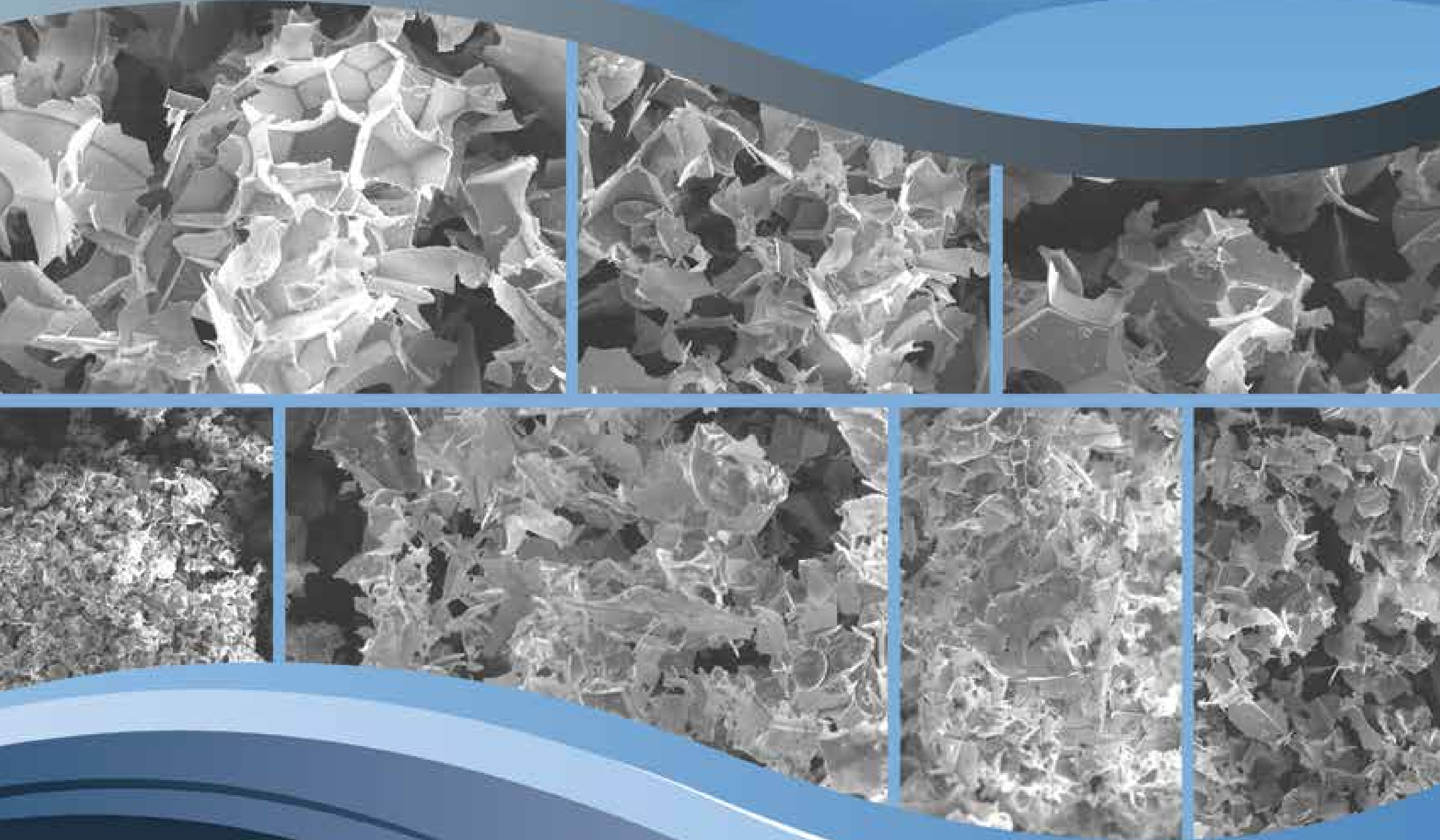
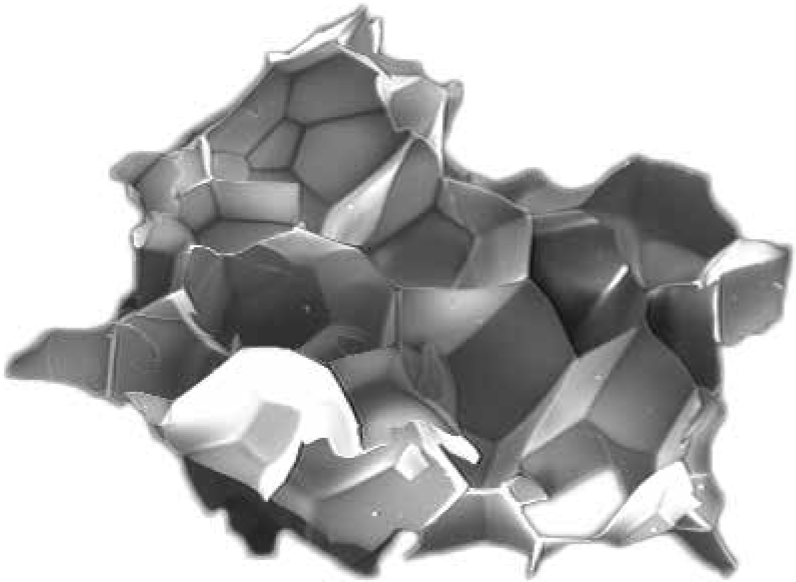
Pressure Filtration with Perlite

