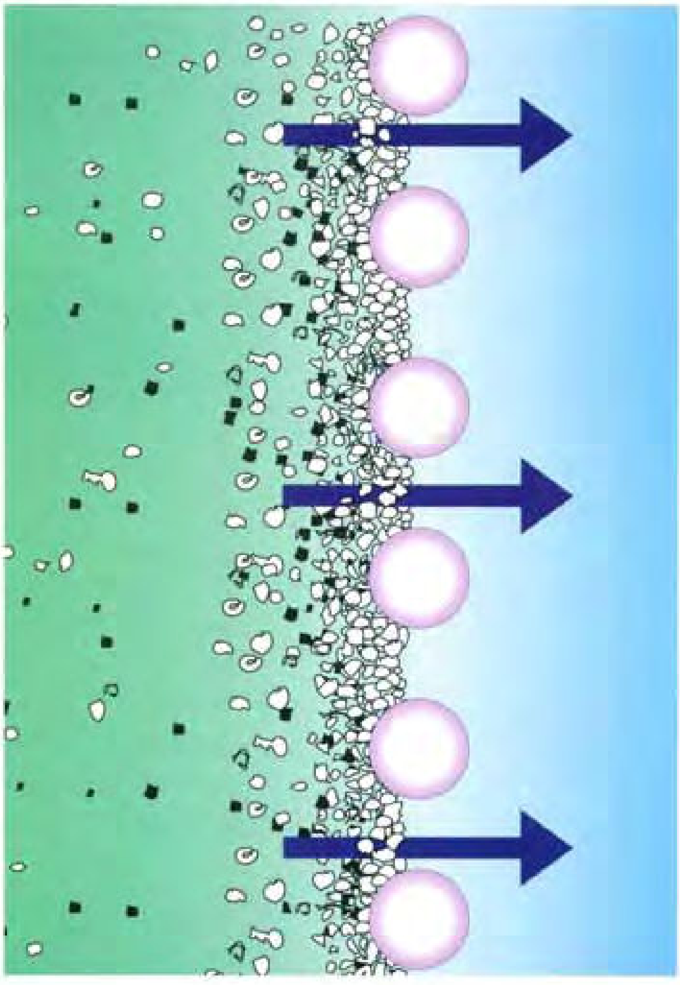
Selection of Filter Aid Grade

Celite processes filter aid grades in a wide range of particle sizes to meet practically any industrial filtration requirement. The relative flow rates of these grades are determined by a standard test and are shown in Graph 1 (page 6). Typical physical properties are shown in Tables 1 and 2 (page 7).

Celite® 500, a very fine Celite® grade giving high clarity and low flow rate, is a natural diatomite which has been selectively quarried, dried, milled and air-classified. To make coarser, faster flow rate filter aids, natural diatomite is sintered and air-classified. These

Scanning electron micrograph of 10μ latex beads in a cake of Hyflo® Super-Cel® (1000x)

Schematic of precoat and filter cake



"straight calcined" grades are Celite® 577, Standard Super-Cel® and Celite® 512. To obtain still larger particles, a flux is added before sintering, giving the "flux-calcined" or white grades of filter aids, which include those from Celite® 513 to Celite® 560, the coarsest.

It is axiomatic in the use of filter aids that the ability of the filter aid to remove small particles of suspended matter decreases as the particle size, and thus the flow rate, increases. Conversely, as filter aid particle size, and therefore the flow rate, decreases, the ability of the filter aid to remove small particles of suspended matter increases. The extent to which this takes place will depend very much on the type and particle size distribution of the undissolved solids being removed.

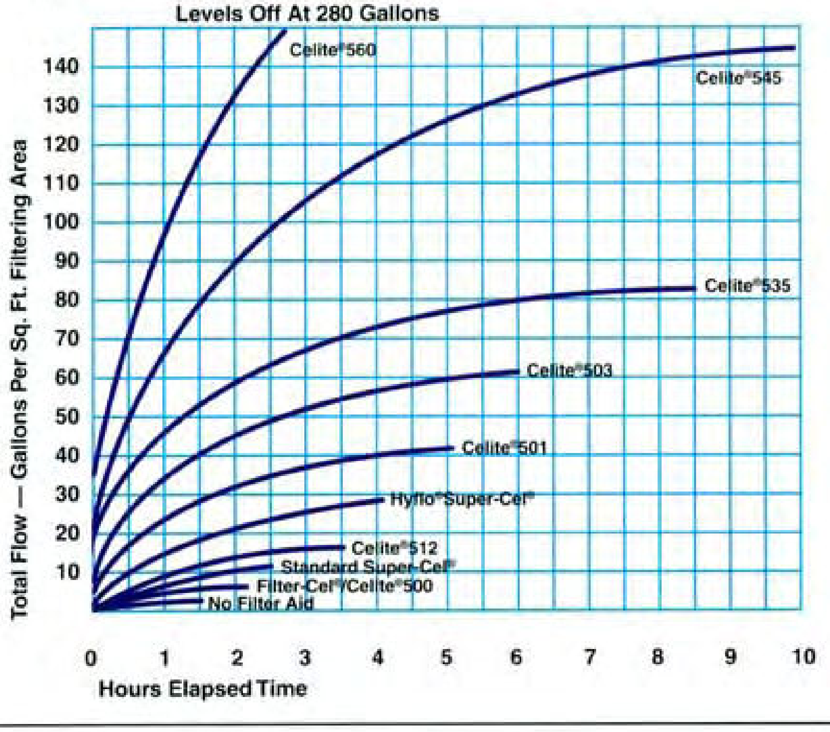
In most instances, the particle size range of undissolved solids is such that a fine grade of filter aid, right down to the finest, will improve clarity. If, however, a given filter aid grade will remove 100% of the suspended solids, a finer grade, while giving a lower flow rate due to its finer structure, will *not* give increased clarity.

Therefore, the selection of the proper filter aid grade is a compromise between high filtrate clarity and low flow rate vs. lower clarity and higher flow rate. The best filter aid is that grade which provides the fastest flow rate (or greatest throughput per dollar's worth of filter aid) while maintaining an acceptable degree of clarity, which must be specified by the filter aid user.

For a given liquid, clarity of filtrate is governed principally by: 1) grade and amount of filter aid for body feed; 2) grade and amount of filter aid for precoat; 3) length of cycle; and 4) filtration rate.

Graph 1

Flow Rate



Desired clarity, or the amount of acceptable suspended solids in the filtrate, can be determined in a number of ways: 1) visual examination of a sample of filtrate; 2) comparing a sample of filtrate with a standard; 3) the use of electronic turbidity instruments; 4) filtering a sample of filtrate on a fine white or black filter paper, such as a membrane filter, and observing the impurities on the paper; 5) chemical or biological analysis; and 6) gravimetric analysis.

It is extremely difficult to state the particle size of the solid that will be removed by any given grade of Celite®. This depends upon the method used for measuring the particle size of the contaminant, the type of liquid involved, the shape of the particle, filtration conditions and the particle characteristics. For example, a needlelike particle might easily be removed if it approaches the filter cake sideways, while it could pass right through if it approaches on end. A compressible, soft particle might extrude its way through a filter cake, whereas a rigid particle of the same size and shape would not. Variations in pressure, vibration and air bubbles may also affect clarity.

An approximation of the degree of clarity obtainable by any one grade of filter aid can be gained by running filtration tests using proper techniques on a Buchner funnel or a test filter specially designed for this purpose. These tests will not be exact because in an actual filtration, as the cycle progresses, the filter cake tends to become partially plugged or "tightened" by the particles of suspended solids being removed. This tightening of the filter cake produces a filtrate of progressively higher clarity. It may be advisable, therefore, if filtrate from the whole length of the cycle is blended, to consider average clarity, rather than spot clarities. Possibly, this may allow the use of a faster grade of filter aid.

Typical Physical and Chemical Properties

All data are typical, or estimated, not to be used as specifications.

Table 1 - Typical Particle Size Distribution (1)

Cumulative Weight % Finer Than Micron Size

Grade	1.0μ	1.5μ	2.0μ	3.0μ	4.0μ	6.0μ	8.0μ	12.0μ	16.0μ	24.0μ	32.0μ	48.0μ	64.0μ	96.0μ	128.0μ	196.0μ	Median Particle Size In Microns
Celite®507	2	5	8	16	25	40	55	72	83	92	96	99	100	100	100	100	7.3
Celite®505	1	2	4	8	14	26	36	54	65	80	89	95	98	99	100	100	10.9
Celite®500	0	0	1	3	7	15	25	37	48	63	74	87	94	98	99	100	17.3
Filter-Cel®	0	0	0	2	4	11	19	32	43	60	72	86	93	98	99	100	19.2
Celite®577	0	0	0	1	3	10	17	29	40	57	70	85	92	97	99	100	20.8
Std. Super-Cel®	0	0	0	1	3	9	16	29	39	56	70	84	92	97	99	100	20.9
Celite®512	0	0	0	1	3	8	14	25	34	50	63	78	88	96	99	100	23.9
Celite®513	0	0	0	1	1	5	9	17	26	43	57	75	87	95	98	100	28.0
Hyflo®Super-Cel®	0	0	0	0	1	4	8	15	23	39	55	72	85	95	98	99	30.1
Celite®501	0	0	0	0	1	3	6	13	21	39	53	72	84	94	98	99	30.6
Celite®503	0	0	0	0	1	2	5	11	19	33	48	68	83	94	98	99	33.9
Celite®535	0	0	0	0	0	1	3	7	11	22	38	57	75	91	96	99	42.9
Celite®545	0	0	0	0	0	0	1	3	7	19	34	52	67	84	93	98	46.5
Celite®560	0	0	0	0	0	0	0	1	2	5	10	17	28	50	72	93	95.7

(1) - As determined by Leeds & Northrup X100 Microtrac particle size analyzer

Table 2 - Typical Physical Properties

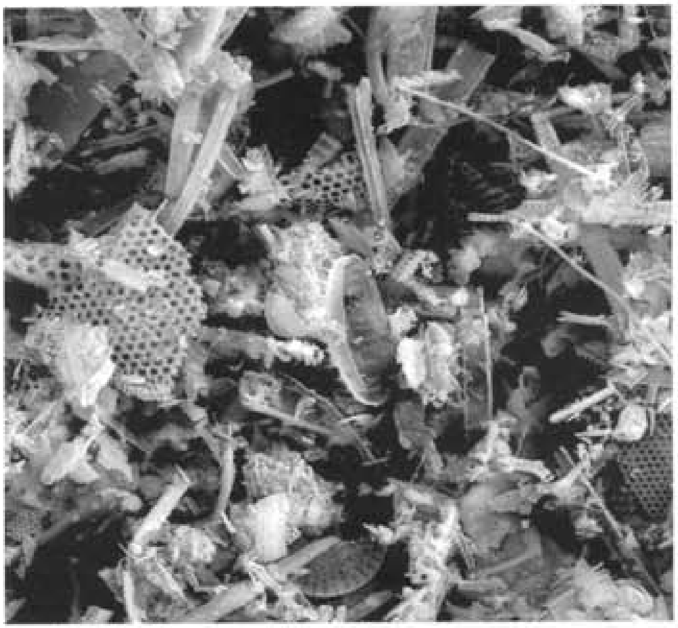
Grade	Color	Product Type	Permeability D'Arcys	Median Pore Size in Microns	Approx ΔP @ 1 GSFM w/ 0.15 lb/SF Precoat	Estimated GSFH Water; 6" Precoat 24" Hg	Loose Wt., PCF	Wet Density, PCF	150 Mesh % Retained	325 Mesh % Retained	% Moisture
Celite®507	Pink/Buff	Calcined	0.02	0.5	8.00	N/A	9.0	24.0	N/A	0.5	0.5
Celite®505	Pink/Buff	Calcined	0.06	2.0	3.0	N/A	9.0	24.0	N/A	0.5	0.5
Celite®500	Gray	Natural	0.05	1.5	3.20	N/A	8.0	17.0	1.0	N/A	3.0
Filter-Cel®	Buff	Lightly Calcined	0.07	2.5	2.60	N/A	8.5	18.5	1.0	N/A	1.0
Celite®577	Pink/Buff	Calcined	0.16	2.5	1.20	N/A	9.0	19.5	1.5	N/A	0.5
Std. Super-Cel®	Pink/Buff	Calcined	0.25	3.5	0.70	10	9.0	19.5	4.0	N/A	0.5
Celite®512	Pink/Buff	Calcined	0.50	5.0	0.40	20	9.0	19.5	5.0	N/A	0.5
Celite®513	White	Flux Calcined	0.75	6.0	0.20	40	10.0	19.5	6.0	N/A	0.1
Hyflo®Super-Cel®	White	Flux Calcined	1.10	7.0	0.10	50	10.0	19.5	7.0	N/A	0.1
Celite®501	White	Flux Calcined	1.30	9.0	0.07	65	10.0	19.5	8.0	N/A	0.1
Celite®503	White	Flux Calcined	1.90	10.0	0.06	130	12.0	19.5	9.0	N/A	0.1
Celite®535	White	Flux Calcined	3.00	13.0	0.03	240	12.0	20.0	10.0	N/A	0.1
Celite®545	White	Flux Calcined	4.00	17.0	0.02	370	12.0	20.0	12.0	N/A	0.1
Celite®560	White	Flux Calcined	25.00	22.0	0.005	1400	16.0	21.5	60.0	N/A	0.1

