NanoCeram®
FILTERING SOLUTIONS

By

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ADVANCED FILTRATION SYSTEMS

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The Industry's Only 40 GPM Big Blue Size Cartridge That Treats Water For Turbidity, Virus, Bacteria, & Cysts.

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A Revolution In Water Treatment!

Available In A Variety Of Sizes From 2.5”x5”, to 4.5”x40”

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The NanoCeram® Primer

A Guide to Understanding the NanoCeram® Advantage

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NanoCeram-P™ Series
Electropositive Pleated Filter Cartridges

Argonide's NanoCeram® "P" series pleated filter cartridge features a thermally bonded blend of microglass fibers & cellulose infused with nanoalumina fibers in a non-woven matrix that creates an electropositively charged depth filter media. When assembled into a pleated cartridge, NanoCeram® offers a unique combination of efficiency, capacity, flow rate & low pressure drop at levels unmatched in today's filtration marketplace. In addition, all NanoCeram filter cartridges are assembled using only FDA-compliant materials.

This cartridge has been designed to satisfy the most difficult requirements in water treatment. By using the scientific principle of electropositive attraction/ capture, NanoCeram®'s NASA-derived technology leads to a rapid and highly efficient adsorption of virtually all particle sizes. NanoCeram®'s media has a high capacity for particles as large as tens of microns or as small as a few nanometers. Each NanoCeram® filter cartridge exhibits a rating of 0.2µ - a rating typically associated with microporous membranes. Yet NanoCeram® flow rates are hundreds of times greater than such membranes.

Retention Characteristics

- Silt Density Index (SDI) $\leq$ 0.5
- >99.99% Efficiency at 0.2 microns (latex spheres)
- >4 LRV Cyst Retention
- >5 LRV Klebsiella terrigena Retention
- <0.01 NTU until Terminal ΔP: 35 psid (2.4 bar)
- Dirt Holding Capacity: 82 g/ft^2

Markets

- Food, Beverage & Bottled Water
- Pharmaceutical & Biomedical
- Cosmetics & Personal Care
- MicroElectronics
- Power Generation
- Potable Water (POE, POU, Municipal, Personal)

Features

- Effective at high pH and in the presence of salt
- Pleated construction yields high flow rates
- Available in standard DOE configurations
- Provides optical clarification to fluids
- Manufactured with strict quality control
- All components are manufactured with materials that meet FDA requirements 21CFR177.1520 for direct food contact applications.

Applications

- Primary Filtration in lieu of microporous membranes
- Make Up Water (particulate, microbial control)
- Polishing Filters (carbon fines, emulsified oil removal)
- RO Prefiltration (SDI reduction)
- Process Water (turbidity, particulate, colloidal suspensions)
- Waste Water (biologicals, proteins, dyes)
- Cooling Towers, Chill Water Loops (iron removal)

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NanoCeram-P™ Series

NANOCERAM® FILTERING SOLUTIONS

Specifications

Part No		P2.5-5	P2.5-10	P2.5-20	P2.5-30	P2.5-40	P4.5-10	P4.5-20	P4.5-40
Surface Area	ft^2 (m^2)	1.4 0.13	3.4 0.32	7.1 0.66	10.6 0.99	14.1 1.31	8.3 0.77	17.0 1.58	35.0 3.25
Dirt Holding Capacity	grams	114.4	280.3	583.4	875.2	1161.2	683.5	1401.4	2882.9
Dimensions	in (cm)	2.8 x 4.85 7.1 x 12.32	2.8 x 9.75 7.1 x 24.77	2.8 x 20 7.1 x 50.8	2.8 x 30 7 x 76.2	2.8 x 40 7 x 101.6	4.5 x 9.75 11.43 x 24.77	4.5 x 20 11.43 x 50.8	4.5 x 40 11.43 x 101.6
Suggested Flow Rate	gpm (lpm)	2 7.5	4 15	8 30	12 45	16 60	10 38	20 76	40 152
Maximum Flow Rate	gpm (lpm)	5 19	10 38	20 76	30 114	40 151	25 95	50 133	100 380

Competitive Comparison— Turbidity and Silt Density Index (SDI_{30}) - 10" cartridges (except where noted)

Manufacturer	Type	Flow Rate (gpm)	Type of Water	Turbidity in	Turbidity Out	SDI_{30} [A]
NanoCeram	P2.5-10	4	A2 dust[B] in RO water	252.00	<0.01	0.2 ± 0.3[C]
			Municipal Tap water	0.87	<0.01	0.5 ± 0.1[D]
A	1µ absolute	4	A2 dust[B] in RO water	239.00	60.00	ND[E]
			Municipal Tap water	0.54	0.10	4.4 ± 0.2[F]
	0.35µ absolute	4	A2 dust[B] in RO water	239.00	55.00	ND
			Municipal Tap water	0.57	0.14	4.6 ± 0.2[F]
B	1µ nominal (20")	4	Municipal Tap water	1.3 ± 0.1[G]	0.4 ± 0.1[H]	N/A
	1µ absolute	4	A2 dust[B] in RO water	243.00	23.00	ND
		4	Municipal Tap water	1.3 ± 0.3[G]	<0.01[H]	5.5 ± 0.2[F]
	5µ nominal (20")	4	Municipal Tap water	1.5 ± 0.7[G]	1.1 ± 0.4[G]	ND

Notes
A) Silt Density Index (SDI_{30}); B) ISO 121030-1 A2 Fine Test Dust; C) Average of 6 measurements; D) Average of 4 measurements; E) Not Tested—Turbidity of filtered water too high; F) Average of 3 measurements; G) Average over 3 hour test; H) During first 30 minutes of run.

Materials of Construction

Media : NanoCeram® Media
Support: Polypropylene, Hot Melt
O-rings/Gaskets: Neoprene

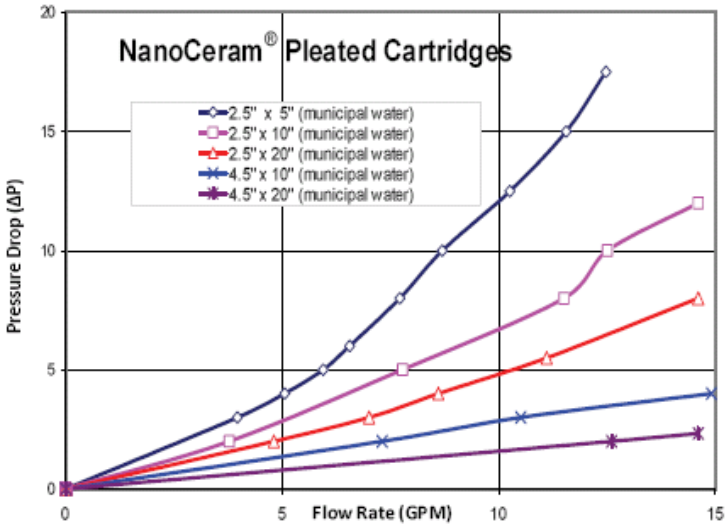
Operating Conditions

Temperature: 39-180°F (4-82°C)
pH Range: 5 to 10
Terminal Pressure Drop: 35 psi (2.4 bar)
Maximum Salinity: 200,000 ppm

Ordering Information

Part No:

P2.5-5
P2.5-10
P2.5-20
P2.5-30
P2.5-40
P4.5-10
P4.5-20
P4.5-40



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What is Pore Size & How Do I Know What is Best for Me?

The current rating systems for filters combined with the wide variety of cartridge filters that are commercially available can make selection of the right one for a specific application a challenging task. Before selecting a cartridge, it is important to understand cartridge filters, how they work, how they are rated, and how technology is paving the way for new ways to consider filtration efficiencies.

Ratings

RATINGS

The pore size corresponding to an 85% removal is generally called the Nominal Rating of the filter. However, different manufacturers rate their nominal values differently.

For our purposes here, an Absolute Rating is the pore size where 99.9% filtration efficiency is achieved. However, and this is important, the definition of absolute pore size varies from filter manufacturer to filter manufacturer. In theory, an absolute pore size rating for a filter is based on the largest challenge particle, usually a glass bead, which will pass through the filter. Nothing larger than this rating should pass through the filter. Others may define this based on log reduction as we do. For example, if the filter can reduce a particle size by 3-log (or 99.9%), then that would be the applied absolute pore size rating.