A Simple Guide for Efficient Filter Operation



Celatom®

Filter Aids



WHAT IS PERLITE?

Perlite, an igneous rock, is formed by the hydration of rhyolitic obsidian, a rock which is the result of rapid chilling of molten high silica rhyolitic lava. The volcanic origin of perlite creates occurrences of perlite rock as dikes, domes, sills, or flows. Flows and domes are the predominant formations of perlite that are mined today; some flows cover several square miles and can be 100 feet thick. Occasionally some domes are thousands of feet across and are several hundred feet thick.

MINING AND ORE PROCESSING

Perlite is typically an open pit, surface mining operation. The first step is removal of overburden (soil, contaminated perlite, and basalt boulders) and is usually accomplished with bulldozers. Once the perlite is exposed, it is broken using a bulldozer mounted ripper. The broken perlite is loaded and transported to a ore processing facility where it is dried, crushed, and sized to specific grades then moved to storage silos or bins for final shipment to an expansion facility. The coarser grades of perlite ore are typically used for the production of horticulture additives. The medium-sized ores are expanded into aggregate and building products and the finest grades are most typically used in the production of filter aids.

PERFORMANCE

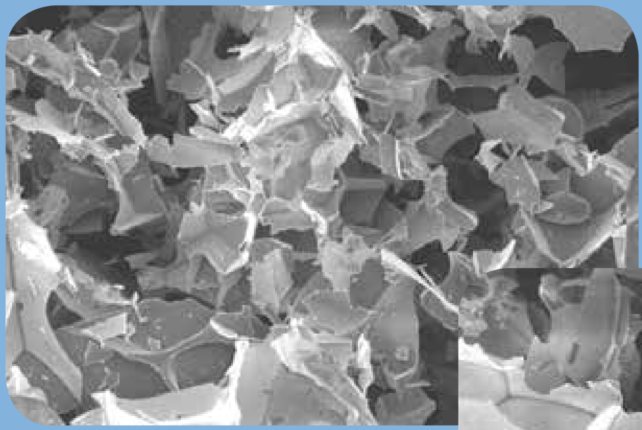
PERLITE FILTER AIDS

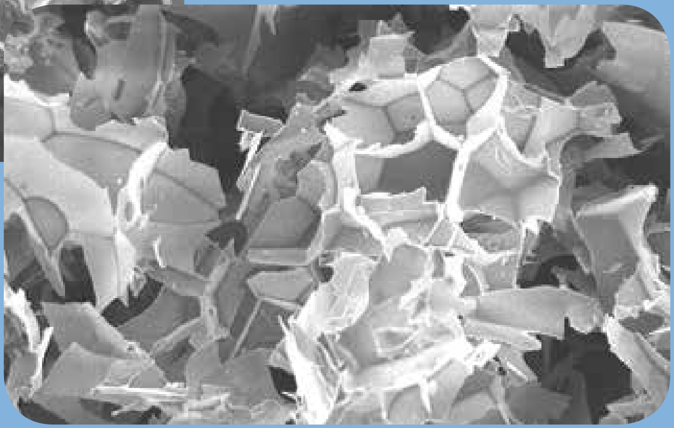
Perlite is an amorphous alumino-silicate rock containing entrapped water. When superheated, the perlite turns to liquid molten glass and the molecular combined moisture is released as water vapor. As a result of the rapid release of the moisture, multi-cellular, irregular glass bubbles are formed. This expansion of the perlite ore is similar to popcorn popping and the resulting expanded perlite can be as much as twenty times its original volume. These glass bubbles are then milled to varying particle sizes to form perlite filter aids.