Table 3 - Typical Chemical Analysis (%) by Product Type

Product Type	pH	LOI	Water Solubles	SiO2	Al2O3	Fe2O3	Na2O+K2O	CaO	MgO	P2O5	TiO2
Natural	7.0	3.6	0.2	85.8	3.8	1.2	1.1	0.5	0.6	0.2	0.2
Lightly Calcined	8.0	1.5	0.2	89.0	3.3	1.4	1.0	0.8	0.6	0.3	0.2
Calcined	7.0	0.5	0.1	92.0	3.3	1.3	1.2	0.4	0.4	0.1	0.2
Flux Calcined	10.0	0.2	0.2	89.5	4.0	1.4	3.3	0.6	0.6	0.2	0.2

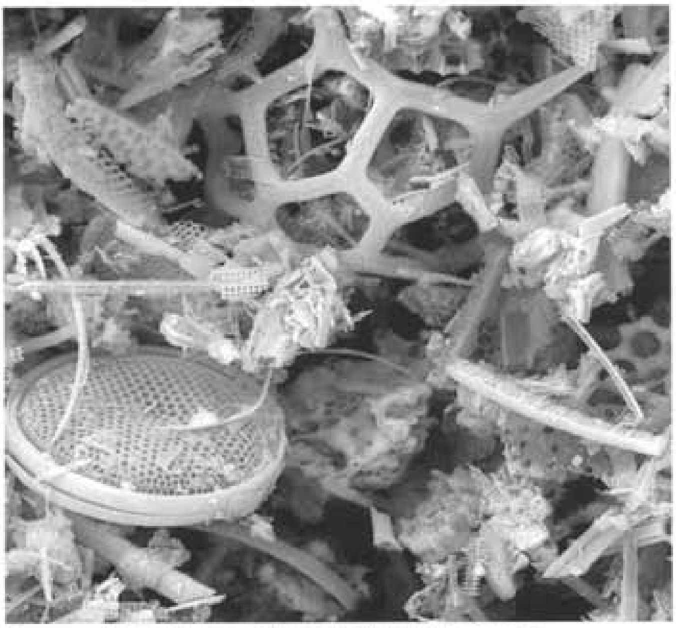
Scanning Electron Micrographs of Select Celite® Grades

Filter-Cel® (1000x)



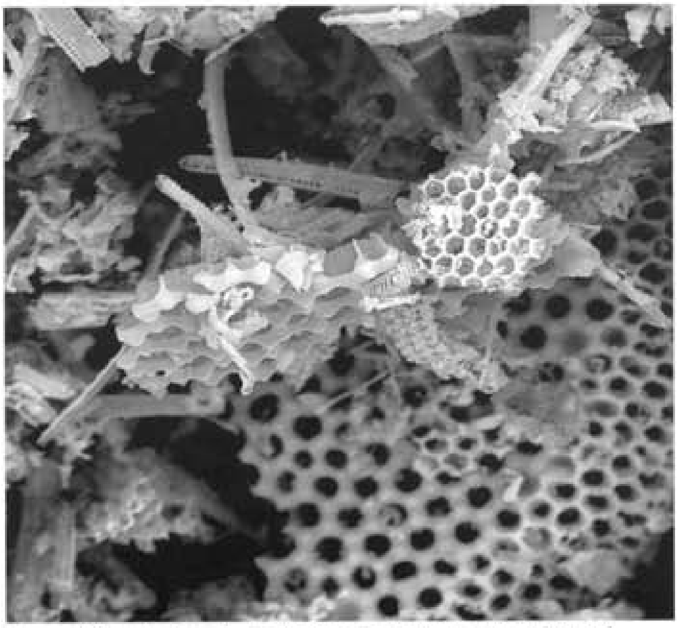
Small whole diatoms and diatom fragments

Standard Super-Cel® (1000x)



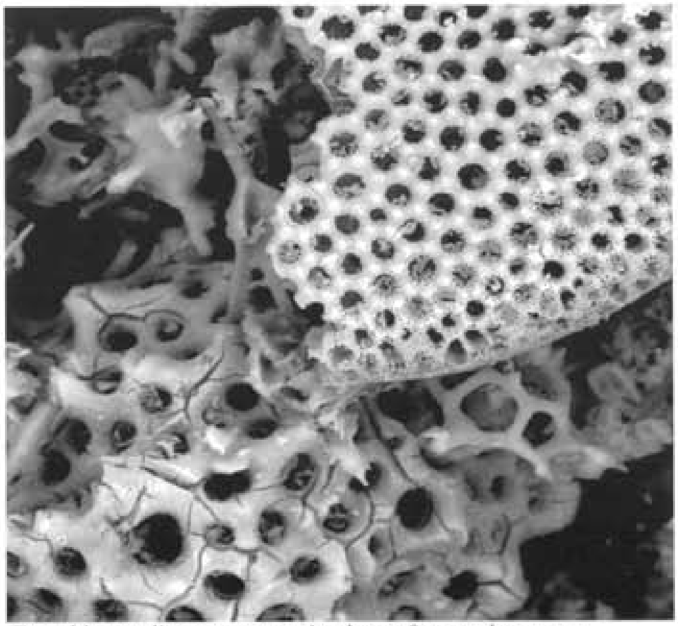
Larger whole diatoms and fused diatom fragments

Hyflo®Super-Cel® (1000x)



Large diatoms, fused small diatom clusters, some loss of secondary pore structure

Celite®545 (1000x)



Fused large diatoms, extensive loss of secondary pore structure

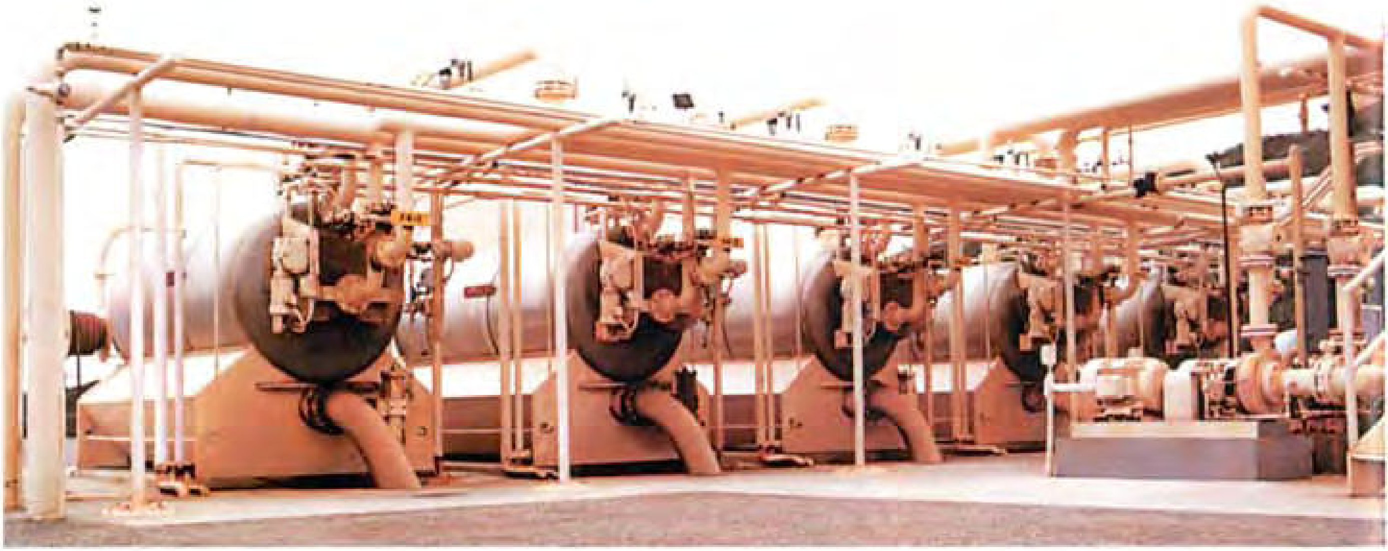
Special Celite® Filter Aids

In addition to the standard grades of Celite® diatomite filter aids, we also produce many specialized products for a wide variety of filtration applications.

Specialty Filter Aids

Name	Composition	Properties and Uses
Fibra-Cel®	Cellulose fiber	Combustible, allowing recovery of suspended solids or where soluble silica is objectionable. Precoats over large openings in septum.
Fibra-Cel® (Diatomite Blend)	Cellulose fiber and diatomite	Widest range of flow rates and clarities. Efficient precoat stability.
Acid-Washed Filter Aids (Available for Most Celite® Filter Aids)	Acid washed to reduce iron and calcium content	Used where exceptional purity is needed as in the filtration of distilled spirits and fine chemicals.
Celite® Analytical Filter Aid	Maximum acid washing	Used as an aid in filtrations for analytical work.
Sorbo-Cel®	An activated diatomite filter aid	Removes emulsified oil from water.
Micro-Cel®	A synthetic hydrated calcium silicate	Adsorbs free fatty acid and trace amounts of inorganic acids.
Celkate®	A synthetic hydrated magnesium silicate	Removes color and protein hazes from animal and vegetable fats and oils, plus other solvents.
Silasorb®	A synthetic hydrated calcium silicate	Controls free fatty acids in cooking oils.
Celite®AF	Process-treated diatomite	Does not flocculate in organic solvents. Provides efficient filtration.

