

Pressure Filtration with Diatomaceous Earth (DE)

A Simple Guide for Efficient Filter Operation



Celatom[®]

Filter Aids

PERFORMANCE

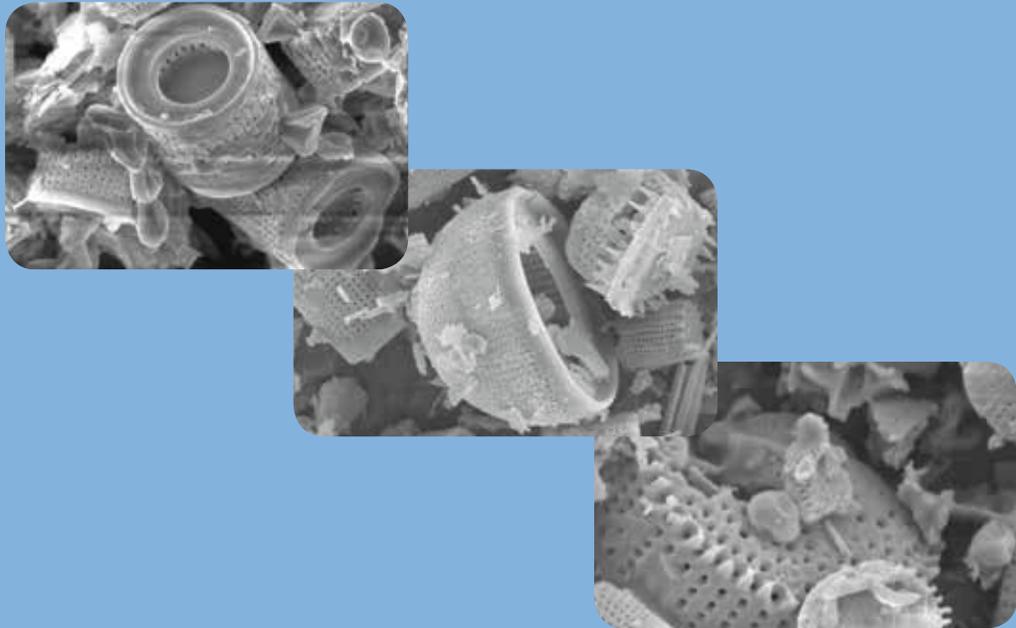
DIATOMACEOUS EARTH (DE)

Diatomaceous earth, or diatomite, is the skeletal remains of microscopic unicellular plants which lived in the ancient fresh and salt water lakes and oceans. The deposits mined by EP Minerals consist primarily of a particular species of fresh water diatom, the *Melosira Granulata*. Its unique, strong, cylindrical geometry, high pore volume, and low resistance to flow make it an excellent filter medium.

EP Minerals surface mines the ore from deposits in Nevada and Oregon where the ore is sun dried before transport to the processing plants. Once at the EP Minerals' processing plants, the raw ore is crushed and pyro-processed to remove all organics, resulting in a pure, chemically inert filter media. Through this pyro-process, we agglomerate the DE to the desired particle size distribution for the grade being produced. A wide selection of grades is manufactured to meet the filtration requirements of many applications.

DIATOMITE IN PRESSURE FILTRATION

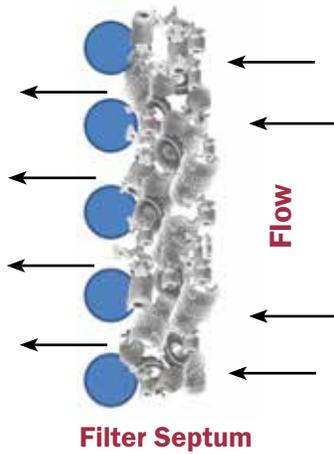
Solid/Liquid separation with diatomite filter aids on pressure type filter systems (pressure leaf, candle filters, or filter presses) is a two-step process. First, a thin protective coating of filter aid ("precoat") is applied. Then small amounts of diatomite, or "bodyfeed," are added to the liquid being filtered, trapping and removing solids from the liquid while maintaining sufficient permeability throughout the filter cycle.