With its unique morphology, expanded milled perlite has excellent properties for removal of difficult to filter suspended solids. The morphology coupled with the resulting light density allow perlite filter aids to retain large volumes of suspended solids while maintaining excellent permeability.

PERLITE IN PRESSURE FILTRATION

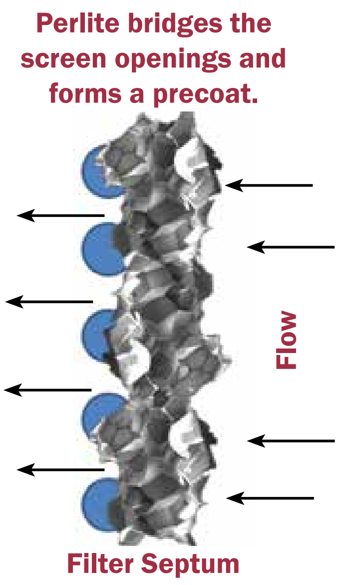
Solid/liquid separation with perlite filter aids on pressure type filter systems (pressure leaf, candle filters, or filter presses) is a two-step process. First, a thin protective coating of filter aid ("precoat") is applied. Then small amounts of perlite, or "bodyfeed," are added to the liquid being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





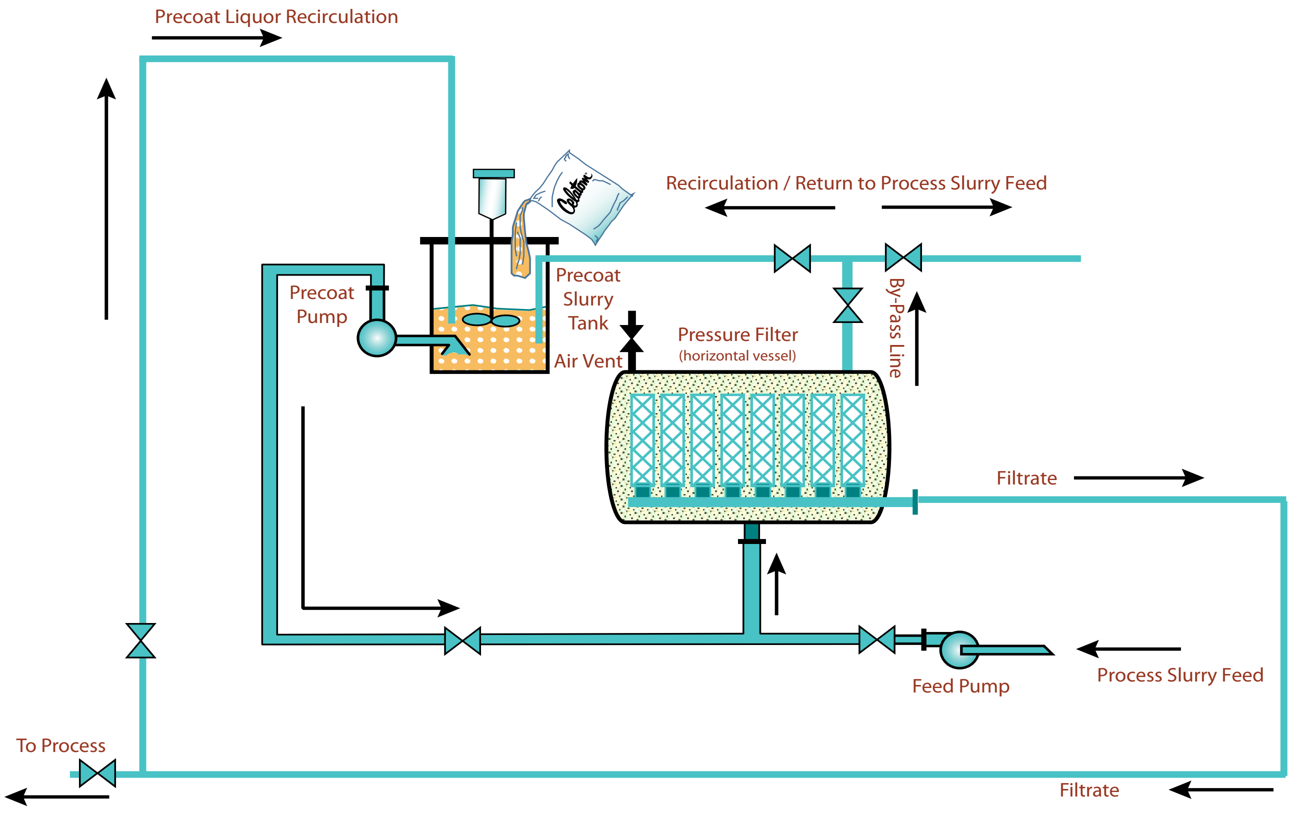
PRECOAT

A thin (1/16˝(1.6mm) – 1/8˝(3.2mm)) precoat layer is built up on the filter septum (Fig. 1). The precoat is applied by recirculating a slurry of perlite 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 perlite precoat and does not function to remove particulates from the liquid.



Perlite bridges the screen openings and forms a precoat.
Flow
Filter Septum

Fig. 1



Precoat Liquor Recirculation
Recirculation / Return to Process Slurry Feed
Precoat Pump
Precoat Slurry Tank
Air Vent
Pressure Filter
(horizontal vessel)
By-Pass Line
Filtrate
Feed Pump
Process Slurry Feed
To Process
Filtrate

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 perlite filter aid required to produce a satisfactory precoat cake 1/16", (1.6 mm) – 1/8˝, (3.2 mm) thickness is 10-15 lbs. per 100 $ft.^2$ (0.49 - 0.73 kg/m^2) of filter area. Pressure filter systems with large surface area (1,000 sq. ft. (93 m^2) or greater) with challenging internal flow characteristics may require a slightly higher precoat rate (20 lbs. per 100 $ft.^2$ (0.98 kg/m^2) to achieve a fully covered filter area.

PRECOAT SLURRY CONCENTRATION

In order to facilitate the formation of a precoat, perlite 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 0.5-1.5% 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 0.2% 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 0.5-1.0 gallons/square foot/minute (GSFM) of filter area or 20-40 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 (sometimes with a fine grade of Diatomaceous Earth to achieve clarity requirements) 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 PERLITE 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 perlite