Multiple unit pressure leaf filtration system filtering water for secondary recovery of oil



Vacuum leaf filter system for potable water

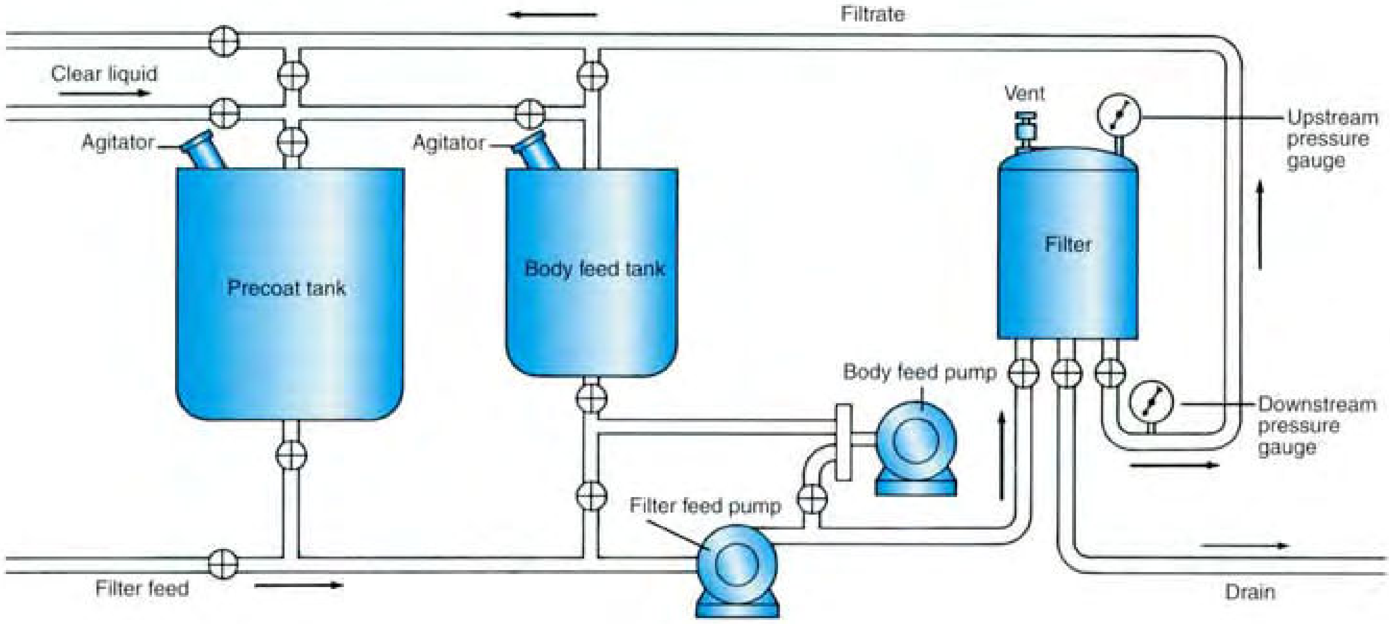
The Filtration System

The essentials of a filter aid filtration system are shown in the drawing (below). These consist of the filter, the filter feed pump, tanks containing filter aid for precoating and body feed addition, and the body feed pump for continuous addition of filter aid. Note also the lines for filling the body feed tank and precoat tank with filtered liquid, and for circulating clear or filtered liquid containing filter aid between the precoat tank and the filter. The system may also include a precoat circulating pump and auxiliary lines for blowing back the filter heel to the feed tank, and for filling and recirculating wash liquid, as well as vent lines and lines for blowing the filter cake dry with air, inert gas or steam.

Continuous addition of filter aid (body feeding) is accomplished either by feeding filter aid as a slurry or by dry feeding. Slurry feeding is usually done with plunger, diaphragm, or peristaltic pumps. If filtration is a batch process, filter aid can be added directly to the batch as admix.

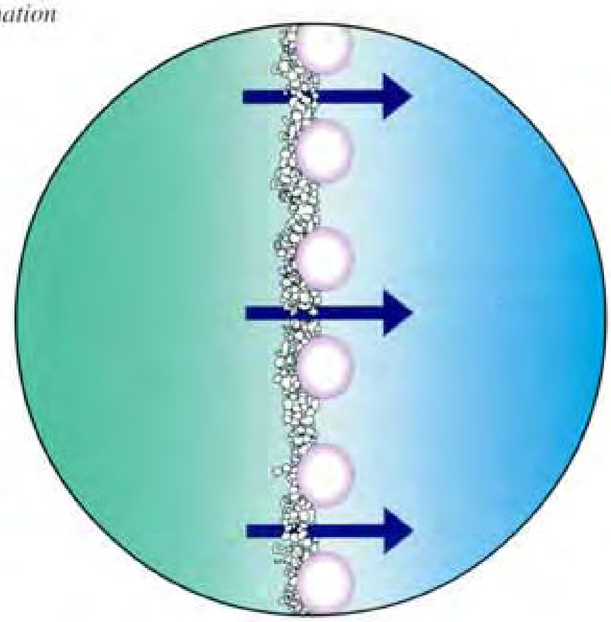
In the operation of a filtration system, the filter is first precoated by circulating a mixture of filter aid and clear or filtered liquid from the precoat tank through the filter and back to the precoat tank through the filter and back to the precoat tank. This is continued until all the filter aid is deposited on the filter septum. The body feed injection system is then started and the filter is changed over, with minimum fluctuations in pressure, from precoating to filtering.

Typical DE pressure filter system flow diagram



Pressure Filtration Procedures

Precoat formation



Precoating

The first step in the use of Celite® is to build up a "precoat" of Celite® filter aid on the filter septum. The purpose of the precoat is threefold:

1. To prevent the filter septum from becoming clogged by impurities, thus prolonging septum life.
2. To give immediate clarity.
3. To facilitate cleaning of the septum at the end of the cycle.

Precoating is accomplished by circulating a slurry of filter aid and filtered or clear liquid between the filter and the precoat tank. Since most of the filter aid particles are smaller than the openings in the septum, they must form the precoat by bridging these openings. These bridges can be upset by air bubbles, sudden changes in pressure, or vibrations, causing the filtrate to become turbid until the upsetting influences have been corrected. If flow distribution in the filter is good, the filter may be filled with clear precoat liquid and a concentrated slurry of filter aid may then be pumped or educted into the filter followed by recirculation.

Amount of Precoat

The amount of precoat should be from 15 to 25 lbs. of filter aid per 100 sq. ft. of filter area, the greater amount being used when distribution of flow in the filter is poor, or in starting up new filters. If it is perfectly distributed, 15 lbs. (6.8 kg) of filter aid per 100 sq. ft. (9.29 sq. m) of filter area will give a precoat of approximately 1/16" (1.6 mm) in thickness. The use of baffles or precoating at a different rate may be necessary for an even precoat at lower precoat amounts.

Precoat slurry concentration will depend primarily on the ratio of filter area to the liquid volume of the filter and piping.

If the filter aid slurry concentration is much below 0.3% by weight, precoating may be difficult since the formation of the bridge depends partly on the "crowding" effect of the particles of Celite® trying to get through the septum openings.

Precoating Rate

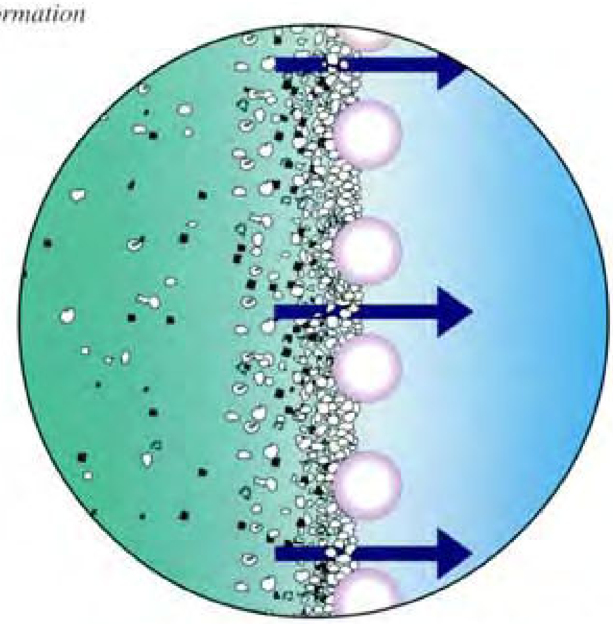
The precoat pumping rate will depend mainly on the viscosity of the liquid used. The rate should be sufficient to keep all the filter aid in suspension but should not be fast enough to cause erosion of precoat in the filter. For water, a typical rate is from 1 to 2 gals. per sq. ft. of filter area per minute (gsfm), or 40-80 liters per sq. m. of filter area per minute. For viscous liquids, the rate may be as low as 5 gals. per sq. ft. per hour (gsfh), or 20 liters per sq. m. per hour. A general rule for precoating is to precoat at that rate which gives a differential pressure of approximately 2 lbs./sq. in. (13.8 kilopascals). For water, an upward velocity of at least 4 1/2 ft./min. (1.4 meters/min.) is required for proper filter aid suspension. The suspension of filter aid can be improved in the tank, or pressure leaf filter, by recirculating part of the inlet flow from the top of the filter back to the precoat tank.

Troubleshooting

Precoating filtrate should clear up in 2 to 5 minutes. However, this does not mean the precoat is all in place. Continue precoating until the liquid in the filter shell is relatively clear. This usually takes place in 10 to 15 minutes at most. Lack of clarity of filtrate could be caused by any of the following: Improper venting of filter; precoat erosion caused by too high a circulation rate; blinding of filter septum; insufficient precoat at top of leaves caused by too little circulation; tears in septum; old screens with worn and/or separated wires; leaks between septum and rim of leaf; worn gaskets between leaf discharge nipple and discharge manifold; wrinkles in septum; negative pressure on discharge manifold causing flashing inside the leaf.

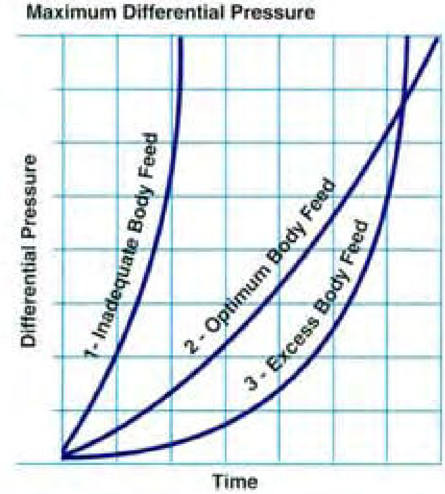
If you have a precoating or other filtration problem that does not yield readily to correction, consult your Celite Filtration Specialist. He is an expert "trouble-shooter" on all types of industrial filtration problems and his broad background of experience is at your disposal.

Filter cake formation



Graph 2

Cycle Length
(Throughput at Constant Flow)



Filtering

After the precoating filtrate has cleared up, the filter is put on-stream by starting the body feed pump, opening the line from the filter feed pump, and simultaneously closing the line from the precoat circulating pump so that flow through the filter is continuous and without sudden fluctuations in pressure. If the filter is precoated with filtered liquid, the precoat tank is best refilled immediately by directing all or part of the filtrate to it. The precoat tank may be filled at the end of the cycle but this may cause problems, since flow through the filter may drop off suddenly, requiring too long a time for filling.

It is possible to remove precoat liquid from the filter by using air to blow the liquid through a drain valve at the bottom of the filter tank, while blowing air through the leaves at the same time to hold the precoat in place. It is hydraulically difficult to blow any significant amount of liquid through the leaves. The precoat may also be held in place by vacuum while the filter is drained. After all precoat liquid is blown from the filter, it can be slowly filled with unfiltered liquid and filtration can then proceed.

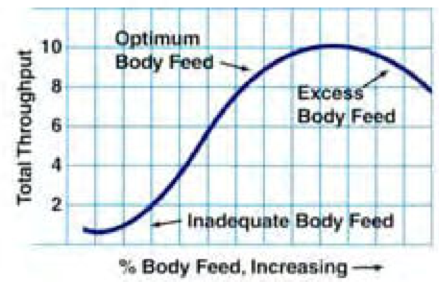
Amount of Body Feed Addition

The effects of excessive body feed are shown on Graph 2. The sudden increase in pressure shown on curve 3 illustrates the result of bridging of the cake between the leaves. This causes a sudden decrease in filter area. It can also result in severe damage to the leaves.

The effects of varying the amount of body feed addition are illustrated in Graphs 2 and 3. Graph 3 shows total throughput on the vertical axis versus percentage of body feed on the horizontal axis. As can be seen in Graph 3, the addition of too small amount of body feed merely reduces the total throughput since the body feed is completely surrounded by undissolved solids and does not, therefore, increase cake permeability. This only increases the cake thickness without adding appreciably to its permeability. From this point, as body feed rate is increased, throughput also increases slowly, then rapidly for a short span of time. The rate of increase then tapers off, reaching a peak, after which it actually decreases once again because the cake thickness is increasing without any further increase in cake permeability.