For example, bacteria are larger than 0.2 microns, so an absolute rating of 0.2 implies sanitization capability. But this doesn't cover virus, most of which are smaller than 0.2 microns.

Electropositive Filters

ELECTROPOSITIVE

Most filters separate particles by the mechanisms of sieving, inertial impaction, interception and diffusion. This is true of most membranes as well as fibrous depth filters. Electropositive filters principally use adsorption (electro-adhesion) as the filtering mechanism, one that has actually been used for decades, both as membranes and in a fibrous depth filter.

Electropositive membranes have several disadvantages including a very low dirt-holding capacity, tendency to foul quickly, low reliability (any flaw in its surface can lead to breakthrough) and high costs for materials, maintenance and actual operation. On the other hand, a highly efficient fibrous filter that is electropositive and has a high flow is much more difficult to achieve.

NanoCeram® is an electropositive fibrous filter media *with high particle removal efficiency* as well as *high dirt holding capacity*. When incorporated into a *pleated filter*, its *flowrate is equivalent to, or higher than pleated filters that are rated at 3 microns*. NanoCeram®'s absolute rating is 0.2 microns, yet the flow through a standard 2.5" diameter x 10" high cartridge is 10 gpm @ an initial pressure drop less than 2 psi. High flow rates (Figure 1) are a characteristic of NanoCeram® filters.

Figure 1 – Flow Rates of NanoCeram Pleated Filter Cartridges.

Part No. *(Size)*		P2.5-5 or PAC2.5-5 *2.5" x 5"*	P2.5-10 or PAC2.5-10 *2.5" x 10"*	P2.5-20 or PAC2.5-20 *2.5" x 20"*	P2.5-30 or PAC2.5-30 *2.5" x 30"*	P2.5-40 or PAC2.5-40 *2.5" x 40"*	P4.5-10 or PAC4.5-10 *4.5" x 10"*	P4.5-20 or PAC4.5-20 *4.5" x 20"*	P4.5-40 or PAC4.5-40 *4.5" x 40"*
Suggested Flow Rate	(GPM)	2	4	8	12	16	10	20	40
	(LPM)	7.5	15	30	45	60	38	76	152
Peak Flow Rate *	(GPM)	5	10	20	30	40	25	50	100
	(LPM)	19	38	76	114	151	95	189	380

* Peak Flow Rate based on initial flow using new filter cartridge and clean water during laboratory testing.

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What is DHC & Why Does it Matter?

DIRT HOLDING CAPACITY

Dirt holding capacity ("DHC") generally refers to the capacity of a filter cartridge to retain a given weight of particles before the cartridge plugs. Logic dictates that for a given pore size, the larger the particle challenging that filter, the greater would be the DHC (based on how long it takes for that filter to plug) as smaller particles would simply pass through the larger pores.

However, there are few applications where capturing those smaller particles don't have significant value.

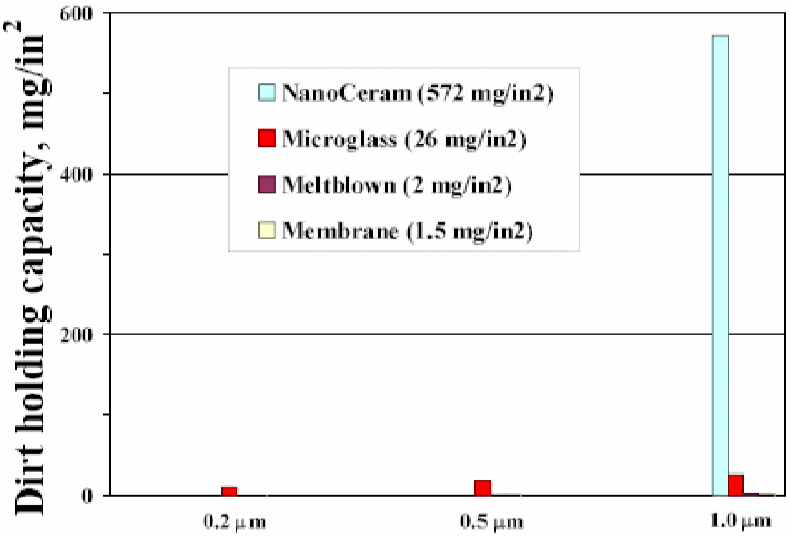
Much like a standard filter, the NanoCeram® electropositive fibrous filter media mechanically sieves particles larger than its average pore size. However, the NanoCeram® *also* adsorbs *smaller* particles throughout its entire fibrous structure, resulting in DHC levels many times greater than standard filter cartridges. In other words, if you were to weigh the amount of "dirt" captured by a NanoCeram filter cartridge versus other filter cartridges, the NanoCeram filter would far outperform the standard filter (see Figure 2).

As a "broad spectrum" particle adsorber, the NanoCeram® cartridge removes both coarse particulate as well as fines. For example, in applications currently using a 3 micron cartridge, the NanoCeram® will remove 3 micron and larger particulate with a similar efficiency to the 3 micron sediment cartridge. Yet, when the two cartridges are weighed and compared after operating under identical conditions and for the same period of time, the NanoCeram® will have removed several times the quantity of particulate (by weight) than the standard sediment cartridge. The difference is that NanoCeram® will remove virtually all of the sub-micron particles that pass through a conventional filter.

In many applications, removing sub-micron particles is vital. They are responsible for much of the fouling of reverse osmosis (RO) membranes, and would degrade the efficiency of ultraviolet (UV) and ozone disinfection systems. Unfiltered fines and colloidal matter can also affect chemical processes and impact the quality of the surfaces of precision products.

Membranes are surface filters with very little DHC. Consequently, while their efficiency might be high, their capacity for holding dirt will often lead to premature fouling resulting in frequent cleaning cycles and increased operational costs.

Figure 2 – Dirt Holding Capacity (A2 Fine Test Dust) of NanoCeram versus other Filter Media



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FILTER LIFE

How Long Will My NanoCeram Cartridge Continue to Work?

How long a filter will last is a very common question, but a difficult one to answer. Several factors can affect life, but the overriding factor is the load and type of particles being filtered. Particulate contaminants may include colloidal inert matter, inorganic particles such as metal oxides, natural organic matter (NOM), total organic carbon (TOC) to include humic/tannic/fulvic acids, endotoxins, bacteria, cysts, virus, etc. New EPA (in the United States) regulations require that the turbidity (defined as a cloudy condition in water due to suspended silt or organic matter) of municipal water must be reduced to less than 1 NTU (Nephelometric Turbidity Units).

The volume of water treated to meet the required NTU limits and/or the pressure drop that is developed, provide useful metrics for the lifespan of a cartridge (Figure 6).

Figure 6 – Filter Life in Municipally-Treated Water for NanoCeram & NanoCeram-PAC Filter Cartridges.

Part No.	P2.5-5 or PAC2.5-5 *2.5" x 5"*	P2.5-10 or PAC2.5-10 *2.5" x 10"*	P2.5-20 or PAC2.5-20 *2.5" x 20"*	P2.5-30 or PAC2.5-30 *2.5" x 30"*	P2.5-40 or PAC2.5-40 *2.5" x 40"*	P4.5-10 or PAC4.5-10 *4.5" x 10"*	P4.5-20 or PAC4.5-20 *4.5" x 20"*	P4.5-40 or PAC4.5-40 *4.5" x 40"*
Capacity before first detection of NTU (sensitivity 0.01 NTU) when challenged by local municipal water @ 1.2 NTU								
Gallons *(Liters)*	7,000 *(26,500)*	17,000 *(64,250)*	34,000 *(128,500)*	51,000 *(192,750)*	68,000 *(257,000)*	39,000 *(147,500)*	80,000 *(302,500)*	160,000 *(605,000)*
Capacity until flowrate ceases when challenged by 1.2 NTU local municipal water								
Gallons *(Liters)*	12,000 *(45,500)*	29,000 *(110,000)*	58,000 *(220,000)*	87,000 *(330,000)*	116,000 *(440,000)*	66,500 *(250,000)*	135,000 *(510,000)*	270,000 *(1,020,000)*

The answer is even more complex when discussing soluble contaminants such as chlorine. In this case, flow velocity (the speed at which water flows through a set surface area of media, often in terms of cm/sec) is a very important metric.