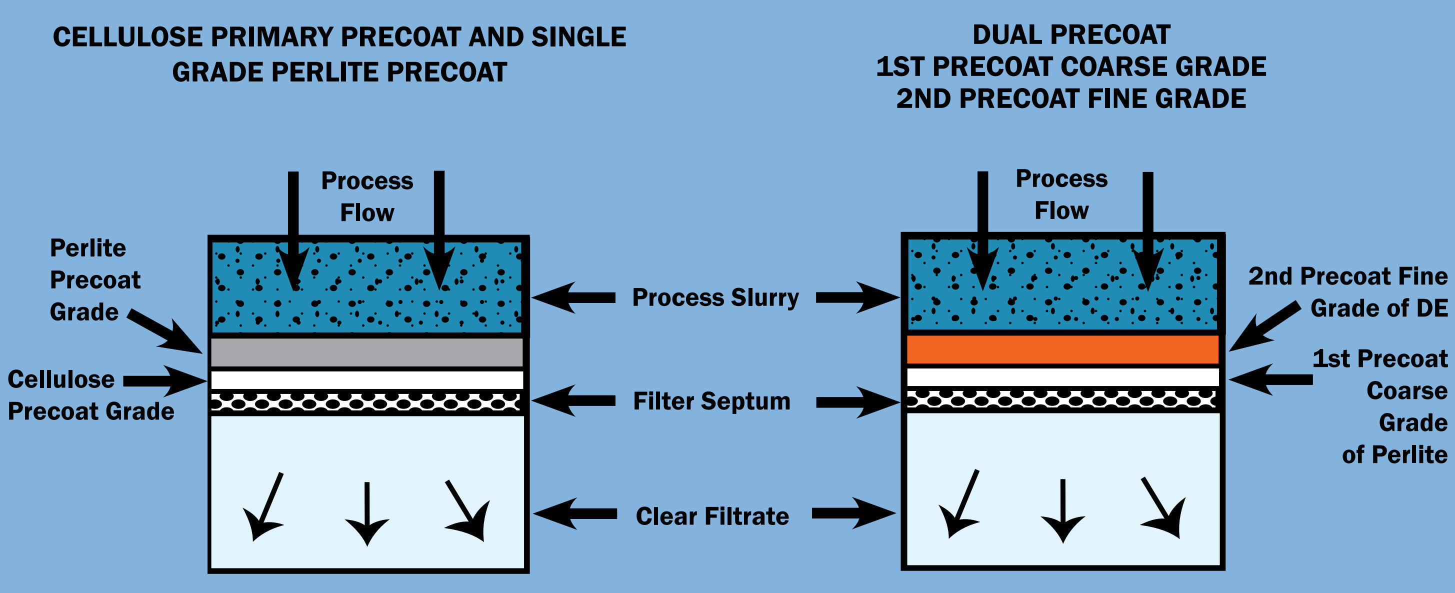


Fig. 3

DUAL PERLITE/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 of DE
- 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® perlite has consistent quality, high permeability, and rigid 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