Graph 3

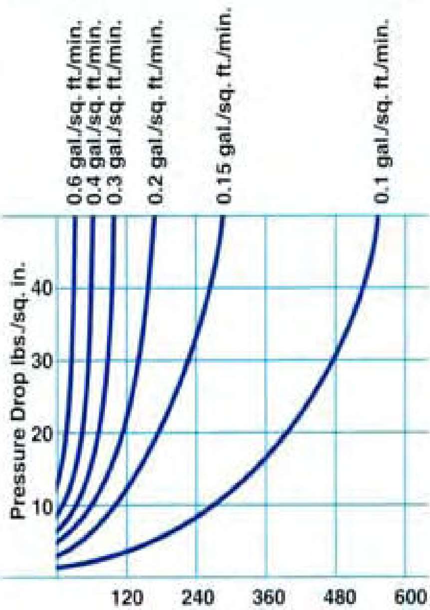
Flow of same solution with different amounts of filter aid.



Filtration Rate

Graph 4 (below) shows the effects of filtration rate on cycle length. For instance, at a rate of 0.1 gal./sq. ft./min. the filter will run for 480 minutes to a pressure of 30 lbs. At twice that rate the cycle length will be approximately 150 minutes, slightly less than that dictated by filtration theory. In a typical pressure leaf filter, when the maximum pressure drop of 50 lbs. per sq. in. is reached, the cycle is ended.

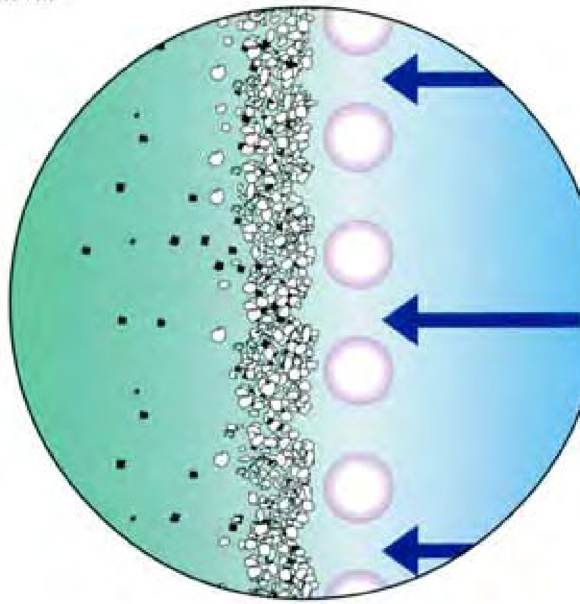
Graph 4



Bridging of Leaves and its Effects

Should cake bridging occur between leaves in pressure filters, unequal pressures on the leaves can cause severe warping. The amount of filter aid that can be added without bridging can be calculated from the cake capacity of the filter (area times cake thickness, allowing at least 1/4" to 1/2" between cakes) and the density of the filter aid and cake. For most Celite® diatomite filter aids use a density figure of 20 lbs. per cu. ft. (320 kg/m^3). This will also equal the cake density since the solid impurities being removed will be contained within the interstices of the filter aid particles.

Filter cake removal



Troubleshooting

When the filter is put on-stream, clarity of filtrate should be immediate. If not, the trouble may be caused by any of the following conditions: Partially blinded septa; air in feed liquid; loss of flow during switch-over from precoating to filter, resulting in disruption of precoat; improper formation of precoat due to reasons given under "Precoating".

Short cycles can be caused by temporary or permanent stoppage of body feed addition, blinded septa, changes in characteristics of the liquid being filtered, entrapment of air in the filter which will decrease the filter area, or too high a filtration rate.

Filter Cake Removal

At the end of the filtration cycle the filter cake is removed by one of the following methods:

1. Backwash or bumping (for tubular element filters)
2. Sluicing
3. Dry cake discharge by tapping or scraping the leaves or by mechanical vibration, after the filter heel has been blown from the filter and the cake blown dry.
4. A combination of dry cake discharge and sluicing
5. For viscous liquids which are filtered hot, hot air or gas should be sued to extract a maximum amount of liquid from the cake.

Whatever method of cake removal is used, it is extremely important that it be complete – otherwise septa will blind and the subsequent result will be inadequate filter performance.

Practical suggestions for cleaning clogged filter septa may be obtained by consulting your Celite Filtration Specialist.

A wide variety of industrial filters is available for use with filter aids, each with its advantages and disadvantages. These all fall, however, into one of two basic classifications: 1) those which operate under pressure, and 2) those which operate under vacuum.

Pressure Filters

Plate and Frame Filter Presses

These filters have the advantages of low cost, near indestructibility, and ease of internal inspection. They have the lowest liquid volume-to-area ratio, which makes them most efficient for the washing of filter cakes. Because of this low ratio, they will also have the smallest unfiltered heel remaining at the end of the cycle.

Plate and frame filters are made in every conceivable combination of inlet and outlet positions, but for good precoating and filter aid suspension, they should have a bottom inlet and a top outlet, and in the larger sizes these should be at opposite ends of the filter. It is absolutely necessary that all air be purged from the filter before precoating is completed. This may be particularly difficult if gasketed filter septa area used. Your Celite Filtration Specialist can give you details as to how to do this.

The capacity of these filters can frequently be increased by the installation of perforated metal or plastic sheets between the plates and septa. Either cloth or paper may be used for the latter. If paper is used, it is usually discarded at the end of the cycle. The perforated sheets serve to keep the septum from sagging into the drainage grooves in the plate where it will reduce the capacity of the filter. Plate and frame filters are available with gasketed surfaces and mechanical leaf moving devices.

A variation on the plate and frame filter press style is the **Recessed Plate Filter**, in which the frame is an integral part of the plate. The filtering surface is thereby recessed below the outer surface of the plate, providing additional space for filter cake.

The following pressure filters, varying in type and arrangement of elements, are those in which the elements are contained in a pressure vessel. They offer the advantages of lower labor costs and less opportunity for leakage, compared to plate and frame filters.

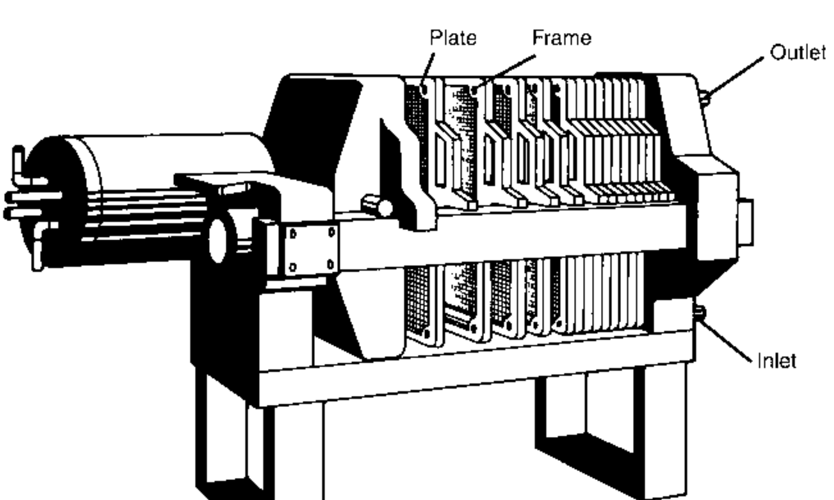
Tubular Filters

These filters offer low cost construction and high hydraulic capacities. They are made with either rigid or flexible tubes. Celite® is used on rigid tube, or candle, filters in the conventional combination of precoat and body feed. With flexible tube filters, instead of body feed, an extra heavy precoat (25 to 30 lbs. (11.4-13.6 kg.) filter aid per 100 sq. ft. (9.29 sq.m.) filter area) is used. After filter pressure has reached a maximum the precoat is "bumped" from the tubes, reslurried, then redeposited. This sequence is repeated until pressure is no longer reduced significantly by bumping, at which time the "precoat" is discarded and a new one applied.

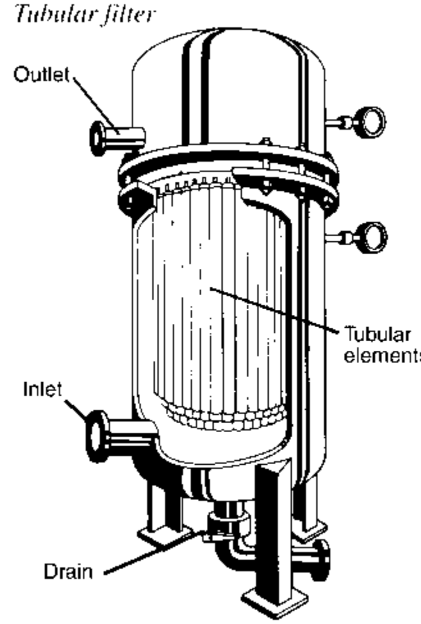
Vertical Tank-Vertical Leaf Filters

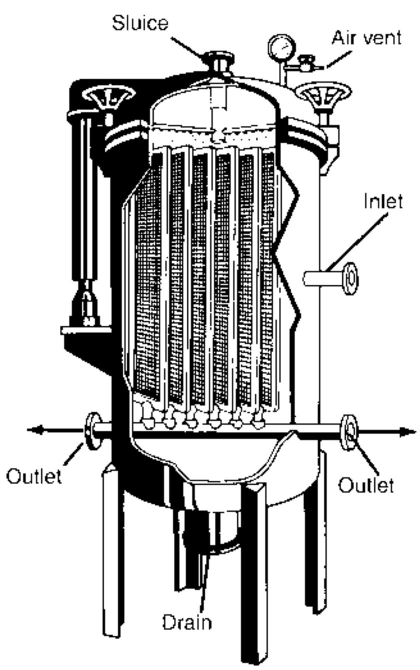
Among the pressure leaf filters, this type is lowest in cost and has the lowest volume-to-area ratio. They are available for wet and dry cake discharge. Wet discharge is effected by means of a sluice, which in some filters oscillates to give more complete coverage at the top of the leaves. Dry discharge is effected by blowing liquid from shell and cake, followed by removal of the cake from the leaves and filter. Vibrators may be used for this purpose. Large diameter, quick-opening doors are available for removal of the dry cake from the bottom of the filter. Whether the cake is sluiced or discharged dry, cake discharge lines should be large enough to prevent the cake from hanging up in the filter shell after it has been removed from the leaves.