All carbon-based products require "residence time" for contact between the contaminant and the carbon itself. The longer the contact time, the greater the dynamic adsorption rate of the carbon for soluble contaminants. This is why the smaller particles of PAC used in NanoCeram-PAC filters offer such an advantage. The huge surface area of such small carbon particles means that available surface area to adsorb the chlorine is enormous (more capture sites). Therefore, the "bounce-back" capacity of the PAC allows for higher flow rates to attain chlorine adsorption rates which would be comparable to GAC-based filters running at much slower flow rates. The static capacity for such filters is still quite high (Figure 7) and is further enhanced by NanoCeram-PAC's particulate adsorption capacity.

Figure 7 – Chlorine Reduction Capacity of NanoCeram-PAC Filter Cartridges.

Part No.	PAC2.5-5 *2.5" x 5"*	PAC2.5-10 *2.5" x 10"*	PAC2.5-20 *2.5" x 20"*	PAC2.5-30 *2.5" x 30"*	PAC2.5-40 *2.5" x 40"*	PAC4.5-10 *4.5" x 10"*	PAC4.5-20 *4.5" x 20"*	PAC4.5-40 *4.5" x 40"*
Capacity for > 50% Reduction of Chlorine (from 2ppm to < 1ppm) @ Flow Rate = 1 gpm/ft^2 PAC Media.								
Gallons *(Liters)*	2,100 *(7,950)*	5,200 *(19,500)*	10,800 *(41,000)*	16,000 *(60,500)*	21,600 *(82,000)*	12,700 *(48,000)*	26,000 *(98,250)*	52,000 *(196,500)*

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How Do I Determine My Filter's Efficiency?

Although not often used in today's world of filtration, it is useful to offer a brief discussion of Filtration Efficiency Percentages. Efficiency is an indicator of how well a filter controls particulate: i.e., if one out of every two particles (> 0.5 µ) in the fluid passes through the filter, the efficiency at 0.5 µ = 2; if one out of every 200 of the particles (> 0.5 µ) passes through the filter the efficiency = 200.

Therefore, filters with higher efficiency retain more particles of a given particle size. Efficiency for a given particle size is also dependent on the quantity of the particle size in a water stream.

Figure 8 – Filtration Efficiency of NanoCeram.

Particle Size	NTU	Efficiency
0.2 µ	10	> 99.9%
0.5 µ	100	> 99.99%
1.0 µ	250	> 99.9996%

NanoCeram® filter cartridges exhibit a level of unmatched efficiency given their high flow rates and low pressure drop. This efficiency is attributed to the strong electropositive forces that capture particulates many times smaller than the media's relatively large pore size. NanoCeram®'s efficiency has been determined through laboratory testing with a given particle size of latex beads (typically used for filtration R & D), their concentration (stated in NTU) in a flowing stream, with the resulting efficiency stated as a percentage of particles removed (Figure 8).

How Does Electroadhesion Work?

The Technical Explanation

Electroadhesion utilizes the difference in charge that may exist between a surface (or fiber) and a particle in an aqueous solution, where a charge is built up by the double layer effect. The zeta potential is a measure of the driving force between the particle and the fixed surface, acting to attract or repel the two. Most bacteria and most other particles are electronegative in water. Smaller particles also tend to become more electronegative. So an electropositive fixed surface would be far more effective at attracting and retaining particles than one that is electronegative. Another factor is the area of solid surface that is exposed to the particles in the fluid. One with a large surface area can support more electropositive charges and therefore adsorb more particles.

The NanoCeram® Advantage

The electroadsorptive ingredient in the NanoCeram® filter is a nano alumina fiber that has a surface area from 350-500 m^2/g, with virtually all of that on the outside surface of the fiber and exposed to the entire spectrum of particulate in an aqueous stream (Figure 9). Such high surface areas are unattainable either in a membrane or in a fibrous filter even where nanofibers are being used. Nanofibers are very difficult to manufacture much below a 100nm diameter versus a 2nm diameter in the case of nano alumina.

And even if a nanoalumina fiber with a 2nm diameter were commercially available, this fiber (and virtually every other nanomaterial) would have a very strong tendency to agglomerate with the other nanofibers. Once this agglomeration occurs, the advantage of that huge surface area is lost. The key to NanoCeram®'s advantage is that we've developed a novel method of grafting these submicron alumina fibers permanently to a scaffold. This serves to keep the fibers separate from one another so that each fiber can do what it is optimized to do . . . attract and capture submicron particles.

The nano alumina is attached to a larger microglass fiber scaffold and then formed into a non-woven filter that has a pore size of approximately 2-3 microns. The filter will retain particles larger than 2

microns by mechanical sieving. *Particles smaller than the average pore size are forced into the matrix where they are adsorbed.* The efficiency of adsorption is dependent upon the flow velocity, the particle size, and the bed depth. With a range from 5 - 9, pH is not a significant variable. Generally a pleated cartridge that has a filter thickness of 1 mm is capable of adsorption rates > 99.999% of bacteria, even smaller ones such as Klebsiella terrigena (0.5 micron). Adsorption studies with 0.2 micron latex spheres show that a pleated cartridge can be rated as an Absolute 0.2 micron filter.

Figure 9 – Filter Media Surface Area vs. Electroadsorptive (Active) Surface Area of NanoCeram Technology

Part No.		P2.5-5 or PAC2.5-5 *2.5" x 5"*	P2.5-10 or PAC2.5-10 *2.5" x 10"*	P2.5-20 or PAC2.5-20 *2.5" x 20"*	P2.5-30 or PAC2.5-30 *2.5" x 30"*	P2.5-40 or PAC2.5-40 *2.5" x 40"*	P4.5-10 or PAC4.5-10 *4.5" x 10"*	P4.5-20 or PAC4.5-20 *4.5" x 20"*	P4.5-40 or PAC4.5-40 *4.5" x 40"*
Filter Surface Area	(in^2)	200	490	1020	1530	2030	1,195	2,450	5,040
	(ft^2)	1.4	3.4	7.1	10.6	14.1	8.3	17	35
	(cm^2)	1,290	3,160	6,600	9,870	13,100	7,710	15,800	32,500
	(m^2)	0.129	0.316	0.66	0.99	1.31	0.771	1.58	3.25
Electroadsorptive (active) Surface Area	(in^2)	8.8×10^6	2.16×10^7	4.88×10^7	6.73×10^7	8.93×10^7	5.26×10^7	1.08×10^8	2.22×10^8
	(ft^2)	61,000	149,700	339,000	467,000	620,000	356,000	750,000	1,540,000
	(cm^2)	5.70×10^7	1.39×10^8	3.15×10^8	4.34×10^8	5.76×10^8	3.31×10^8	6.97×10^8	1.43×10^9
	(m^2)	5,700	13,900	31,500	43,400	57,600	33,100	69,700	143,000

The NanoCeram® Value Proposition: Higher Price . . . Lower Cost

TOTAL COST OF OWNERSHIP

Here is the challenge. How do you present an item which may have a higher price tag than an alternative product, but provides other values such as longer life, better performance or higher reliability? The terms "cost effective", "lifecycle costing", "cost efficient", "cost of ownership" etc. all come to mind. Each of these terms recognizes that there may be value in a higher priced item.

For our purposes, we will refer to this as the Total Cost of Ownership (TCO). As a management tool, TCO modeling systematically accounts for all costs related to an investment decision. TCO models were initially developed by Gartner Research in 1987 and are now widely used in virtually every industry. Simply stated, TCO evaluates all costs, direct and indirect, incurred throughout the life-cycle of an asset, including acquisition and procurement, operations and maintenance, and end-of-life management.