PRECOAT

A thin (1/16" (1.6mm) - 1/8" (3.2mm) thick) precoat layer is built up on the filter septum (Fig. 1). The precoat is applied by recirculating a slurry of diatomite and clean water (or filtered clean process liquor) between the precoat slurry tank and the filter (Fig. 2). The filter septum is merely a support for the diatomite precoat and does not function to remove particulates from the liquid.

DE bridges the screen openings and forms a precoat.



Filter Septum

Fig. 1

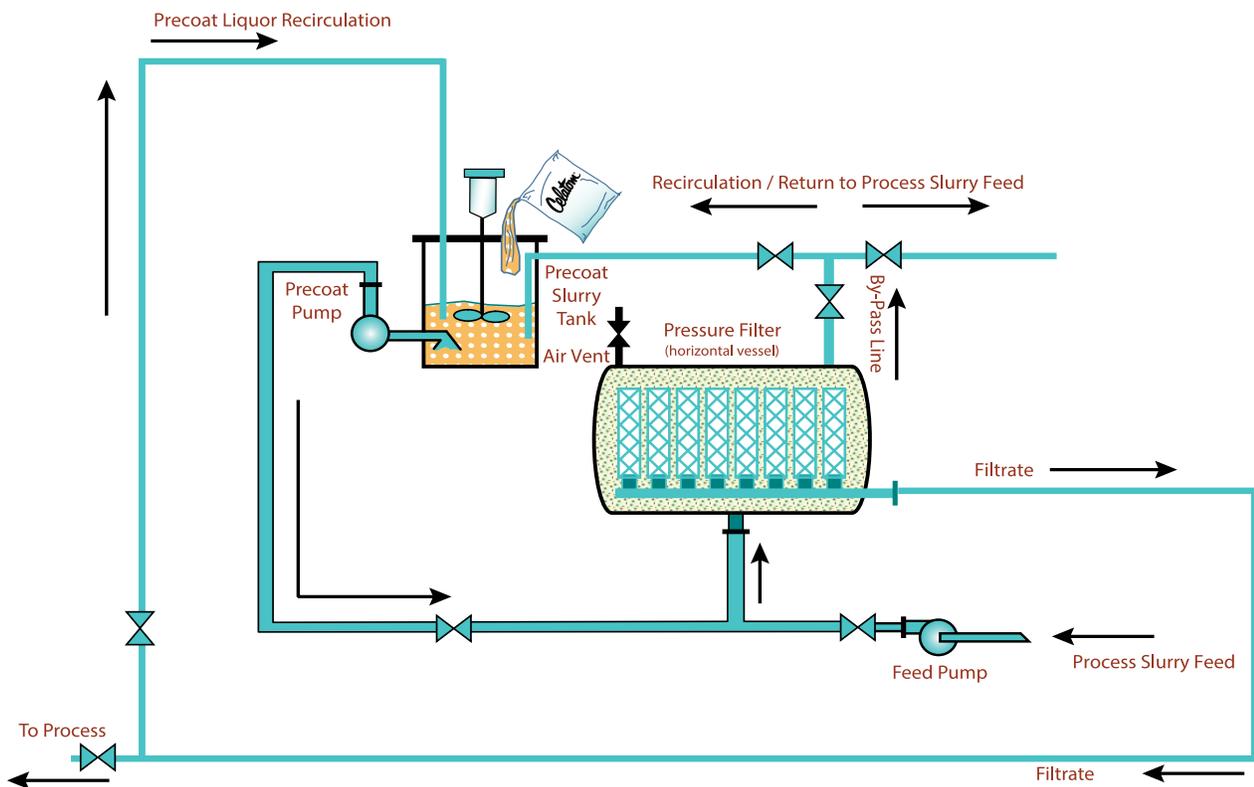


Fig. 2

THE BASIC FUNCTIONS OF THE PRECOAT ARE TO:

- ▶ establish immediate filtrate clarity
- ▶ prevent blinding of the filter septum and prolong septum life
- ▶ enhance filter cake release, reducing filter clean up time
- ▶ maintain filtrate clarity throughout the filtration cycle

PRECOAT LOADING RATE

The amount of diatomite filter aid required to produce a satisfactory precoat cake 1/16", (1.6 mm) – 1/8", (3.2 mm) thickness is 15-20 lbs. per 100 ft.² (0.73 - 0.98 Kg/m²) of filter area. Pressure filter systems with large surface area (1,000 sq. ft. (93 m²) or greater) with challenging internal flow characteristics may require a slightly higher precoat rate (25 lbs. per 100 ft.² (1.22 Kg per m²) to achieve a fully covered filter area.

PRECOAT SLURRY CONCENTRATION

In order to facilitate the formation of a precoat, diatomite particles must "bridge" or "crowd" at the septum openings. To achieve this, the filter aid's slurry concentration must be adequate to cause the crowding. The ratio of filter area to the liquid volume of the system, including precoat tank, filter vessel and piping volume, must be considered. The best precoat will be formed using slurry concentrations that range between 1-3% by weight at the filter septum. Higher slurry concentrations in the precoat tank are necessary to achieve the required concentrations at the filter septum. Levels below 0.3% by weight of slurry concentration will likely make precoat formation difficult. Another consideration to achieve the bridging is the pumping rate during precoating: The pumping rate must be high enough to keep the filter aid in suspension and facilitate the bridging at the septum. Pump rates for water-based precoats can be achieved with 1-2 gallons/square foot/minute of filter area (GSFM) or 40-80 liters/square meter/minute. Liquid viscosity will have a significant influence on the required pumping rates: Higher viscous liquids require lower rates to maintain filter aid suspension and bridging.

PRIMARY PRECOATS AND DUAL PRECOATS

Worn or damaged screens or worn discharge manifolds can cause precoat and process slurry solids to “bleed through” into the filtrate stream (Fig. 3). A cellulose fiber “primary precoat” can eliminate these operating problems. A “dual precoat” consisting of an initial coarse grade top coated with a finer grade can also prevent filter aid bleed through in polishing filtrations where very tight, or “fine,” grades of filter aid must be used. This method will typically improve filter flow rates compared to those achieved with a single grade precoat.

CELLULOSE AND DIATOMACEOUS EARTH PRECOATS

An initial (primary) precoat of cellulose fiber is especially useful when performing fine or polishing filtrations, or when the screens/septums are worn or damaged. Some of the benefits from using a cellulose precoat are:

- ▶ bridges over small tears and holes in filter screens
- ▶ seals worn discharge manifold joints
- ▶ protects the screens from blinding by fines
- ▶ eliminates filter aid bleed through when using fine grades of diatomaceous earth