Plate and frame filter

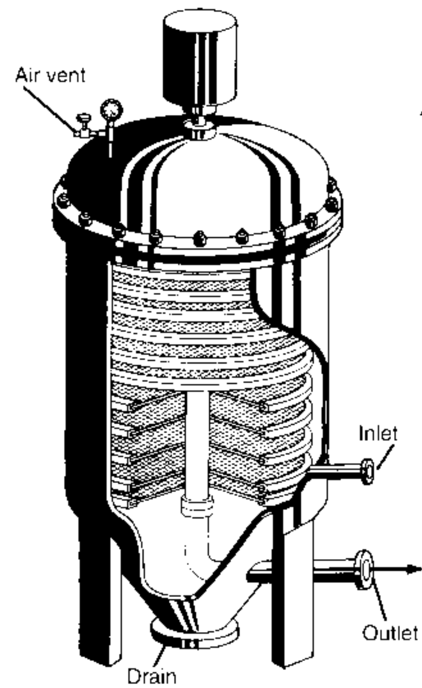


Tubular filter

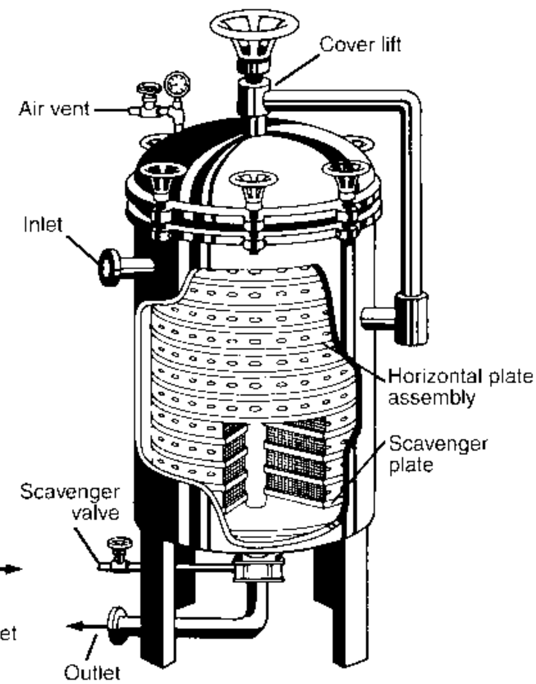




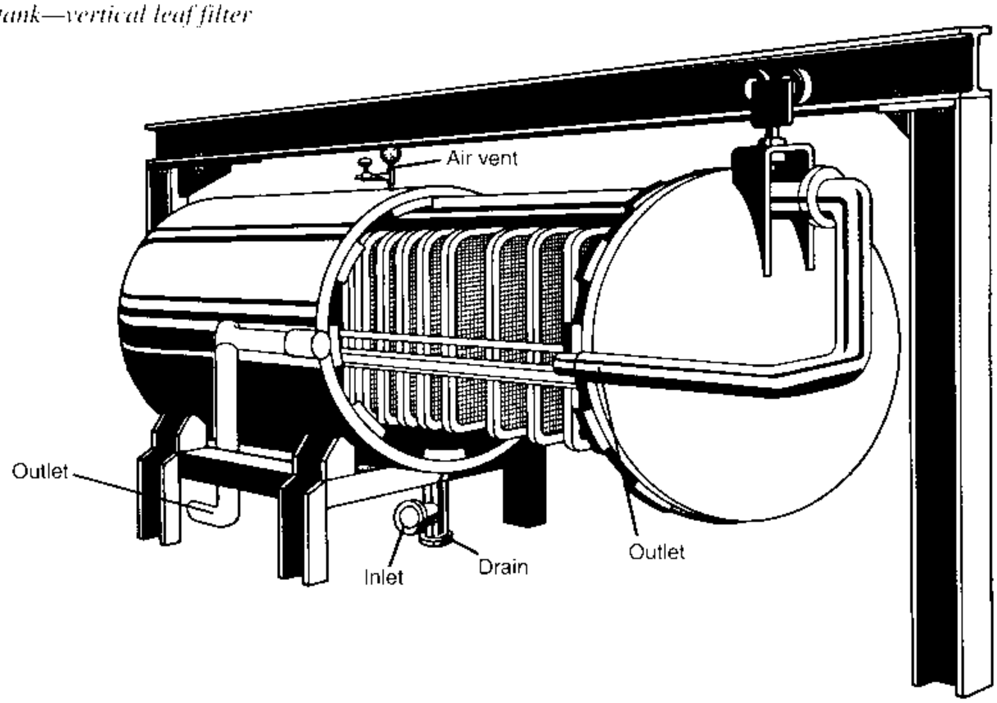
Vertical tank – vertical leaf filter



Rotating leaf filter (centrifugal discharge)



Horizontal leaf filter



Horizontal tank—vertical leaf filter

Horizontal Tank-Vertical Leaf ("H" Style) Filters
Since these filters are made so that the leaves can be rolled from the filter quickly, they can be easily inspected for tears in the septum, leaks around the edges of the screens or around the gaskets in the manifold, improper precoating, etc. If the cake is blown dry in the filter before the leaves are removed from the filter shell, it will usually remain on the leaves so that it can be discharged either manually or by means of a vibrator.

For more efficient leaf cleaning, horizontal tank-vertical leaf filters are available with various types of movable sluices.

Rotating Leaf Filters
This filter is particularly well adapted for applications where the cake is difficult to remove by sluicing. It is designed so that the leaves can be rotated with the sluice sprays on, allowing the entire area of the leaf to receive the full force of the sluice jet. If it is undesirable to mix the entire cake with sluice liquid, the bulk of the cake can be vibrated off the leaves first and removed from the filter shell, after which the remaining cake can be sluiced off.

Direct Sluicing of all parts of the leaf is also obtained in some filters by the use of moving sluices.

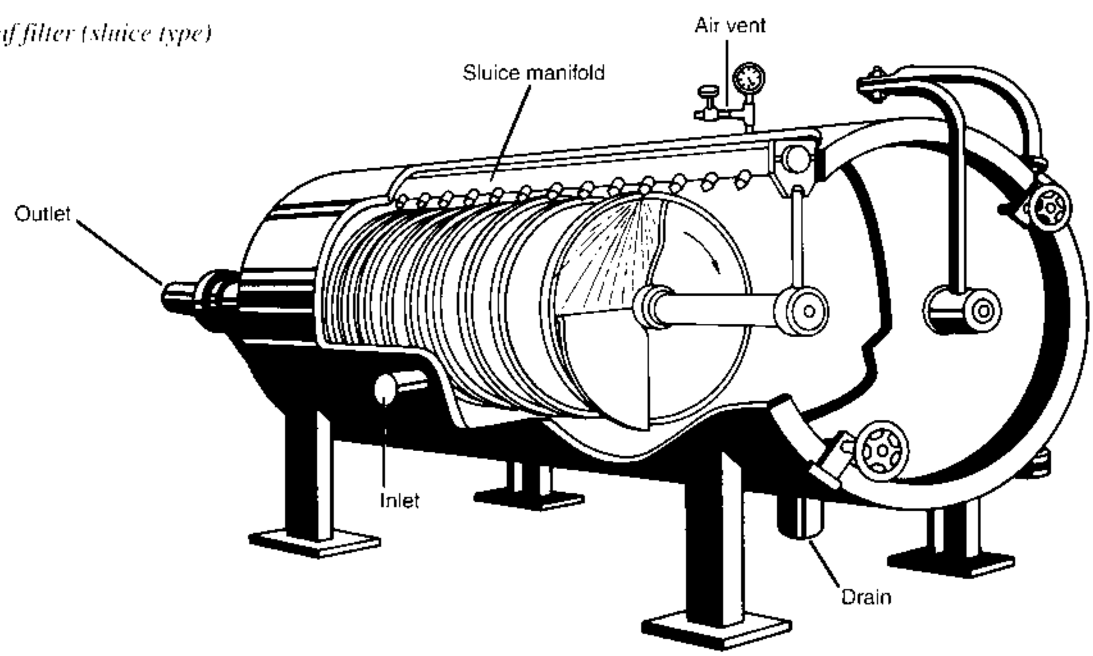
Horizontal Leaf Filters
All the filters described so far have the cake held on the filter element by means of a continuous differential pressure across the element, caused by the flow of liquid through the element. Operation must, therefore, be continuous for good filtration. Where operation is intermittent, the horizontal leaf filter can be used to advantage. This filter may be designed so that the leaves and septa are assembled as a unit outside the filter, or with rotating leaves in the filter for discharge by centrifugal force. In the former, paper is generally used as the filter septum. This type filter is generally used as a polish or guard filter where solids loading is low and cycles are relatively long.

The primary disadvantage of this configuration is a reduction of filter area by half, since the bottoms of the leaves cannot be used.

Specialty Filters
There are a number of specially designed filters such as horizontal tray filters with tilting leaves for cake discharge, filter heel filtration with scavenger leaves, indexing filters, and others. These filters are more expensive than the standard filters but are adapted to certain specialized applications. For instance, scavenger leaves are in general not effective because they can become so coated with sediment that it takes too long to filter the liquid heel through them. During this time, of course, the entire filter is tied up. A better solution, if the unfiltered heel cannot be blown back to the filter feed tank, would be to employ a small plate and frame filter for this purpose.

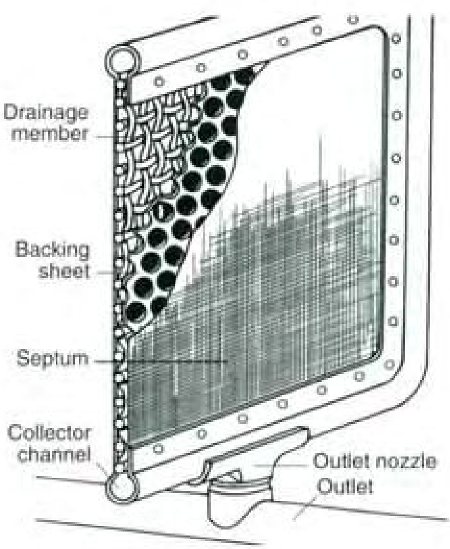
Indexing filters employ a movable septum which is stationary beneath a chamber during filtration and indexes forward to dispose of a dry cake after the chamber is raised at the end of the cycle. The septum may be roll goods or a continuous belt.

Rotating leaf filter (sluice type)



Filter Leaves

Filter Leaf



The shape and construction of filter leaves varies widely. Basically, there are two types: three-ply and five-ply. The three-ply leaf consists of a center drainage member (which may be a coarse wire mesh screen or any of a variety of expanded or punched metals) covered by a metal or cloth septum on each side. The five-ply leaf consists of a heavy backing material with a finer mesh screen or perforated metal sheet on either side covered by a cloth or metal septum.

Leaves should be rigid and free from flexing as filtration pressure increases. Any movement of the leaf during filtration will form cracks in the filter cake and permit unfiltered liquid and filter aid to bypass the precoat.

The filter septum should be applied tightly (especially in the case of wire cloth) so that no wrinkles or movement of the septum can occur during filtration.

The septum should be securely attached to the edge of the leaf so that bypassing of unfiltered liquid cannot occur and so that the septum cannot work loose.

Leaf design should provide for good drainage at the edge of the leaf to prevent accumulation of solids inside the leaf, and for adequate discharge capacity so as not to form more than 0.5 psi back pressure during normal precoating and filtration rates.

Filter Septa

The main function of the septum, or screen, is to support the Celite® filter aid which does the actual filtering. A heavy dense septum is therefore not necessary except where there may be cake instability due to pressure fluctuations or other outside influences. If the cake is discharged dry and is thick or heavy, a strong septum should be used to resist mechanical damage.

Septa are made in such a great variety of materials that a discussion of all available types is beyond the scope of this booklet. In general, septa should have:

1. Good dimensional stability.

2. Adequate strength to bridge over openings in the backing screen or plate without stretching.

3. Uniform openings of larger cross section than the precoat channels or openings.

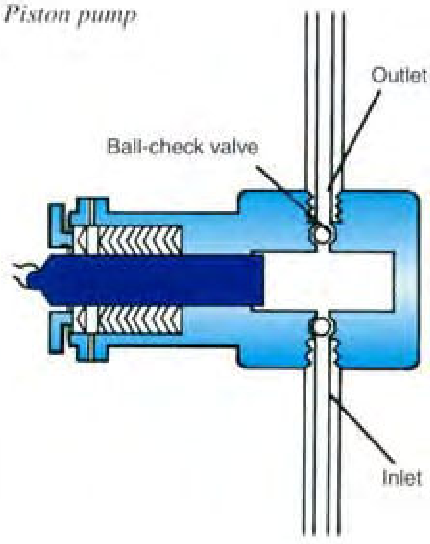
Septa may be made of metal, natural, or synthetic yarns. Plain, twill, and dutch weaves are available in the metal cloths. In the natural and synthetic fiber cloths, plain, twill, chain, and satin weaves in monofilament, multi-filament and staple yarns are used.

Generally, any septum having an opening of less than 0.005" should be satisfactory for medium flow rate filter aids. In metal cloths the most commonly used weave is 24 x 110 single dutch with 0.016" x 0.011" wire. A 60 x 60 twill with 0.011" wire and 70 x 80 twill with 0.007" wire are also satisfactory.

Keep in mind that mesh does not necessarily indicate the size opening; it also depends upon the wire diameter.

With natural and synthetic fibers, going from plain through twill to satin weave, cake retention is increased. Discharge characteristics, resistance to blinding and flow rate *decrease* in the same order. The same order of events also takes place when going from monofilament through multi-filament to staple yarn.