In water filtration (historically, the value proposition incorporates known values of flow rates, ΔP, dirt-holding capacity, absolute ratings, etc.) the question of price vs. cost has been fairly well documented and is somewhat straightforward. This has resulted in the development, market maturation and the now relatively flat sales growth with venerable filters such as melt-blown, string-wound and even some membrane-based and pleated polypropylene products.

These types of filters can be considered "commodities" and attempts to improve on their performance are somewhat limited as these matured technologies typically make small incremental advances - if any. With this in mind, the principal market drive is price, and tends to be affected most by low cost labor content and/or substantial investment in automation which can be risky.

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NanoCeram® filters offer a major cost benefit derived from the following advantages:

- Enhanced Operations – by removing fines in addition to the coarser particulate in a water stream, many industries will see dramatically improved performance
  - Highly efficient last line of defense for downstream processes and equipment
    - → Reverse Osmosis (RO) systems
    - → Ozone or UV disinfection systems
    - → Ultraporous membranes
    - → Carbon & resin beds
    - → Small aperture foggers & spray nozzles, pumps, waterjet cutting systems, etc.
  - Reduced microabrasions on finished goods will reduce reject rates.
- DHC – Capacity that can be hundreds of times greater than conventional filters
  - Fewer replacement elements;
  - Lower maintenance costs;
  - Less system downtime.
- ΔP – A lower pressure drop
  - Less energy consumed in forcing fluids through a "tight" filter media;
  - Less wear & tear on other system components;
  - Freedom to design additional processes into a treatment system as NanoCeram doesn't significantly add to the total pressure drop of a treatment regimen.
- Reduced Operational Costs – none of the ongoing operational costs of membranes
  - Capital intensive backflush systems and chemicals;
  - Energy consumption during backflush cycles;
  - Water waste;
  - Labor costs for cleaning operations;
  - Reduced system down-time versus membrane systems that require constant cleaning;
  - Hazardous waste disposal from the backflushing cycles.

"NanoCeram filters may have a higher price tag, but they cost a lot less to use"

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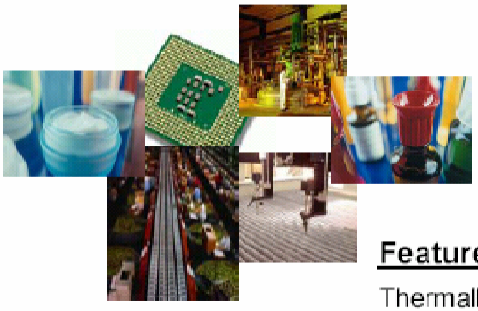
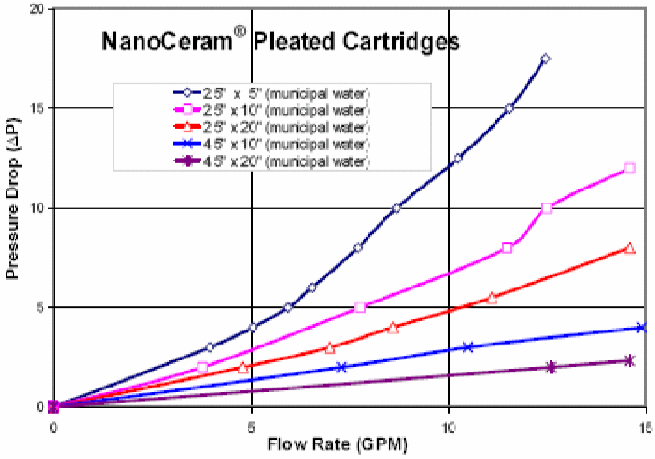


NanoCeram® "P" Series

Pleated Filter Cartridges

Features and Benefits

Thermally bonded blend of microglass fibers & cellulose infused with nanoalumina fibers in a non-woven matrix creates an electropositively-charged depth filter media. When assembled into a pleated cartridge, NanoCeram® offers a unique combination of efficiency, capacity, flowrate & low pressure drop at levels unmatched in today's filtration marketplace.



- Silt Density Index (SDI): ≤ 0.5
- Turbidity Reduction: < 0.01 NTU until Terminal ΔP (40psi)
- Low ΔP: < 1.5psi @ 4gpm (Part No. P2.5-10)
- Efficiency: 99.9% reduction of 0.2µ particulate (monodispersed latex spheres)
- Flow Rate: 5mL/cm^2/min @ 4gpm (Part No. P2.5-10)
- Dirt Holding Capacity (DHC): 572 mg/in^2 (A2 Fine Test Dust)
- Cyst Retention: > 5 LRV
- Bacteria (*Klebsiella terrigena*): > 5 LRV
- Temperature Range: 39 - 135° F (4 - 57°C)
- Maximum Pressure: 70 psi (4.83 bar)
- Effective pH Range: 5 - 10

Applications

- Primary filtration in lieu of ultraporous and microporous membranes
- Prefiltration/Polishing for:
  - Reverse Osmosis (R.O.)
  - Ultrafiltration
  - Microfiltration
  - Ultraviolet (UV)
  - Ozonation
  - Chlorination
- Industries

Food, Beverage & Bottled Water	Pharmaceutical & Biomedical
Cosmetics & Personal Care	Microelectronics
Power Generation	Machining (including EDM)
Potable:	Pool & Spa

  - Point-of-Use (POU)
  - Point-of-Entry (POE)
  - Municipal
  - Personal

Each NanoCeram® pleated filter cartridge is designed to satisfy the most difficult requirements in water treatment. By using the scientific principal of electropositive attraction/capture, NanoCeram® technology leads to a rapid and highly efficient adsorption of virtually all particle sizes. NanoCeram®'s media has a high capacity for particles as large as tens of microns or as small as a few nanometers. Each NanoCeram® Filter Cartridge exhibits a rating of 0.2µ . . . a rating typically associated with ultraporous membranes. Yet NanoCeram® flow rates are hundreds of times greater than such membranes.

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ADVANCED FILTRATION SYSTEMS

NANOCERAM®
FILTERING SOLUTIONS

NanoCeram® P Series:

Part No.		P2.5-5 2.5" x 5"	P2.5-10 2.5" x 10"	P2.5-20 2.5" x 20"	P2.5-30 2.5" x 30"	P2.5-40 2.5" x 40"	P4.5-10 4.5" x 10"	P4.5-20 4.5" x 20"	P4.5-40 4.5" x 40"
Filter Surface Area	(in^2) (ft^2) (cm^2) (m^2)	200 1.4 1,290 0.129	490 3.4 3,160 0.316	1020 7.1 6,600 0.66	1530 10.6 9,870 0.99	2030 14.1 13,100 1.31	1,195 8.3 7,710 0.771	2,450 17 15,800 1.58	5,040 35 32,500 3.25
Dirt Holding Capacity**	(mg)	114400	280280	583440	875160	1161160	683540	1401400	2882880
Electroadsorptive (active) Surface Area	(in^2) (ft^2) (cm^2) (m^2)	8.8×10^6 61,000 5.70×10^7 5,700	2.16×10^7 149,700 1.39×10^8 13,900	4.88×10^7 339,000 3.15×10^8 31,500	6.73×10^7 467,000 4.34×10^8 43,400	8.93×10^7 620,000 5.76×10^8 57,600	5.26×10^7 356,000 3.31×10^8 33,100	1.08×10^8 750,000 6.97×10^8 69,700	2.22×10^8 1,540,000 1.43×10^9 143,000
Diameter × Length	(in) (cm)	2.75 × 4.8 7 x 12.2	2.75 × 9.75 7 x 24.8	2.75 × 20 7 x 50.8	2.75 × 30 7 x 76.2	2.75 × 40 7 x 101.6	4.45 × 9.75 11.3 x 24.8	4.45 x 20 11.3 x 50.8	4.45 x 40 11.3 x 101.6
Suggested Flow Rate	(GPM) (LPM)	2 7.5	4 15	8 30	12 45	16 60	10 38	20 76	40 152
Peak Flow Rate *	(GPM) (LPM)	5 19	10 38	20 76	30 114	40 151	25 95	50 189	100 380

*Peak Flow Rate based on initial flow using new filter cartridge and clean water during laboratory testing.
** Dirt holding capacity is based on A2 Fine Test Dust