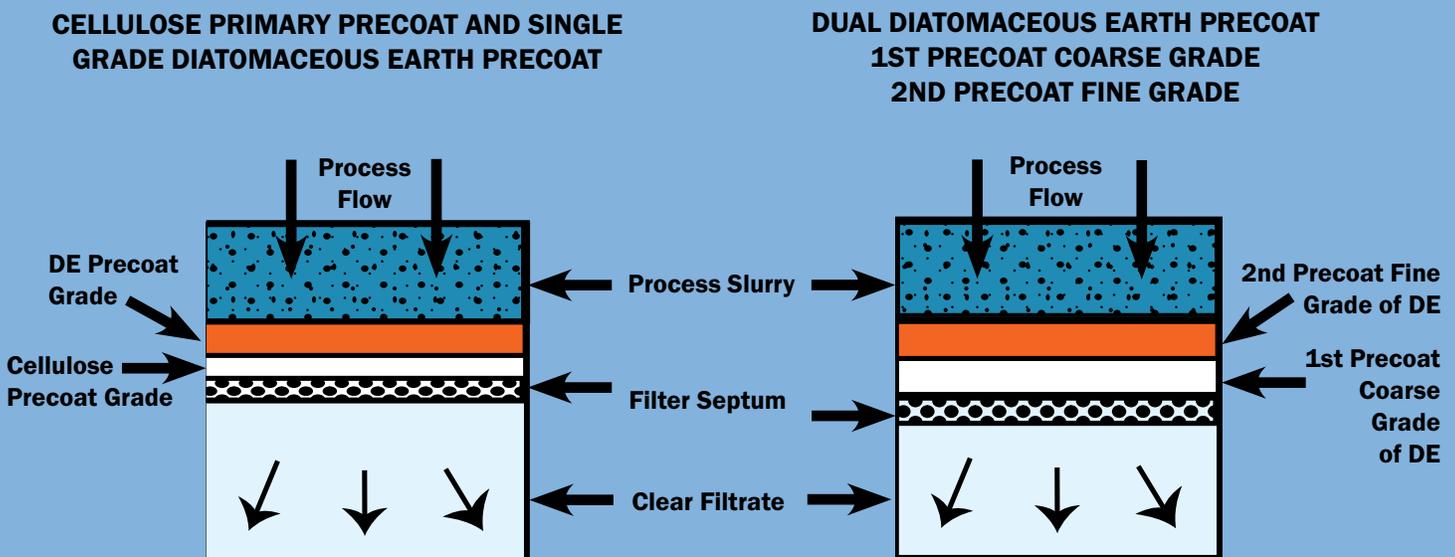


Fig. 3

DUAL DIATOMACEOUS EARTH PRECOATS

A dual precoat divides filter aid cake formation and filtrate clarity into two separate functions. The typical benefits are:

- ▶ a strong and permeable precoat from the coarse grade
- ▶ high clarity from the fine grade
- ▶ eliminates filter aid "bleed through" from fine grade
- ▶ minimizes screen blinding from fines
- ▶ higher flow rates than with a single grade precoat
- ▶ more efficient use of filter aid

FILTERING AND BODYFEED

The filtration of liquids containing gelatinous, slimy, and/or compressible solids typically result in poor filtration performance, low flow rates, and very short cycle times. The addition of non-compressible solids as bodyfeed can improve the performance of the filtration operation in these situations. Celatom[®] diatomite has consistent quality, high permeability, and rigid non-compressible characteristics that work especially well as a bodyfeed.

SIMPLE THEORY

The addition of a bodyfeed changes the physical characteristics of the formed filter cake by increasing its permeability/reducing its resistance to flow. A simple filtration equation demonstrates the influence of these operating parameters on flow rate and filtration performance.

$$Q_r = \frac{A \cdot \Delta P}{\mu(R_c + R_m)}$$

where: **Q_r** = filtration flow rate
A = filtration area
ΔP = operating pressure
μ = liquid viscosity
R_c = cake solids resistance
R_m = septum resistance