Piston pump



Auxiliary Equipment

Filter Feed Pumps

Centrifugal pumps are almost universally used for feeding filters because they produce no pulsations to disturb the filter cake. These pumps, however, have two disadvantages: their high speed (which tends to break down any large flocculated solids, making them more difficult to filter) and their decrease in delivery as pressure increases. To minimize degradation of impurities, low-speed (1800 rpm) pumps with open impellers should be used. Where solids are large and floc-like it may be advisable to use a recessed impeller centrifugal pump or a diaphragm pump with suitable air cushioning chambers. Reciprocating pumps should have ball valves. Gear or rotary pumps may be used where solids are not abrasive and filter aid is not present.

All filter feed pumps should operate under a positive suction head to prevent entry of air into the filter feed liquid.

Precoat and Body Feed Tanks

These tanks should be equipped with sweep-arm agitators rotating at approximately 50 rpm or slow-speed, large-bladed, propeller-type agitators. Filter aid, once in suspension, is easy to keep in suspension. Tanks should have dished, coned, or slanted bottoms so that all liquid can be drained from the tank and so that in the precoat operation a minimum heel can be maintained during circulation of liquid between the precoat tank and the filter.

Precoat tanks should be 125% of the filter's volume (including connecting piping) so that a small heel, giving rapid turnover, remains in the tank after the filter is filled with precoat slurry. The return line from the filter to the precoat tank should run to the bottom of the tank to prevent aeration of the heel. Baffles should be installed, if necessary, to prevent vortexing so that air will not draw back into the filter. The tank should be high enough above the precoat circulating pump, and the line to the pump should be large enough to provide positive pressure on the suction side of the pump.

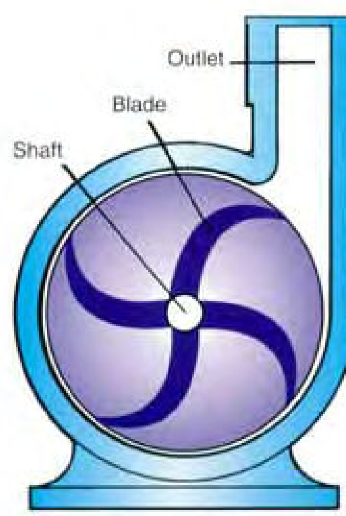
Body Feed Systems

Body feed addition may be dry or in slurry form. Slurry concentrations can be as high as 18% but are best kept at 5 to 10% for lowest pump maintenance. Whatever system is used, it should have the following properties:

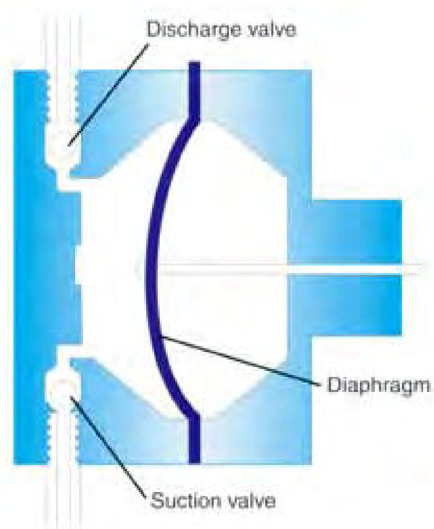
1. Low maintenance.
2. Constant feed rate from minute to minute.
3. Have a means of regulating the rate of body feed addition while the system is running. Feed rate should be constant at each setting.
4. No degradation of the filter aid. (Systems which require constant recirculation of slurry over long periods of time are likely to break down diatomite and are, therefore, not recommended).

Body feed pumps work best if run continuously, recirculating back to the body feed tank only when the filter is off-stream for cleaning. Piston pumps should have ceramic pistons, and automatic flush-out on packings is desirable. Outlets on diaphragm pumps should be at the top of the diaphragm chamber to prevent accumulation of filter aid in the chamber. An automatic clear liquid flushing device is recommended for all types of slurry pump heads and valves.

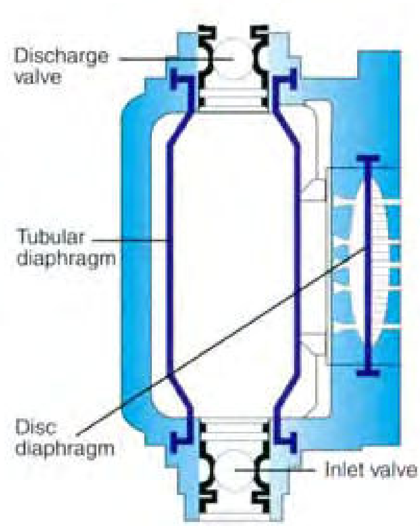
Centrifugal pump



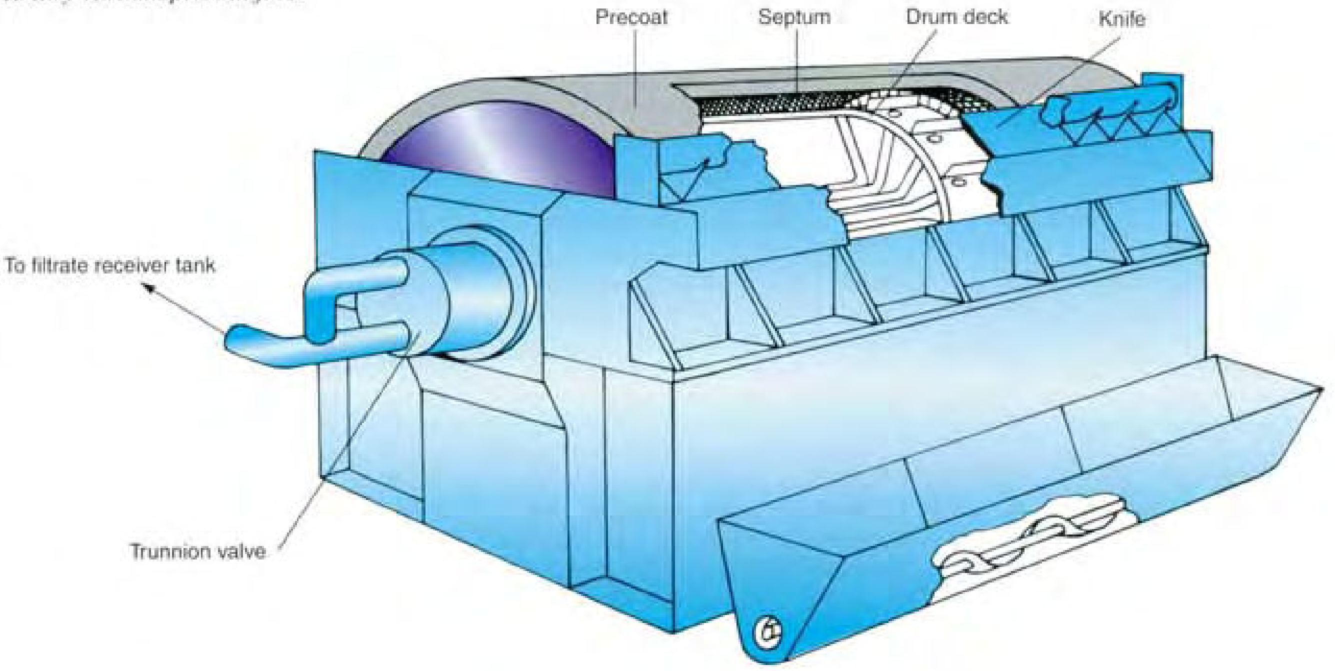
Diaphragm pump



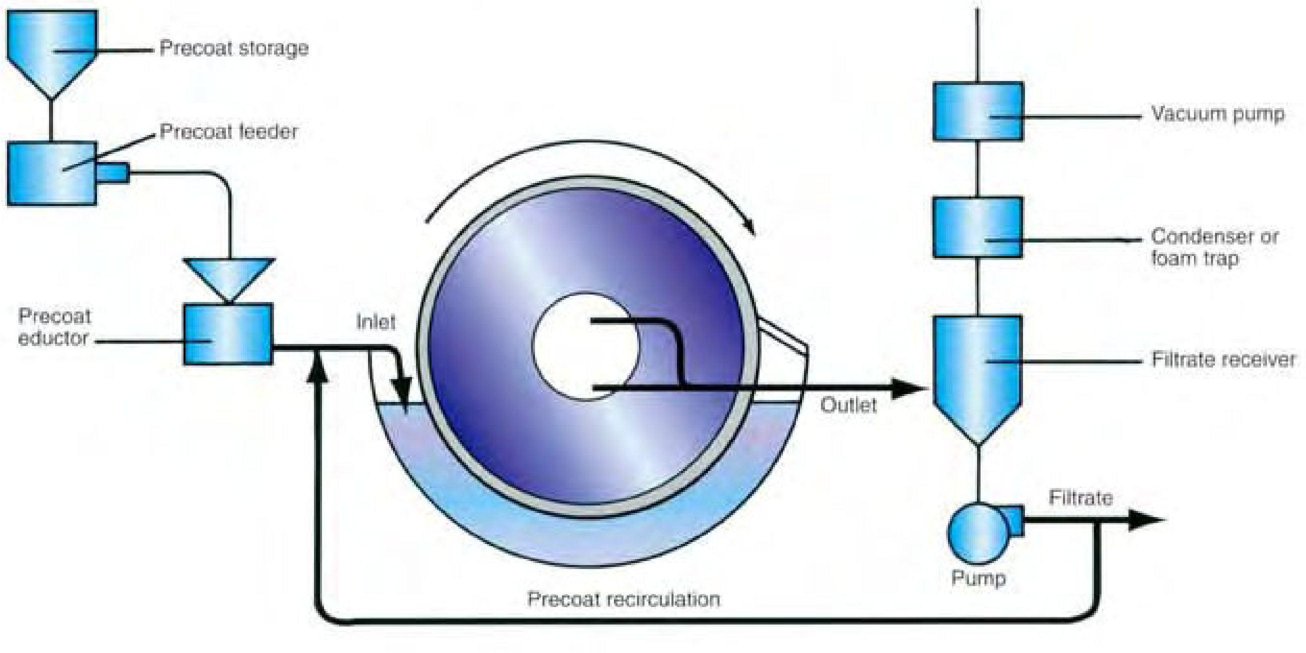
Tubular diaphragm pump



Rotary vacuum precoat filter



Schematic of rotary vacuum precoat filter system



Vacuum Filters

There are two types: 1) the vacuum leaf filter, and 2) the rotary vacuum precoat filter.

Vacuum Leaf Filters
This filter has leaves, or tubes, arranged vertically in an open tank, and connected to a discharge manifold. Liquid is drawn through the filter elements by a pump connected to the discharge manifold. Vacuum leaf filters have advantages of low cost (no pressure vessel) and ease of inspection, but are necessarily limited to one atmosphere of differential pressure across the septum. These filters operate on the standard precoat and body feed principles.

Rotary Vacuum Precoat Filters
There are some liquids with solids so slimy that it is impossible to filter them on a pressure or vacuum leaf filter. Other liquids contain such a high volume of solids that the filters described previously would quickly become filled with cake, resulting in an uneconomical amount of time spent in cleaning and precoating. The rotary vacuum precoat filter was designed to meet these conditions.

Precoating the Rotary Vacuum Precoat Filter
Precoating techniques developed by Celite can substantially increase filtration efficiency in terms of reduced precoat usage and increased flow rate. Celite will gladly demonstrate these techniques for you.

The filter consists of a horizontal drum, 30% to 50% of which is submerged in the unfiltered liquid. The drum is covered with a septum capable of retaining filter aid. Vacuum is applied to the surface of the drum by means of internal piping which emerges through the drum trunnion and valve on one end of the filter.

From the valve, the filtrate goes to a receiver where liquid and air (or other gas) are separated, the liquid usually being removed by a centrifugal pump on the bottom of the receiver, and the gas by a vacuum pump and/or condenser.