Turbidity Reduction & Silt Density Index (SDI_{30}):

Manufacturer	Type	Flow Rate (GPM)	Type of water	Turbidity, NTU		SDI_{30}[a]
				in	out	
Argonide (NanoCeram®)	P2.5-10 *2.5" x 10"*	4	A2 dust[b] in RO water	252.00	<0.01	0.2 ± 0.3[c]
			Municipal tap water	0.87	<0.01	0.5 ± 0.1[d]
"A"	1µ Absolute *2.5" x 10"*	4	A2 dust[b] in RO water	239.00	60.00	ND[e]
			Municipal tap water	0.54	0.10	4.4 ± 0.2[f]
	0.35µ Standard *2.5" x 10"*	4	A2 dust[b] in RO water	239.00	55.00	ND[e]
			Municipal tap water	0.57	0.14	4.6 ± 0.2[f]
"B"	1µ Standard *2.5" x 20"*	4	Municipal tap water	1.3 ± 0.1[g]	0.4 ± 0.1[g]	N/A
	1µ Absolute *2.5" x 10"*	4	A2 dust[b] in RO water	243.00	23.00	ND[e]
			Municipal tap water	1.3 ± 0.3[g]	<0.01[h]	5.5 ± 0.2[f]
	5µ Standard *2.5" x 20"*	4	Municipal tap water	1.5 ± 0.7[g]	1.1 ± 0.4[g]	ND[e]
"C" *	0.1µ Hollow Fiber Membrane *6.5" x 85" Module*	22	N/A	N/A	<0.08	< 2.0 - 3.0

* Manufacturer's published specifications.

Notes:
a) Silt Density Index (SDI_{30});
b) ISO 121030-1, A2 Fine Test Dust available from PTI technology Inc.;
c) Average of six measurements;
d) Average of four measurements;
e) Not done since turbidity of filtered water is unacceptable high (expected to be less than 1 NTU);
f) Average of three measurements;
g) Average over 3 hrs test;
h) During first 30 minutes of run;
i) After 30 minutes of continuous water run.

ARGONIDE
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This product has been tested and certified to meet NSF/ANSI Std. 53 for Material Safety only.

Testing performed by the Water Quality Association has determined that this product reduces Cysts by at least 99.98%.

NanoCeram-PAC™ Series

Powder Activated Carbon Filter Cartridges

Features and Benefits

Pleated filter cartridges combine high efficiency particulate filtration with a high efficiency (powdered) activated carbon (PAC) in a single depth media. NanoCeram-PAC™ is a further advancement in Argonide's series of filters and is a major breakthrough in activated carbon filtration. The line of NanoCeram-PAC™ filter cartridges offer a unique combination of efficiency, capacity, flowrate & low pressure drop for both particulate and chemical adsorption or soluble contaminants such as soluble organics and chlorine. Their best use is in those applications where a combination of fouling-resistant soluble contaminant removal and particulate reduction is desired.

- Chlorine Reduction Efficiency: 2ppm to less than 1ppm for > 5,000 gallons (Part No. PAC2.5-10)
- Silt Density Index (SDI): ≤ 1.0 ± 0.1
- Effective pH Range: 5 - 10
- Cyst Retention: > 4 LRV
- Bacteria (*E coli*) Retention: > 6 LRV
- Temp. Range: 39 - 135° F (4 - 57°C)
- Max. Pressure: 70 psi (4.83 bar)
- Turbidity Reduction: < 0.01 NTU until terminal pressure drop (35psi)
- Low ΔP: < 1.3psi @ 4gpm (Part No. PAC2.5-10)
- Efficiency: > 99.9% reduction of 0.2µ particulate (monodispersed latex spheres)
- Flow Rate: 5mL/cm^2/min @ 4gpm (Part No. PAC2.5-10)
- Dirt Holding Capacity (DHC): 572 mg/in^2 (A2 Fine Test Dust)

Applications

- Waste Water - VOC's, disinfection by-products (DBP's), trace toxic organics (i.e., organic pesticides, endocrine disruptors, soluble & particulate dyes, etc.)
- POE & POU - Residual chlorine, toxic organic pollutants and particulate
- Polishing Filter - downstream of large granular carbon beds, coagulation processes, and filtration water purification systems
- Removal of particulate sorbents downstream of filter beds (e.g., arsenic sorbents or IX resins)
- Prefilter for protecting RO membranes for both fresh water and sea water (reduces chlorine that can damage membranes as well as sub-micron particles that tend to foul RO membranes)
- Iron removal in cooling towers & chill water systems
- Chemical-Biological Filters - protection against terrorist contamination of water supplies

Industries

Food, Beverage & Bottled Water
Pharmaceutical & Biomedical
Cosmetics & Personal Care
Microelectronics & Semiconductors
Automobile Manufacturing
Power Generation
Machining (including EDM)
Paints & Coatings

ARGONIDE
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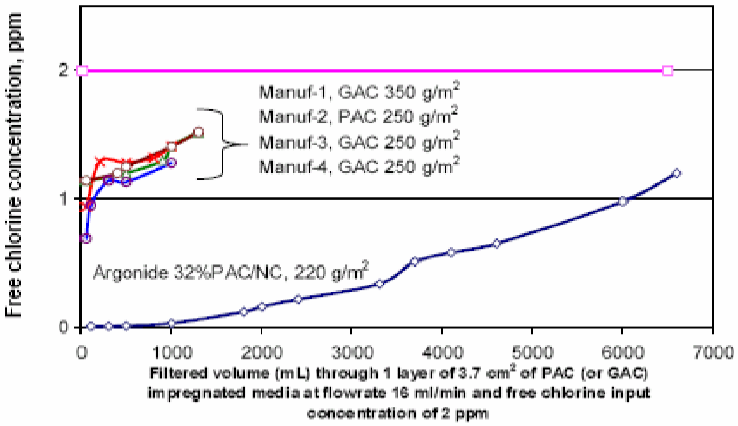
NANOCERAM®
FILTERING SOLUTIONS

NANOCERAM-PAC

What is NanoCeram-PAC?

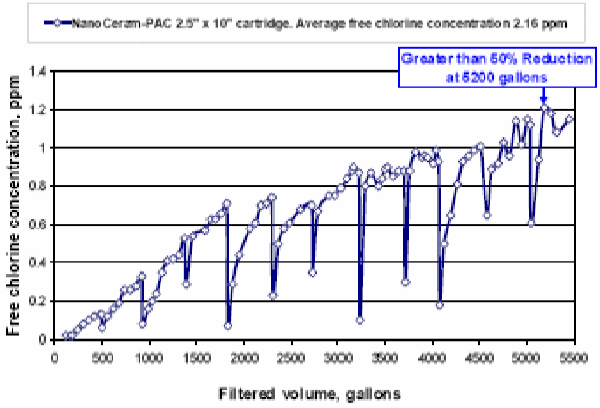
Activated carbon has been used for years to improve the quality/taste of drinking water. Typically GAC (granular activated carbon) is used in a packed bed or is combined into a filter media. To incorporate these carbon granules into a filter media requires adhesives or a starch additive to keep the carbon from washing out; or the carbon granules can be enmeshed into a foam system.

Figure 3 – Dynamic Adsorption of Chlorine by NanoCeram-PAC versus other carbon-based Filter Media.



NanoCeram-PAC represents a paradigm shift in carbon filtration in that fine activated carbon powder (-625 mesh) can now be utilized in filter media as it is held within the structure by electroadhesive forces, without using adhesives or starches that would blind or possibly deactivate the carbon. As compared to media containing GAC, PAC offers a much greater external surface area resulting in much more rapid adsorption of soluble contaminants (Figure 3).

Figure 4 – Chlorine Adsorption Capacity for NanoCeram-PAC



Contaminants removed include chlorine, iodine and soluble organics that may be highly toxic or may cause unpalatable taste and odor. The result is much greater adsorption efficiency at moderate to high flow rates and/or with thin beds of media, such as a single layer pleated cartridge (Figure 4).