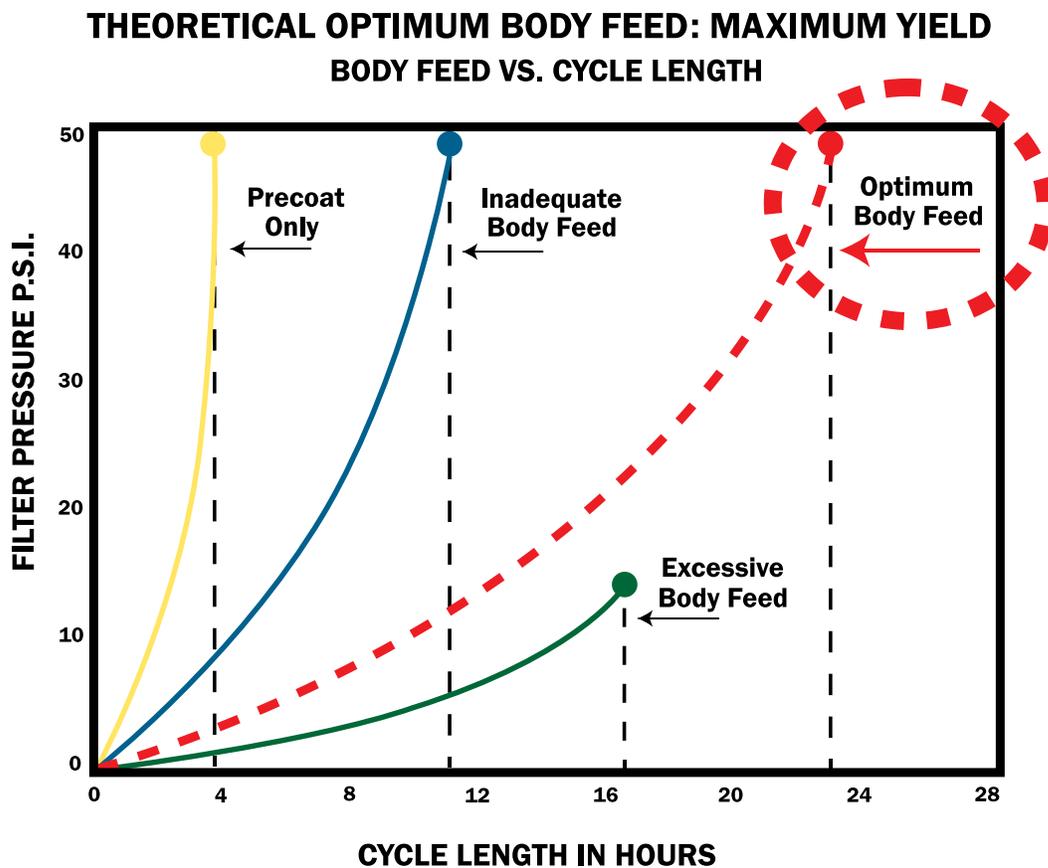
BODYFEED FUNCTION

The addition of bodyfeed reduces flow resistance of the formed process solids. The relative resistance of compressible solids is high and rises with increasing operating pressures and solids deposition. The appropriate grade and amount of filter aid as a bodyfeed can reduce cake resistance and lessen the rate of increase due to operating pressure (ΔP), cake thickness, and time (filtering cycle). Permeability of the formed cake solids can also be increased for slimy and gelatinous solids. Lower cake resistance means the filter will produce the same flow rate as at lower ΔP, more slurry can be filtered because it takes longer to reach the terminal ΔP, and improved cake dryness and wash efficiencies. The capacity of the filter is increased as the cake-forming volume can now be fully utilized (filter presses and pressure filters).

The optimum amount of bodyfeed addition is the quantity which:

1. minimizes the initial filter ΔP (pressure filters and filter presses)
2. prevents a rapid increase in the rate of ΔP
3. prevents terminal ΔP until the cake space is fully utilized

The graph demonstrates the influence of underutilization of bodyfeed, optimal and excessive bodyfeed. Optimal bodyfeed addition rates will depend on the type and amount of solids being filtered.