In operation, a precoat of filter aid up to 6" thick is build up on the drum by pumping a slurry of filter aid from a precoat tank through the filter and either back to the precoat tank or on to the process. After the precoat is built up, unfiltered liquid is introduced into the filter. As the drum rotates, a blade running across the face of the drum above the liquid level continually advances toward the drum, peeling off solids plus a very small amount of precoat. This continues until the knife is within ¼" to ⅜" (6.3 to 9.5 mm) of the drum, at which time the drum is cleaned and precoated again.

For the most economical operation of a rotary precoat filter, a number of factors must be considered:

A. Drum speed

B. Drum submergence

C. Drying time

D. Differential pressure

E. Knife advance rate

F. Filter aid grade

G. Cake permeability

H. Liquid viscosity

I. Septum permeability

Variables A, B and C are closely related and should be optimized as a group. During filtration, as the drum rotates filtered solids build up on the surface of the precoat, forming a cake. The thickness and, therefore, resistance of the cake will be inversely related to drum speed. The filtration rate is inversely related to cake thickness. Thus, the higher the drum speed the lower the cake resistance and the higher the filtration rate. For any given drum speed, the submergence should be at the maximum level that will result in a dry cake or that is permitted by the filter design.

Higher drum speeds, however, mean more frequent shaving of the precoat by the blade. To maintain rates, the precoat must be cut to a depth below that which solids have penetrated, and therefore, partially blinded the precoat. A grade of precoat material must be selected, then, to minimize this cake penetration. If this is done, it is possible to take a small enough cut to maintain precoat filter aid economy at high drum speeds and filtration rates.

With the correct combination of these variables, it is frequently possible to increase filtration efficiency severalfold.

Automated Handling

Automation
With equipment now available, it is possible to completely automate a filtration station. By simply pressing a button, the filter can be:

1. Precoated and drained
2. Filled
3. Put on-stream
4. Drained with cake in place after differential pressure reaches a predetermined limit
5. Filled with wash liquid and the cake washed
6. Drained
7. Cleaned of cake by any of the methods previously discussed

During the operation, protection can be provided against the following:

1. Incomplete filling in any phase of the filter operation
2. Filter going on-stream before precoat clears up
3. Poor clarity when on-stream
4. Low or high pressures
5. Too thick filter cakes
6. Power failures, etc.

The decision to automate should be based on the same reasoning as applied to the automation of any other operation. Because automation reduces or eliminates cleaning and precoating labor costs, it may be economical to reduce filter area and go to shorter cycles, increasing throughput per square foot. Against this must be weighed the disadvantages of shorter filtration cycles and higher filter aid costs.

Bulk Handling
With the largest bulk handling capabilities in the industry to supplement modern production and processing techniques, Celite is well equipped to render prompt, efficient service on bulk orders for Celite® filter aids at all times. Ample storage facilities, which include a number of multi-carload storage tanks, not only assure that each order can go out on schedule, but also provide opportunity for a final check on specifications before the filter aid is loaded onto the rail car. Thus the rigid quality control exercised throughout processing is followed through at the point of shipment.

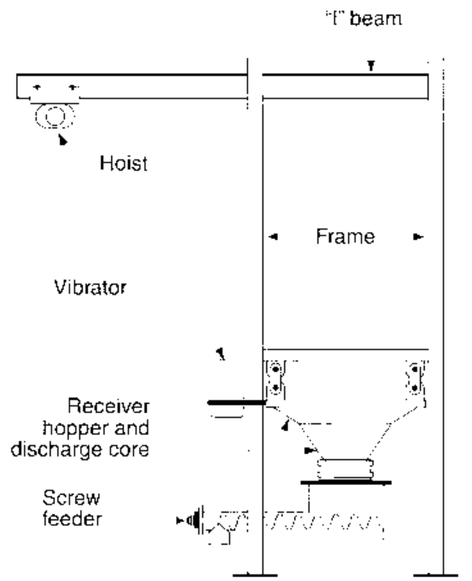
Bulk orders of Celite® filter aids are shipped in 50-ton pressure differential rail cars. The filter aid is generally conveyed from the car to a storage silo of from 75 to 100 tons capacity, using a conventional air conveying pressure system. From the storage silo it may be conveyed to any location within several hundred feet.

In California, bulk truck shipments are available. These units are provided with self-contained unloading equipment and can be emptied into a storage silo by the driver.

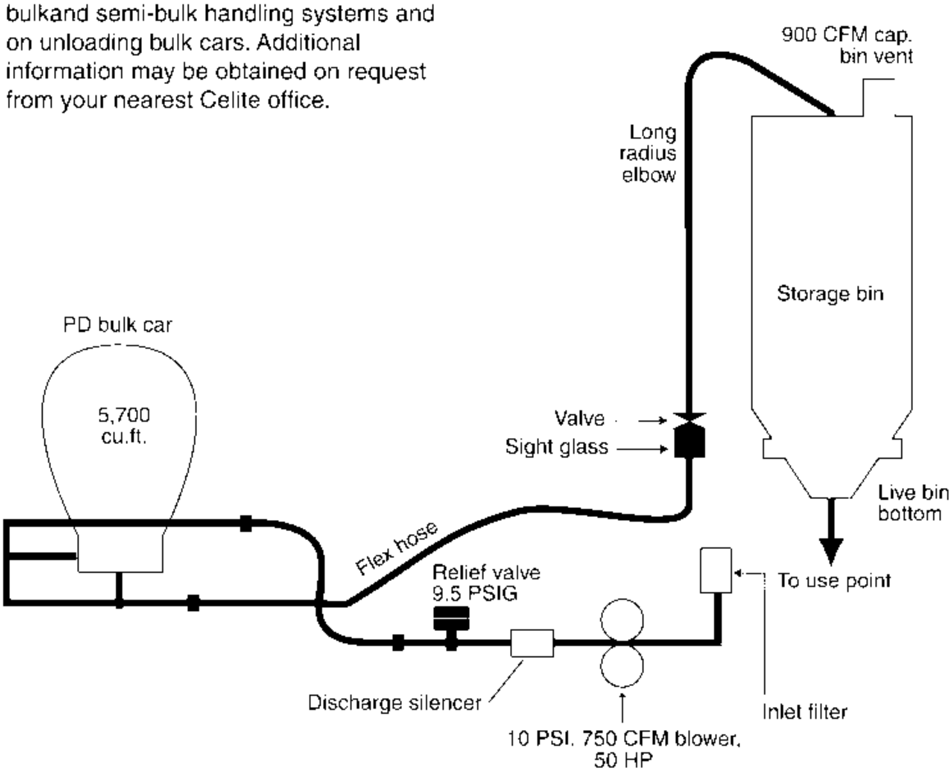
Semi-Bulk Handling
Celite® filter aids are available in semi-bulk woven poly bags of approximately 50 cubic feet (1.4 m^3) in volume. The filter aid may be dispensed directly into a mix tank, or incrementally from a suitable unloading stand.

Your Celite Filtration Specialist will be glad to give you further information on bulkand semi-bulk handling systems and on unloading bulk cars. Additional information may be obtained on request from your nearest Celite office.

Semi-bulk unloading stand



Bulk handling



Troubleshooting Chart

Trouble and Cause(s) Poor Clarity	Refer to Pages
During Precoating	
Not enough filter aid	12
Filter not properly vented	12,13 & 14
Flow too slow during precoating – settling	12
Flow too fast during precoating – washing	12
Poor baffling – cake washing	Note 1
Filter aid bleed-through	
Filter septum too open	12 & 18
Mechanical leaks – Screens/Gaskets/Manifold	15,17 & 18
Dirty Screens	12, 13 & 14
Precoat slurry concentration too dilute	12
During Filtering	
Filter aid too coarse	6, 7 & 24
Filter aid bleed-through	
Warped screens	
Septum too loose	
Filter septum too open	18 & 19
Mechanical leaks – Screens/Gaskets/Manifold	12 & 13
Improper switching of valves between precoating & filtering	13 & 14
Pressure fluctuations	18 & 19
Cake washing – poor baffling	Note 1
Cake washing – rate too fast	12 & 13
Negative pressure on outlet – flashing of filtrate	12 & 13, Note 2
Air in filter	12 & 13
Changes in liquid being filtered	6, 7, 18 & 24
Dirty screens	6, 7 & 18

Trouble & Cause(s) Short Cycles / High Pressure / Low Flow	Refer to Pages
During Precoating	
Pump air bound due to low level or vortexing in feed tank	19
Filter partially filled with air	12 & 14
Septum partially blinded	12, 13 & 14
Suspended solids in precoat liquid	12
During Filtering	
Incorrect grade of filter aid	6, 7 & 24
Dirty screens	14 & 18
Too high or low a body feed rate	6, 7,13,14 & 24
Plugged screens due to precoating with unfiltered or dirty liquid	11 & 12
Flow lines too small	Note 4
Leaf drainage insufficient	18 & 19
Uneven body feed rate	13 & 14
Body feedline plugged	13 & 14
Filter aid degradation – pumps & mixers	18,19 & 22
Obstruction in outlet line	Note 5
Pump sucking air	21
Changes in liquid being filtered	13 & 14
Incorrect precoat & body feed combination	6, 7 & 24
Wide variation in feed rates	13 & 14
Short cycles due to excessive recirculation	Note 6
Too low a pressure differential due to:	
Feed pump worn	18 & 19
Feed pump too small	18 & 19
Back pressure too high	Note 3

Note 1
If baffling is non-existent or poorly designed, excessive turbulence may occur at localized areas on the septum, preventing formation of the precoat in these areas.

Note 2
"Flashing" is the formation of bubbles at the septum-precoat interface, causing a continual disruption of the precoat and resultant bleed through of filter aid. Flashing may be due to localized boiling or release of dissolved gases.

Note 3
Excessive back pressure decreases the amount of pressure drop that should be available for filtration, appreciably reducing cycle length. High back pressure may be avoided by the use of transfer pumps on the filter outlet. Care should be taken, however, to insure that the transfer pump is not creating negative pressure on the outlet of the filter.

Note 4
If inlet lines are too small, friction losses in the lines reduce the effectiveness of the feed pump. If outlet lines are too small, the same friction losses create excessive back pressure.

Note 5
Care should be exercised particularly when filtering chilled aqueous solutions where ice may be formed or product can solidify in the outlet lines.

Note 6
During any filter aid filtration, 100% solids removal is never accomplished on the first pass. After the precoat is formed, if recirculation is continued for an excessive period of time, more and more particles are taken out. These particles collect at the surface of the precoat and may in time form an impervious layer, reducing flow and increasing pressure.

Testing and Evaluation

Walton test filter

Before any but the most routine filtrations take place, tests must be run, since it is impossible to predict filtration results accurately from physical data. The sample selected must be representative and have stable filtration characteristics. It may be chemically stable but its filter properties may *not*. Filtration testing embraces the following three categories:

1) Lab tests using a Buchner funnel or similar apparatus – good rough estimates of clarity and flow rate.

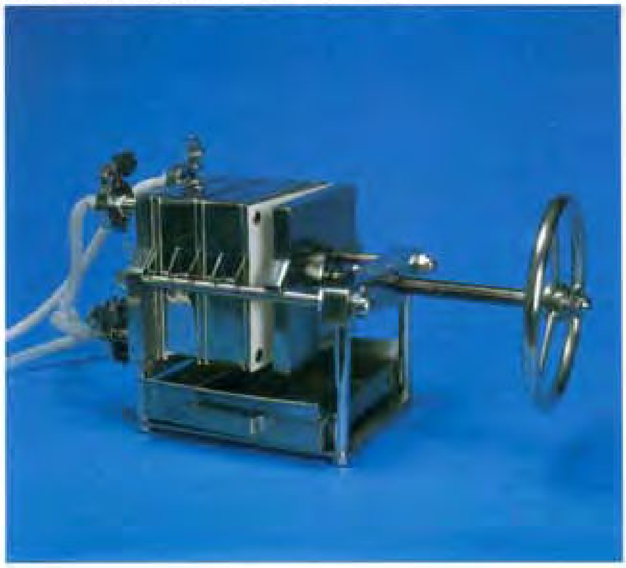
2) Short cycle, constant pressure tests.