The full line of NanoCeram-PAC pleated filter cartridges combine high efficiency particulate filtration as found with the original NanoCeram filters, with this high efficiency (powdered) activated carbon (PAC) - all in a single depth media. As a result, each NanoCeram-PAC™ filter cartridge offers a unique combination of efficiency, capacity, flowrate & low pressure drop for both particulate and chemical adsorption or for soluble contaminants such as soluble organics and chlorine. Their best use is in those applications where a combination of fouling-resistant soluble contaminant removal and particulate reduction is desired.

Figure 5 – Drinking Water Certification.

This product has been tested and certified to meet NSF/ANSI Std. 53 for Material Safety only.

Testing performed by the Water Quality Association has determined that this product reduces Cysts by at least 99.98%.

For drinking water applications, the entire line of standard-sized NanoCeram-PAC filter cartridges have been certified to the NSF/ANSI Std. 53 for Material Safety only. Further testing by the WQA determined that these filter cartridges reduce Cysts (parasites) by at least 99.98% (Figure 5).

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ADVANCED FILTRATION SYSTEMS

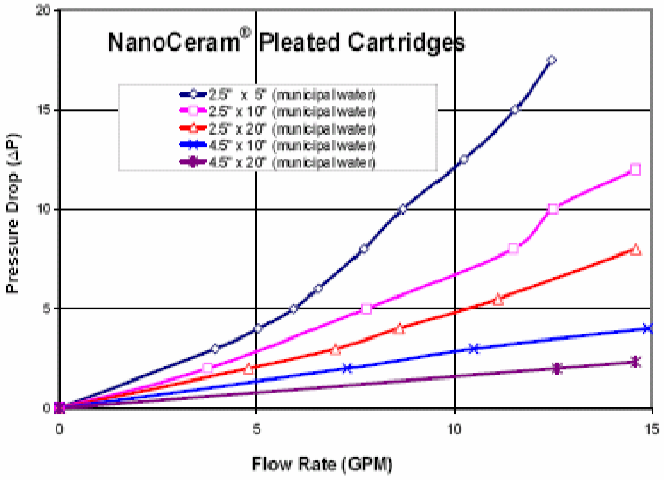
NANOCERAM®
FILTERING SOLUTIONS

NanoCeram-PAC™ Series:

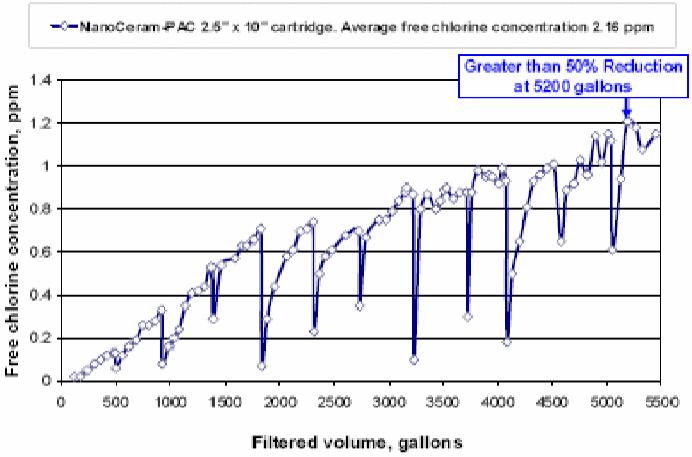
Part No.		PAC2.5-5 2.5" x 5"	PAC2.5-10 2.5" x 10"	PAC2.5-20 2.5" x 20"	PAC2.5-30 2.5" x 30"	PAC2.5-40 2.5" x 40"	PAC4.5-10 4.5" x 10"	PAC4.5-20 4.5" x 20"	PAC4.5-40 4.5" x 40"
Filter Surface Area	(in^2) (ft^2) (cm^2) (m^2)	200 1.4 1,290 0.129	490 3.4 3,160 0.316	1020 7.1 6,600 0.66	1530 10.6 9,870 0.99	2030 14.1 13,100 1.31	1,195 8.3 7,710 0.771	2,450 17 15,800 1.58	5,040 35 32,500 3.25
Dirt Holding Capacity**	(mg)	114400	280280	583440	875160	1161160	683540	1401400	2882880
Electroadsorptive (active) Surface Area	(in^2) (ft^2) (cm^2) (m^2)	8.8×10^6 61,000 5.70×10^7 5,700	2.16×10^7 149,700 1.39×10^8 13,900	4.88×10^7 339,000 3.15×10^8 31,500	6.73×10^7 467,000 4.34×10^8 43,400	8.93×10^7 620,000 5.76×10^8 57,600	5.26×10^7 356,000 3.31×10^8 33,100	1.08×10^8 750,000 6.97×10^8 69,700	2.22×10^8 1,540,000 1.43×10^9 143,000
Diameter × Length	(in) (cm)	2.75 × 4.8 7 x 12.2	2.75 × 9.75 7 x 24.8	2.75 × 20 7 x 50.8	2.75 × 30 7 x 76.2	2.75 × 40 7 x 101.6	4.45 × 9.75 11.3 x 24.8	4.45 x 20 11.3 x 50.8	4.45 x 40 11.3 x 101.6
Suggested Flow Rate	(GPM) (LPM)	2 7.5	4 15	8 30	12 45	16 60	10 38	20 76	40 152
Peak Flow Rate *	(GPM) (LPM)	5 19	10 38	20 76	30 114	40 151	25 95	50 189	100 380

*Peak Flow Rate based on initial flow using new filter cartridge and clean water during laboratory testing.
** Dirt holding capacity based on A2 Fine Test Dust

NanoCeram-PAC™ Chlorine Adsorption:



Left: ΔP vs. Flow Rate



Right: Chlorine adsorption by 2.5" x 10" NanoCeram-PAC™ Filter Cartridge.

ARGONIDE
ADVANCED FILTRATION SYSTEMS

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FILTERING SOLUTIONS

NanoCeram-PACB™ Series

Powder Activated Carbon + Carbon Block Filter Cartridges

Features and Benefits

Pleated filter cartridges with a carbon block centercore combine high efficiency particulate filtration with a high efficiency (powdered) activated carbon (PAC) plus the carbon block for increased chlorine adsorption. NanoCeram-PACB™ is a further advancement in Argonide's series of filters and is a major breakthrough in activated carbon filtration. The addition of a carbon block provides a greater chlorine adsorption curve than a NanoCeram-PAC™ filter cartridge for applications requiring greater reduction of such contaminants. The line of NanoCeram-PACB cartridges offers a unique combination of efficiency & capacity for both particulate and chemical adsorption and soluble contaminants such as soluble organics and chlorine. Their best use is in those applications where a combination of fouling-resistant soluble contaminant removal and particulate reduction is desired.

- Chlorine Reduction Efficiency: 2ppm to less than 1ppm for > 30,000 gallons (Part No. PACB4.5-20)
- Silt Density Index (SDI): ≤ 1.0 ± 0.1
- Effective pH Range: 5 - 10
- Cyst Retention: > 4 LRV
- Bacteria (*E coli*) Retention: > 6 LRV
- Temp. Range: 39 - 135° F (4 - 57°C)
- Max. Pressure: 70 psi (4.83 bar)
- Turbidity Reduction: < 0.01 NTU until terminal pressure drop (35psi)
- Low Initial ΔP: < 5psi @ 7gpm (Part No. PACB4.5-20)
- Efficiency: > 99.9% reduction of 0.2µ particulate (monodispersed latex spheres)
- Dirt Holding Capacity (DHC): 925g (A2 Fine Test Dust)

Applications

- Waste Water - VOC's, disinfection by-products (DBP's), trace toxic organics (i.e., organic pesticides, endocrine disruptors, soluble & particulate dyes, etc.)
- POE & POU - Residual chlorine, toxic organic pollutants and particulate
- Polishing Filter - downstream of large granular carbon beds, coagulation processes, and filtration water purification systems
- Removal of particulate sorbents downstream of filter beds (e.g., arsenic sorbents or IX resins)
- Prefilter for protecting RO membranes for both fresh water and sea water (reduces chlorine that can damage membranes as well as sub-micron particles that tend to foul RO membranes)
- Iron removal in cooling towers & chill water systems
- Chemical-Biological Filters - protection against terrorist contamination of water supplies