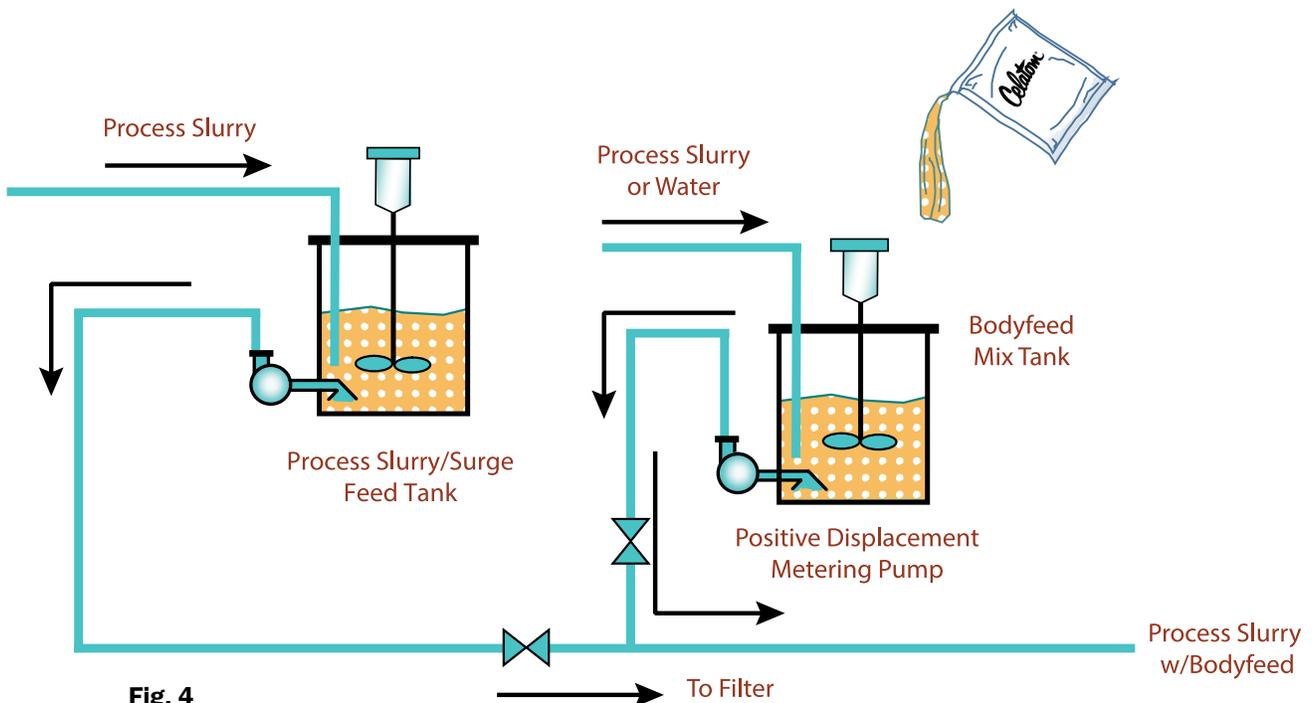
Legend

- Yellow and blue lines demonstrate too short a cycle length and too rapid pressure decay. Cake blinds off and cycle terminates before all available cake space is used.
- Green line represents too much bodyfeed, resulting in a short cycle due to premature filling of available cake space.
- Red line demonstrates the correct combination using optimal bodyfeed.

BODYFEED ADDITION

There are three methods of adding bodyfeed to the process slurry: The batch method adds a specific amount of filter aid directly to a tank full of process slurry. The slurry is then pumped directly to the filter where particulate and bodyfeed are removed. A continuous batch method receives bodyfeed directly to the process slurry via a volumetric meter as new process slurry is fed to the tank. Continuous feed injects a filter aid slurry directly into the feed line to the filter and combines with the slurry as it goes to the filter (Fig. 4).

The continuous feed method offers the most flexibility, allowing for immediate and easy changes in bodyfeed concentration. This flexibility can adapt to feed variability and changes to solid loading.



AMOUNT OF BODYFEED

To achieve optimal bodyfeed addition rates for a particular solid type, some trial and error will be necessary. Contact your EP Minerals representative to arrange bench scale test work either at your facility or in EP Minerals Laboratory to determine the best starting point for your filtration operation.