3) Full cycle length tests at design flow rates.

One of the most useful test filters Celite can provide is the Walton Filter. This constant-rate filter is a portable, self-contained unit containing a 3.14 sq. in. leaf with all pumps, lines, valves, controls and other auxiliary equipment. The filter leaf, which is contained in either an acrylic or stainless steel shell, can be operated in the horizontal or vertical position to simulate different types of commercial filters.

Horizontal leaf pressure filter test stand

Plate and frame filter press test stand



Research and Technical Services

Of necessity, this book covers only the broad, general concepts of filtration. The particular needs of specific applications can only be determined through individual analysis by trained filtration specialists, supported by extensive research and analytical facilities.

Experience

Our filtration experience goes back over 100 years when diatomite was first used for filtration in the brewing and cane sugar industries.

This knowledge has been passed on, directly and in engineering and research records, to succeeding Celite specialists. Since filtration is still as much an art as a science, this depth of knowledge and library of data is a valuable resource. Celite can provide this benefit to the customer's full advantage.

Research

The Celite Corporation Research and Development Center is located in Lompoc, California. The specialists, engineers, chemists, and lab technicians have at their disposal test filter units, representing different types of filters, duplicating practically every filtration situation found in the field.

The R & D staff also has available state-of-the-art equipment and instruments to further research and develop programs.

Technical Services

The Celite Technical Services Department staff has vast practical experience both in the laboratory and in the field.

Celite Technical Services can make positive contributions in the following areas:

1. **Product or Process Development**
   Laboratory and pilot scale filtration assistance, conducting tests in your plant or in Celite laboratories, to determine the correct filter aids for your needs.

2. **Filter Station Design**
   Celite can offer recommendations on different types of filters and auxiliary equipment, to help fit a design to your needs.

3. **Filter Station Start-Up**
   Services during start-up offer you experienced help to spot and correct troubles sooner and prevent bottlenecks.

4. **Bulk Handling & Storage**
   A Celite specialist can help you evaluate the efficiencies and economics of a bulk handling system.

5. **Routine Operations**
   Celite specialists are readily available for technical process audits and optimization of your existing filtration system, whenever process changes are made or contemplated and filter aid adjustments may be necessary, or should trouble develop.

Scanning electron microscope

X-ray fluorescence spectrometer

Common Filtrations

Celite® filter aids are widely used in industry and the filtration unit operations become an integral part in many processes. Besides turbidities naturally occurring as a result of processing, Celite® filter aids are used to remove catalysts, stabilization chemicals, adsorbents, and turbidity produced as a result of chill-proofing. Listed here are just a few of the products which are being filtered by Celite® products. No attempt is made to state the grade and amounts of filter aids as these can vary up to tenfold for the same product at different locations. A Celite Filtration Specialist will be glad to assist in determining the type and amount of filter aid for your specific application.

Typical Applications of Celite® Filter Aids

Antibiotics
Fruit and vegetable juices
Alginates
Animal oils
Vegetable oils
Waxes
Dairy products
Gelatin
Inorganic chemicals
- Brine
- Sodium hydroxide
- Gold salts
- Magnesium salts
- Potassium salts
- Bleaching compounds
- Titanium dioxide muds

Drycleaning solvents
Lube oils
Industrial wastes
Rolling mill oils
Cutting oils
Jet fuels
Organic chemicals
Acids
- Sulfuric
- Phosphoric

Varnishes
Lacquers
Water
- Process
- Municipal
- Waste
- Boiler
- Condensate

Cane sugar
Beet sugar
Corn sugar
Beverages
- Beer
- Wine
- Soft drinks
- Fruit Juices
- Spirits

Glossary of Filtration Terms

Absolute – A degree of filtration that guarantees 100% removal of suspended solids over a specified particle size.

Absorb – To take up a liquid, like a sponge takes up water.

Activated Carbon – An adsorbent carbon which removes dissolved color, odor and taste, etc. from liquids or gases.

Activated Clay – An adsorbent clay that removes color, odor and free fatty acids, etc. from oils and tallows.

Admix – Celite® that is added directly into the batch tank of prefilt to create a permeable filter cake. Usually used in place of body feed.

Adsorb – The act of selectively attracting and holding a gas, vapor, liquid or colloid onto the surface of a solid.

Amorphous - Non-Crystalline. Having no ordered molecular structure of its own.

Area – The surface available in a filter for the passage of liquid and formation of a filter cake. Usually measured in square feet.

Atm. – Atmosphere. A measurement of pressure. The air pressure at sea level: 14.7 psi.

Attrition – Breaking down or wearing away by friction. Usually as particle to particle degradation in a diatomite slurry.

Backwash – A reverse flow of liquid to remove solids from the filter.

Baffle – A plate or deflector to provide flow distribution in a filter. Primary functions are to prevent erosion of precoat and settling of body feed in the filter tank.

Blinding – Plugging or sealing of any portion of a filter septum by solids that are not removed during the normal cleaning cycle.

Blind Spots – Any place on a filter septum where liquid cannot flow through due to blinding.

Blowdown – The use of air or inert gas pressure to displace a liquid out of a filter. Usually through the filter cake. Continued blowdown is sued to dry a filter cake in situ.

Body Feed – Celite® that is continuously added to the filter while it is on-stream. Its purpose is to create a permeable filter cake.

Bridging – (1) The act of particles forming an arch over the openings on a septum.(2) Filter cakes that have grown to a size where they actually touch each other in the filter.

Cake – The accumulation of solids (and Celite®) on the surface of a precoat or septum.

Cake Space – The volumetric space available in a filter to support the formation of a cake.

Celite® – A Celite Corporation registered trade name for its line of diatomaceous earth filter aids and fillers.

Cellulose – A fibrous material of vegetable origin.

Clarity – Clearness of a liquid as measured by a variety of methods.

Cloth – A type of woven filter septum made from natural or synthetic yarns.

Colloid – Very small, insoluble, nondiffusable solid or liquid particles that remain in suspension in a surrounding liquid. Solids usually on the order of 0.2 μm or less.

Compressibility – Degree of physical change in suspended solids (or filter cake) when subjected to pressure.

Contact Time – The length of time an adsorbent is in contact with a liquid prior to being removed by the filter.

Cycle – The length of time a filter is "on-stream" before cleaning is needed. Frequently meant to include cleaning time as well.

d'Arcy – A measurement of filter cake permeability expressed by the formula:

K = HL / (1)A ∆ P
Q

Named after the French mathematician who first developed the equation.

D.E. – A commonly used abbreviation for diatomaceous earth.

Deformable – Used to describe suspended solids that extrude into the interstices of a filter cake and cause rapid filter plugging.

Delta (∆) P – A commonly used symbol denoting the pressure drop across a filter.

Density - The weight of a given volume of Celite® or its filter cake. Usually measured in pounds per cubic foot (pcf). Can be measured wet or dry.

Diatomite – An abbreviation of diatomaceous earth.

Diatomaceous Earth – The fossilized skeletons of minute, prehistoric aquatic plants.

Differential Pressure – The difference in pressure between the upstream and downstream sides of a filter of filter cake.

Dissolved Solids – Any solid material that will dissolve in the liquid that is being filtered, such as sugar in water. Celite® filtration does not remove these solids.

Doctor Blade (Knife) – A sharp, hard blade that cuts the cake off the surface of a filter. Usually found on rotary vacuum precoat filters.

Effluent – Any liquid that is discharged from a factory, waste treatment facility or filter. Frequently used erroneously to mean filtrate.

Element – Any structural member in a filter on which the septum is supported. May be round, rectangular or cylindrical.

Feed – The mixture of solids and liquid that enters the filter. Synonyms: prefilt influent and incoming slurry.

Filter – Verb – To pass a liquid containing solids through a filter medium whereby the solids and liquid are separated from each other.
Noun – A device for containing the filter media.

Filter Aid – Any material that assists in the separation of solids from liquids. Usually used on difficult filtration applications.

Filter Medium – The permeable material that separates particles from a fluid passing through it.

Filter System – The combination of a filter and associated hardware required for the filtration process.

Filtrate – Any liquid that has passed through the filter media. Sometimes erroneously called effluent.

Filtration – The process by which solid particles are separated from a liquid by passing the liquid through a permeable material.

Filtration Rate – The volume of liquid that passes through a given area of filter in a specific time. Usually expressed as gallons per square foot per minute (or hour).

Flow Rate – The unit rate at which a liquid is passed through a system. Usually expressed in gallons per minute (or hour).

Frazier – A test to measure the air permeability of filter septums. Expressed in cfm of air at ΔP of ½" W.C.

Friable – Easily crushed or crumbled.

Gelatinous – Used to describe suspended solids that are slimy and deformable, causing rapid filter plugging.

GSFM – Abbreviation for gallons per square foot per minute. Also gsfh for hour.

GPH – Abbreviation for gallons per hour.

GPM – Abbreviation for gallons per minute.

Heel – (1) The liquid left in a filter shell at the end of a cycle.
(2) The precoat left on a RVPF at the end of its cycle.

Hydrophilic – Water accepting.

Hydrophobic – Water rejecting.

Interstices – Any void spaces in and around solid particles that are packed together.

Kenite® – A Celite Corporation registered trade mark for its line of diatomaceous earth filter aids and fillers.

Leaf – Any flat filter element that has or supports the filter septum.

Liquor – Any liquid carrying or intended to carry dissolved solids.

Manifold – A pipe or assembly into which the filter elements are connected to form one common discharge for the filtrate.

Media (medium) – The material that performs the actual separation of solids from liquids. Sometimes erroneously used to mean septum.

Membrane – Media through which a liquid is passed; usually associated with a very fine or tight type of filtration.

Mesh – (1) Number of strands in a lineal inch of woven filter fabric.
(2) A commonly used synonym for septum, as in wire mesh.

Micron – Now expressed as micrometer (μm). A unit of length: 10^{-6} meters or 39/1,000,000 inches.

Monofilament – A single synthetic fiber of continuous length; used in weaving filter cloths.

Multifilament – A number of continuous fiber strands that are twisted together to form a yarn; used in weaving filter cloths.

Nonwoven – A filter cloth or paper that is formed of synthetic fibers that are randomly oriented in the media. Usually held together with a binder.

On-Stream – Describes when a filter system is producing a filtered product.

Particle Size Distribution – The distribution obtained from a particle count grouped by specific micron sizes.

Permeability – The property of the filter medium that permits a fluid to pass through under the influence of a pressure differential.

pH – Potential Hydrogen. A measurement of the acidity of alkalinity of a substance. A pH of 7.0 is neutral.

Plate – Any flat surfaced filter element. Usually found in horizontal plate filters.

Porosity – The ratio of the void volume to the total bulk volume.

PPM – Parts per million. A unit of concentration: e.g., 3 ppm would be 3 pounds of solids in 1,000,000 pounds of water.

Precoat – The initial layer of Celite® that is deposited on the filter septum. Usually ⅛" thick on pressure filters and 2" to 6" thick on RVPF.

Prefilt – Material to be filtered.

RVPF – Rotary Vacuum Precoat Filter. A drum filter that is coated with a thick (up to 6") precoat of Celite®.

Scavenger – A filter, or element in the bottom of a filter, that recovers the liquid heel that remains in a filter tank at the end of the cycle.

Screen – A term commonly used for septum.

Septum – Any permeable material that supports the filter media.

Slurry – Any liquid containing suspended solids.

SpG – Specific gravity. The weight of any substance relative to the weight of water (water SpG = 1.0).

Suspended Solids – Solids that do not dissolve in liquid; those solids that remain suspended and can be removed by filtration.

Suspension – Any liquid containing undissolved solids, such as a Celite® slurry.

Turbidity – Any insoluble particle that imparts opacity to a liquid.

Voids – The openings or pores in a filter medium.

The physical or chemical properties of Celite Corporation products represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Check the nearest Celite Corporation sales office to assure current information.

Certified ISO 9002

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FA84-2

Printed in U.S.A.