Industries

Food, Beverage & Bottled Water
Pharmaceutical & Biomedical
Cosmetics & Personal Care
Microelectronics & Semiconductors
Automobile Manufacturing
Power Generation
Machining (including EDM)
Paints & Coatings

ARGONIDE
ADVANCED FILTRATION SYSTEMS

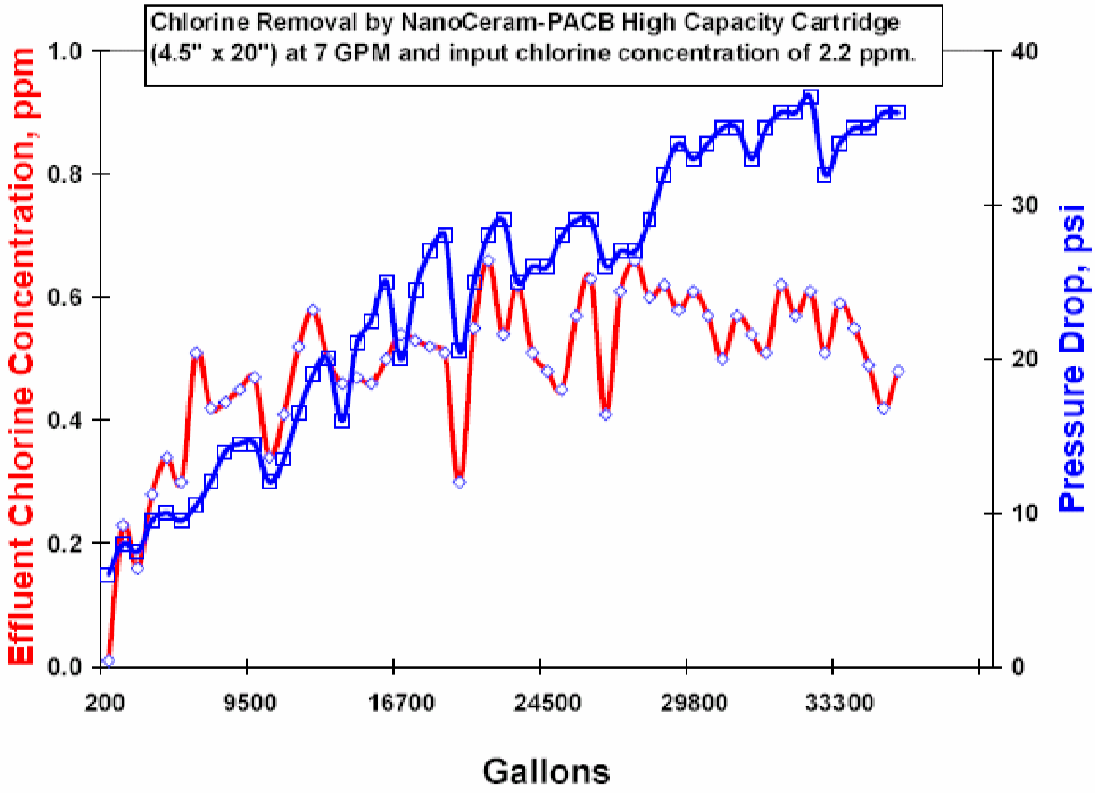
NANOCERAM
FILTERING SOLUTIONS

NanoCeram-PACB™ Series:

	Part No.	PACB2.5-10 2.5" x 10"	PACB4.5-10 4.5" x 10"	PACB4.5-20 4.5" x 20"
Filter Surface Area (NanoCeram-PAC Media Only)	(in^2) (ft^2) (cm^2) (m^2)	420 2.9 2,700 0.27	780 5.4 5,030 0.503	1,620 11.2 10,400 1.04
Electroadsorptive (active) Surface Area	**(in^2) (ft^2) (cm^2) (m^2)**	**1.85×10^7 128,500 1.19×10^8 11,900**	**3.44×10^7 240,000 2.22×10^8 22,200**	**7.14×10^7 496,000 4.61×10^8 46,100**
Diameter × Length	(in) (cm)	2.75 × 9.75 7 x 24.8	4.45 × 9.75 11.3 x 24.8	4.45 x 20 11.3 x 50.8
Suggested Flow Rate	(GPM) (LPM)	1 4	3.5 13	7 27
Peak Flow Rate *	(GPM) (LPM)	4 15	12 45	24 90

*Peak Flow Rate based on initial flow using new filter cartridge and clean water during laboratory testing.

NanoCeram-PACB™ Chlorine Adsorption:



ARGONIDE
ADVANCED FILTRATION SYSTEMS

NANOCERAM®
FILTERING SOLUTIONS

NanoCeram® "SOE" Series

Double "O" Ring Pleated Filter Cartridges

Features and Benefits

Thermally bonded blend of microglass fibers & cellulose infused with nanoalumina fibers in a non-woven matrix creates an electropositively-charged depth filter media. Argonide's line of SOE cartridges use our NanoCeram® filter media which are constructed with 100% polypropylene materials and assembled using the latest thermal bonding equipment. NanoCeram® offers a unique combination of efficiency, capacity, flowrate & low pressure drop at levels matchless in today's filtration marketplace. These cartridges are designed for use in most applications where absolute rated pleated filtration is needed with the added assurance of an absolute seal between cartridge and housing; and are available with flat, fin or spring endcaps with 222 or 226 double o-rings.

- Silt Density Index (SDI): ≤ 0.8 ± 0.1
- Turbidity Reduction: < 0.01 NTU until terminal pressure drop (35psi)
- Low ΔP: < 1.5psi @ 4gpm (Part No. SOE2.5-10)
- Efficiency: >99.9% reduction of 0.2µ particulate (monodispersed latex spheres)
- Flow Rate: 5mL/cm^2/min @ 4gpm (Part No. SOE2.5-10)
- Dirt Holding Capacity (DHC): 572 mg/in^2 (A2 Fine Test Dust)
- Cyst Retention: > 5 LRV
- Bacteria (*Klebsiella terrigena*): > 5 LRV
- Temperature Range: 39 - 190° F (4 - 88°C)
- Maximum Pressure: 70 psi (4.83 bar)
- Effective pH Range: 5 - 10

Applications

Primary filtration in lieu of ultraporous and microporous membranes

Prefiltration and/or Polishing for:

- Reverse Osmosis (R.O.)
- Ultrafiltration
- Microfiltration
- Ultraviolet (UV)
- Ozonation
- Chlorination
- Mixed Bed
- Carbon Bed

Food, Beverage & Bottled Water
Pharmaceutical & Biomedical
Cosmetics & Personal Care
Microelectronics
Power Generation
Machining (including EDM)

Each NanoCeram® pleated filter cartridge is designed to satisfy the most difficult requirements in water treatment. By using the scientific principal of electropositive attraction/capture, NanoCeram® technology leads to a rapid and highly efficient adsorption of virtually all particle sizes. NanoCeram®'s media has a high capacity for particles as large as tens of microns or as small as a few nanometers. Each NanoCeram® Filter Cartridge exhibits a rating of 0.2µ . . . a rating typically associated with ultraporous membranes. Yet NanoCeram® flow rates are hundreds of times greater than such membranes.

ARGONIDE
ADVANCED FILTRATION SYSTEMS

NANOCERAM®
FILTERING SOLUTIONS

NanoCeram® SOE Series:

Part No.		SOE2.5-10 2.5" x 10"	SOE2.5-20 2.5" x 20"	SOE2.5-30 2.5" x 30"	SOE2.5-40 2.5" x 40"
Filter Surface Area	(in^2) (ft^2) (cm^2) (m^2)	450 3.1 2,900 0.29	960 6.7 6,200 0.62	1,500 10.5 9,700 0.97	2,000 14 13,000 1.3
Electroadsorptive (active) Surface Area	**(in^2)** **(ft^2)** **(cm^2)** **(m^2)**	**1.98×10^7** **137,500** **1.28×10^8** **12,800**	**4.22×10^7** **293,000** **2.73×10^8** **27,300**	**6.6×10^7** **460,000** **4.26×10^8** **42,600**	**8.8×10^7** **613,000** **5.67×10^8** **56,700**
Diameter × Length (Nominal)	(in) (cm)	2.7 × 10 7 x 25.4	2.7 × 20 7 x 50.8	2.7 × 30 7 x 76.2	2.7 x 40 7 x 101.6
Suggested Flow Rate	(GPM) (LPM)	4 15	8 30	12 45	16 60
Peak Flow Rate *	(GPM) (LPM)	10 38	20 76	30 114	40 152

*Peak Flow Rate based on initial flow using new filter cartridge and clean water during laboratory testing.