For rigid, non-compressible solids, here are some general guidelines which can be used as a starting point:

- ▶ **For low suspended solids levels (less than 0.1%):** Use a bodyfeed addition ratio greater than 1:1; i.e., more bodyfeed than suspended solids.
- ▶ **For moderate suspended solids levels (approx. 0.5%):** Use a bodyfeed addition ratio approximately 1:1; i.e., the same amount of bodyfeed as suspended solids.
- ▶ **For high suspended solids levels (greater than 1.0%):** Use a bodyfeed addition ratio less than 1:1; i.e., less bodyfeed than the amount of suspended solids.

Slimy, gelatinous, and highly compressible solids typically require higher bodyfeed addition rates to affect cake permeability. This can require ratios from 2-3:1 to as high as 10:1. (Percent and ratios are on a wt:wt basis.)

GRADE SELECTION

EP Minerals offers a wide range of Celatom[®] filter aid grades for any filtration application. It is important to choose the correct grade that will give the lowest cost per unit volume of filtered product while maintaining an acceptable clarity level at maximum allowable throughput. EP Minerals offers DE as well as Perlite filter aid grades. When choosing Perlite, consider wet bulk density differences for dosing precoat and bodyfeed addition rates. Please refer to our Pressure Filtration with Perlite brochure or contact your Technical Representative if making these changes.

Other Helpful Pointers:

It is quite common to use the same grade of filter aid for both precoat and bodyfeed applications. When two different grades are used, the bodyfeed will typically be the more “coarse” or “open” grade. (This does not refer to the grades in dual precoat applications.)

For suspended solids which are relatively non-compressible: Use a grade of DE which has a median micron size comparable to the solids being filtered; i.e., for fine solids use a “fine” grade of filter aid; for coarse solids use a “coarse” grade of filter aid.

For slimy, gelatinous, or compressible solids: For better filtered cake solids permeability, use a more “coarse” grade of filter aid than might be typical.

To help with any of your filtration requirements, please consult with your EP Minerals Technical Representative. They can help you further understand the optimal use of Celatom[®] filter aids and help troubleshoot problems with your filtration systems.

TECHNICAL DATA SHEET

Typical Physical Properties

Grade #	FN-1	FN-2	FN-6	FP-22	FP-1	FP-2	FP-3	FP-4	FP-6	FW-6	FW-12	FW-14	FW-18	FW-20	FW-40	FW-50	FW-60	FW-70	FW-80	
Sieve Analysis ¹																				
%+150 Mesh	0.6	1.1	0.1	2.5	3.0	3.0	3.5	4.2	4.5	5.0	6.6	7.1	7.6	10.5	16.8	19.3	25.5	33.2	49.5	
%+325 Mesh	4.2	10.1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Median Particle Diameter (microns)	13.0	16.0	12.0	13.0	12.7	13.0	14.0	15.0	18.0	18.0	24.0	28.0	31.0	33.0	40.0	42.0	48.0	62.0	77.0	
Permeability ² (darcy)	0.036	0.076	0.028	0.070	0.087	0.120	0.200	0.315	0.500	0.550	0.900	1.450	1.900	2.250	2.860	3.850	5.000	6.700	13.000	
Density (lbs/ft ³)																				
Wet Bulk	23	23	25	23	23	23	24	25	24	21	21	21	21	21	20	20	20.5	21	20	
Dry Bulk	12	14	12	13	12	12	12	12	12	12	13	14	14	14	15	15	15	16	16	
Density (g/l)																				
Wet Bulk	368	368	400	368	368	368	384	400	384	336	336	336	336	336	320	320	328	336	320	
Dry Bulk	192	224	192	208	192	192	192	192	192	192	208	224	224	224	240	240	240	256	256	
pH (10% Slurry)	7.0	7.0	7.0	6.0	6.5	6.5	6.5	6.5	7.0	9.0	9.5	9.5	9.5	10.0	10.0	10.0	10.0	10.0	10.0	
Color	Buff	Buff	Buff	Buff/Pink	Buff/Pink	Buff/Pink	Buff/Pink	Buff/Pink	Buff/Pink	Pink/White	White/Lt. Pink	White/Lt. Pink	White							
Brightness (Y)	80	77	80	-	-	-	-	-	-	68	68	70	75	75	80	80	80	75	75	