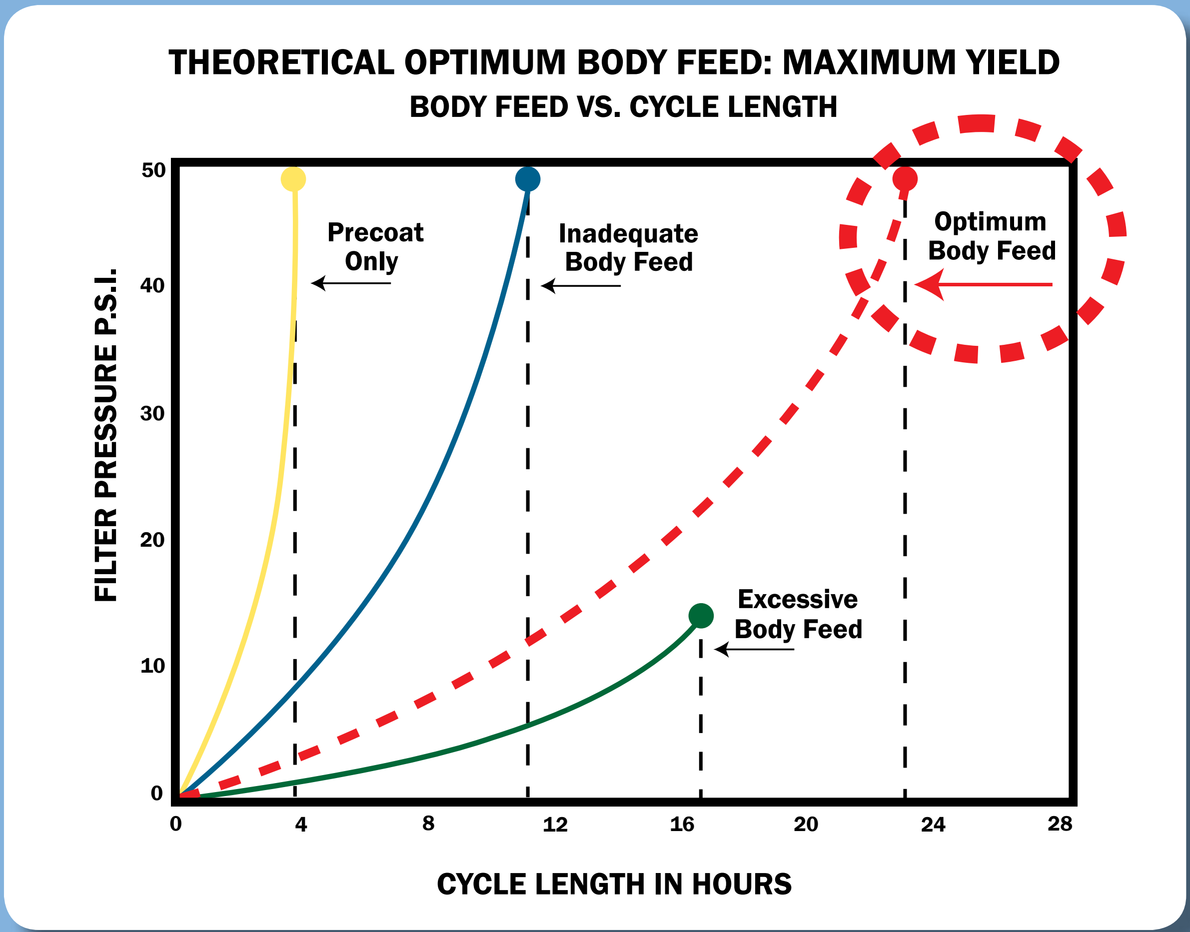
BODYFEED FUNCTION

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 inadequate body feed, optimal body feed and excessive body feed. 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.

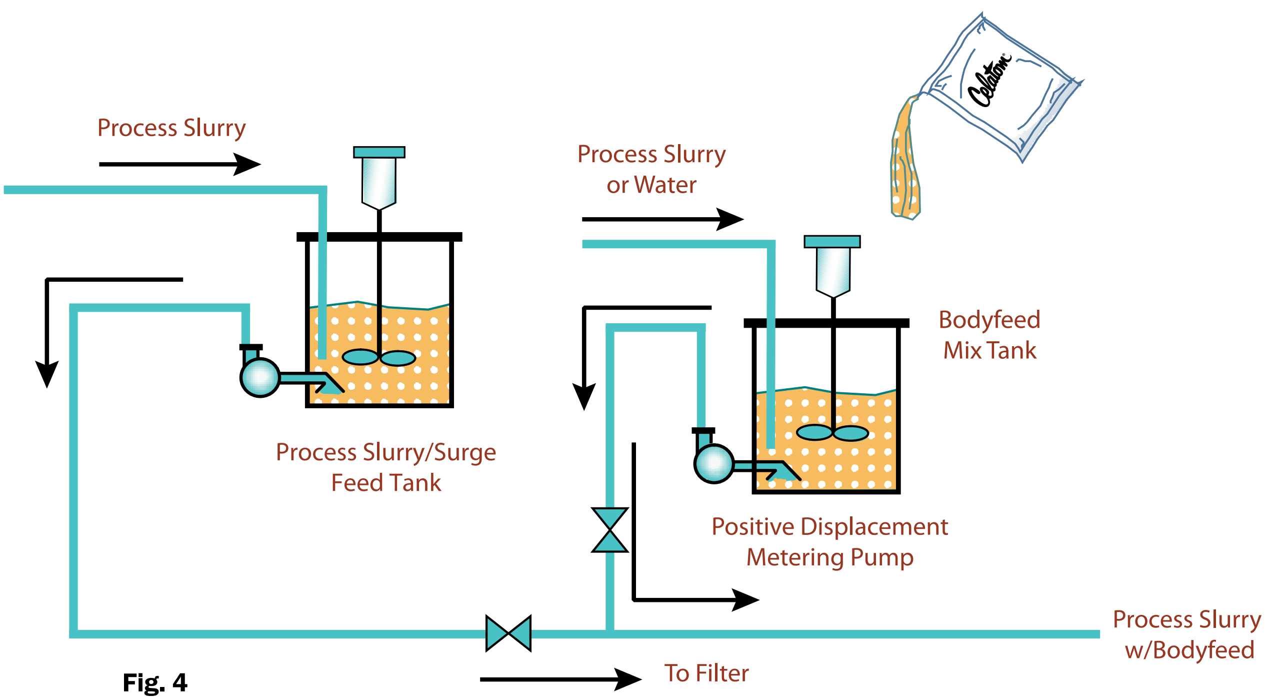


Fig. 4

AMOUNT OF BODYFEED

To achieve optimal bodyfeed addition rates for a particular solid type, some testing 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: (Because Perlite Filter aids are lighter in density than DE by about 60% the resulting cake volume will be equal.)

► **For low suspended solids levels (less than 0.1%):** Use a bodyfeed addition ratio greater than 0.6:1; i.e., more bodyfeed than suspended solids.

