Comparing Conventional Diatomite and Celpure® Filter Aids

Technical Note AMC02
Version 3.5

Summary

Celpure media is a new high purity, high-performance diatomite filter aid. This technical note summarizes the purity and filtration performance differences between Celpure diatomite and conventional diatomite filter aids.

Background

Both Celpure media and conventional diatomite are composed of the siliceous remains of diatoms (Figure 1). However, the differences between conventional diatomite and Celpure media may affect overall filtrate quality and filtration performance; these differences include the following diatomite characteristics:

- Purity
- pH
- Surface Chemistry
- Density
- Particle Retention *vs.* Permeability

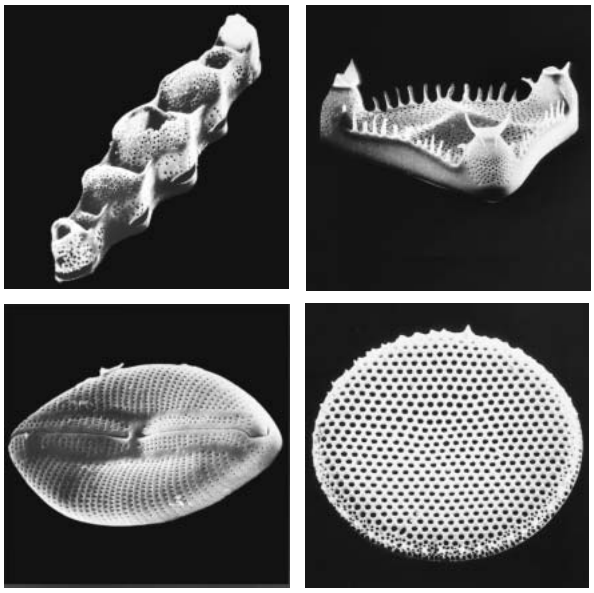

Figure 1. Typical shapes of diatoms (10–200 µm in diameter).

Differentiating Factors

PURITY

Celpure media's bulk chemical composition ranges from 96-98% SiO_2; conventional diatomite ranges from 86-93% SiO_2. Typically, the balance consists of impurities such as oxides of Al, Fe, and Na (Table 1).

	Celpure® 300 (high purity grade)	Celite Standard Super-Cel® (conventional grade)
SiO_2	98.65%	91.62%
Al_2O_3	0.60	4.20
Fe_2O_3	0.27	1.39
Na_2O	0.14	0.50
K_2O	0.10	0.83
MgO	0.08	0.61
CaO	0.08	0.41
TiO_2	0.03	0.24
P_2O_5	0.03	0.13
MnO_2	nd*	0.01
Total	99.98	99.94
*(nd) Below detectable limit		

Table 1. Typical bulk chemical analysis by X-ray fluorescence.

Celpure media enables a reduction of soluble impurities in filtration processes. In one study, after replacing conventional diatomite with Celpure media, extractable impurities were reduced dramatically (Table 2).

	Celpure® 300 (high purity grade)	Celite Standard Super-Cel® (conventional grade)
Al	nd* (PPB)	1682 (PPB)
Ca	nd	1050
Mg	124	1010
Fe	56	400
Zn	nd	210
Cu	12	16
Sb	nd	12
Mn	4	14
Cr	nd	4
Cd	nd	0.6
*(nd) Below detectable limit		

Table 2. Solubles expressed as concentration in the filtrate. Solubles extracted from 2-g samples incubated in 100-mL solutions. Solution: 10 mg/mL albumin, 50 mM sodium acetate, pH 4.3. Incubation: 4 h, 160 rpm, 50°C. Analysis by ICP-MS except for Fe (colorimetric complex with 1,10-phenanthroline).

PH

Conventional diatomite is rarely produced with pH specifications. However, data shows that conventional diatomite can shift the pH of unbuffered solutions to as high as pH 11.

Celpure grades are produced with pH specifications, significantly minimizing pH shifts. Celpure media has less of an influence on pH because it contains less soluble impurities (see Purity).

SURFACE CHEMISTRY

The presence or absence of impurities embedded in the diatom surface (Figures 2a, 2b, and Table 1) can modulate interactions between soluble feedstock substances and the filter media. Factors including diatom surface area (Table 3), feedstock pH, and solute concentration can magnify these interactions.

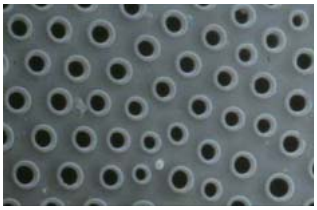

Figure 2a. Surface detail: Celpure diatom (96–98% SiO_2).

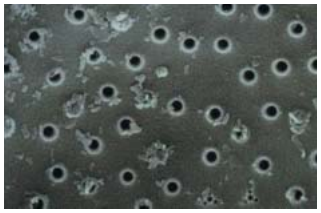

Figure 2b. Surface detail: conventional diatom (86-93% SiO_2).

If interaction with the diatomite media is a possibility, the first evaluation step is a contact-agitation test:

1. Begin by calculating the filter aid to feedstock ratio with your current process.
2. Prepare a sample feedstock with an equivalent charge of filter aid and agitate the suspension for approximately 3 hours at process temperature.
3. Separate the media from the suspension and assay the solution for the substance in question. When using this assay to compare conventional diatomite to Celpure media, reduce the Celpure media usage by 20%–30% (see Density).

DENSITY

The wet density of Celpure 300 is approximately 0.25 g/cm^3, while the wet density of equivalent conventional diatomite is approximately 0.30 g/cm^3. Because this relationship is typical when comparing conventional diatomite to Celpure media, Celpure media will produce 20-30% more cake volume than conventional diatomite. For this reason, it may be beneficial to reduce Celpure media usage when converting from conventional diatomite to Celpure media. Because Celpure media's solids-holding capacity significantly exceeds that of conventional diatomite, this reduction will not negatively impact filtration performance.

PARTICLE RETENTION *VS.* PERMEABILITY

Filter aids are frequently classified in Darcy permeability units, which can also be used as a predictor of particle-size retention (Table 3). Celpure grades improve on this conventional permeability-retention barrier.

Celpure® Grade	Permeability (mDarcy)	Surface Area (m^2/g)	99% Retention (micron*)
65	40-80	6.0-7.0	< 0.3
100	70-140	5.0-6.0	< 0.45
300	150-300	3.0-4.0	< 0.65
1000	750-1,250	1.0-2.0	< 2.0

* *Data is provided for comparison purposes only. Depending on the compressibility of the solids, values may vary from those in the table.*

Table 3. Listed in order of increasing permeability (the least permeable is Celpure 65 media).

For example, the conventional diatomite Celite® 521 has a rating of approximately 300 mDarcy. Based on this rating, Celite 521 will also retain, on average, 99% of particles down to 1.2 µm from a process stream. If greater throughput is required, a grade with greater permeability will be necessary; however, greater permeability will reduce the particle removal efficiency.

The Darcy rating for Celpure 300 is also approximately 300 mDarcy; however, its nominal particle retention is typically down to 0.45 µm (Table 3). Because this improvement in retention *vs.* permeability is typical when comparing conventional diatomite to Celpure media, Celpure media generally enables enhanced filtration efficiency.

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