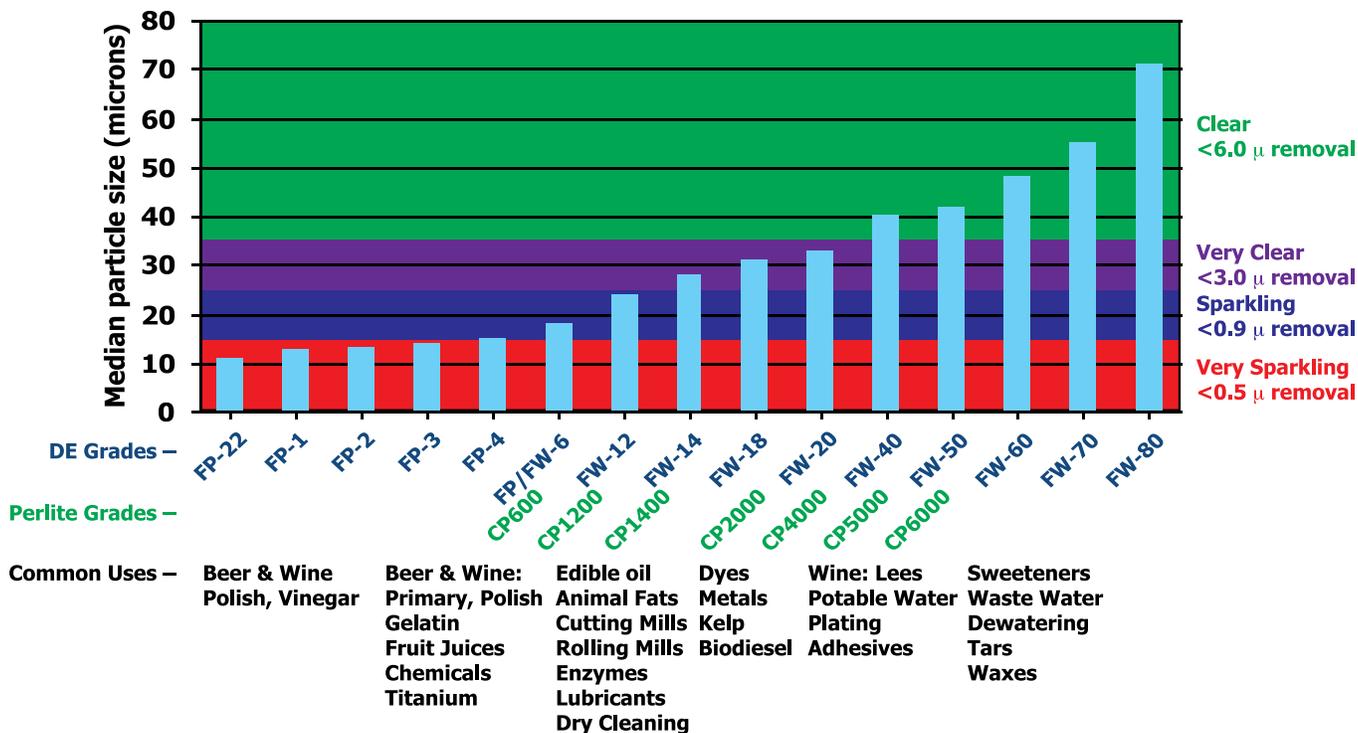
(1) w/Tyler Screen: +150 mesh = >105 microns, +325 mesh = >44 microns

(2) Determined w/VEL Permeameter

DE = Diatomaceous Earth

Read appropriate **SAFETY DATA SHEET** before using. **NOT TO BE USED FOR SPECIFICATIONS.**

EP Filtration Guidelines by Application



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Filter Aids