► **For moderate suspended solids levels (approx. 0.5%):** Use a bodyfeed addition ratio approximately 0.6:1; 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 0.6:1; 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 1.2-1.8 to as high as 6:1. (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 contact your local Technical Representative for help in choosing the optimal perlite grade for your application.

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 perlite 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.

EP Minerals®

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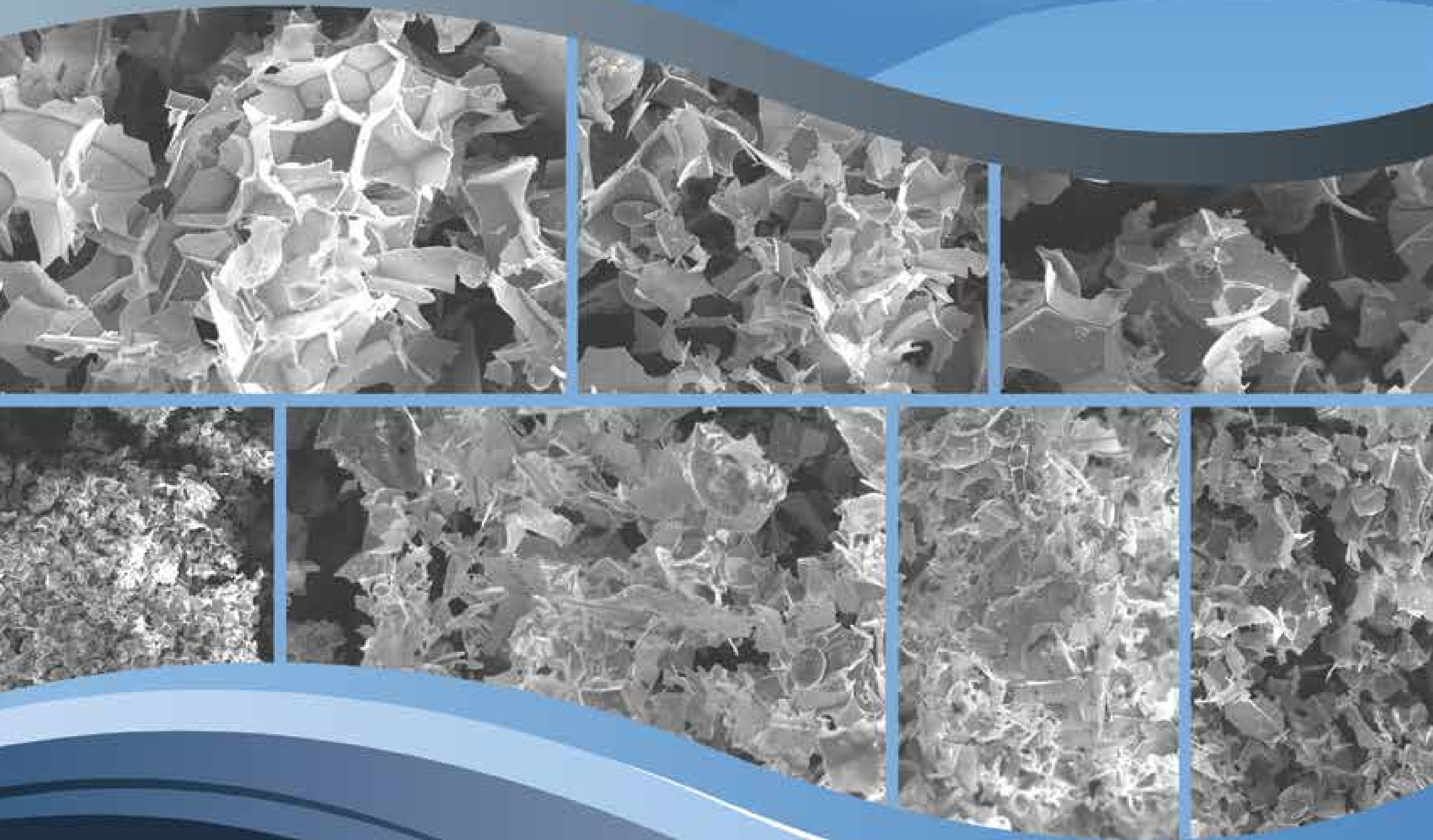

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Filter Aids

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