Construction Materials

Filtration Media	NanoCeram / NanoCeram-PAC
Support Media	Polypropylene
End Caps	Polypropylene
Center Core	Polypropylene
Outer Support Cage	Polypropylene
O-rings/Gaskets	Buna, Viton, EPDM, Silicone, Teflon® Encapsulated Viton

Turbidity Reduction & Silt Density Index (SDI_{30}):

Manufacturer	Type	Flow Rate (GPM)	Type of water	Turbidity, NTU		SDI_{30} [a]
				in	out	
Argonide (NanoCeram®)	SOE2.5-10 *2.5" x 10"*	2	Municipal tap water	0.05	<0.01	0.8 ± 0.1[d]
"A"	1µ Absolute *2.5" x 10"*	4	A2 dust [b] in RO water	239.00	60.00	ND[e]
			Municipal tap water	0.54	0.10	4.4 ± 0.2[f]
	0.35µ Standard *2.5" x 10"*	4	A2 dust [b] in RO water	239.00	55.00	ND[e]
			Municipal tap water	0.57	0.14	4.6 ± 0.2[f]
"B"	1µ Standard *2.5" x 20"*	4	Municipal tap water	1.3 ± 0.1[g]	0.4 ± 0.1[g]	N/A
	1µ Absolute *2.5" x 10"*	4	A2 dust [b] in RO water	243.00	23.00	ND[e]
			Municipal tap water	1.3 ± 0.3[g]	<0.01[h]	5.5 ± 0.2[f]
	5µ Standard *2.5" x 20"*	4	Municipal tap water	1.5 ± 0.7[g]	1.1 ± 0.4[g]	ND[e]
"C" *	0.1µ Hollow Fiber Membrane *6.5" x 85" Module*	22	N/A	N/A	<0.08	< 2.0 - 3.0

* Manufacturer's published specifications.

Notes:

a) Silt Density Index (SDI_{30});
b) ISO 121030-1, A2 Fine Test Dust available from PTI technology Inc.;
c) Average of six measurements;
d) Average of four measurements;
e) Not done since turbidity of filtered water is unacceptable high (expected to be less than 1 NTU);
f) Average of three measurements;
g) Average over 3 hrs test;
h) During first 30 minutes of run;
i) After 30 minutes of continuous water run.

ARGONIDE
ADVANCED FILTRATION SYSTEMS

NANOCERAM®
FILTERING SOLUTIONS

NanoCeram-DP™ Series
Double Layer Pleated Filter Cartridges

Argonide's NanoCeram-DP™ Series Pleated Filter Cartridges offer two pleated layers of our patented electropositively-charged filter media, providing a unique combination of high efficiency, capacity, flow rate for particulate adsorption while maintaining a low pressure drop.

A combination of a thermally-bonded blend of microglass fibers & cellulose infused with nanoalumina fibers in a non-woven matrix creates an electropositively-charged depth filter media. When assembled into a pleated cartridge, the NanoCeram-DP™ filter offer an ultra-high level of filtration efficiency because of the extra bed-depth of the two layers of electropositive filter media.

These cartridges are available in four (4) versions: standard, powder activated carbon (PAC), and two hybrid filters both of which incorporate an activated carbon block as the center core with one using standard NanoCeram media and the other using NanoCeram-PAC media as a pleated layer surrounding the carbon block.

Retention Characteristics

- >99.99% Efficiency at 0.2 microns (latex spheres)
- >4 LRV Cyst Retention
- >6 LRV Virus Retention
- >7.5 LRV E. coli Retention
- <0.01 NTU until Terminal ΔP (35 psid) using A2 Fine Test Dust

Markets

- Food, Beverage & Bottled Water
- Pharmaceutical
- Cosmetics & Personal Care
- MicroElectronics
- Power Generation
- Inks, Paints & Coatings
- Potable Water (POE, POU)

Features

- Effective at high pH and in the presence of salt
- Pleated construction yields high flow rates
- Available in standard DOE configurations
- Provides optical clarification to fluids
- Manufactured with strict quality control
- All DP Components are manufactured with materials that meet FDA requirements 21CFR177.1520 for direct food contact applications.

Applications

- Make Up Water (particulate, microbial control)
- Polishing Filters (carbon fines, emulsified oil removal)
- RO Prefiltration (SDI reduction)
- Process Water (turbidity, particulate, colloidal suspensions)
- Waste Water (biologicals, proteins, dyes)
- Cooling Towers, Chill Water Loops (iron removal)
- Clarifying Filtration of Cell Cultures

ARGONIDE
ADVANCED FILTRATION SYSTEMS

NANOCERAM®
FILTERING SOLUTIONS

NanoCeram-DP™ Series

Specifications

Part No	P2.5-5DP	P2.5-10DP	P2.5-20DP	P4.5-10DP	P4.5-20DP
Surface Area	1.5ft^2 0.14m^2	3.3ft^2 0.31m^2	6.8ft^2 0.63m^2	7.7ft^2 0.72m^2	16.2ft^2 1.5m^2
Dimensions	2.8 x 4.85" 7.1 x 12.32 cm	2.8 x 9.75" 7.1 x 24.77 cm	2.8 x 20" 7.1 x 50.8 cm	4.5 x 9.75" 11.43 x 24.77 cm	4.5 x 20" 11.43 x 50.8 cm
Suggested Flow Rate	2 gpm 7.5 lpm	4 gpm 15 lpm	8 gpm 30 lpm	11 gpm 42 lpm	22 gpm 84 lpm
Maximum Flow Rate	5 gpm 19 lpm	10 gpm 38 lpm	20 gpm 76 lpm	25 gpm 95 lpm	35 gpm 133 lpm

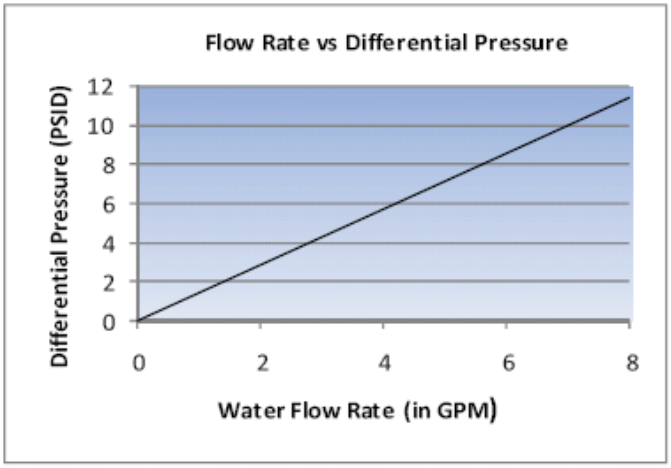
Materials of Construction

Media :
NanoCeram® Media
Support:
Polypropylene, Hot Melt
O-rings/Gaskets:
Neoprene

Operating Conditions

Temperature:
39-180°F (4-82°C)
pH Range:
4.0 to 9.5
Maximum Operating Pressure:
70 psid (4.8 bar)

WATER FLOW RATE P2.5-10DP



Virus (MS2) and Bacterial (E. coli) Retention Testing

Testing was conducted on NanoCeram-DP cartridges for the purpose of the determining the retention of the MS2 Virus and E. coli bacteria.

Twenty five liters of the MS2 or the E. coli suspension were passed through a cartridge at 4 gpm @ 7 psid.

Test	Flow Rate GPM	MS2 inlet Concentration PFU/mL[1]	MS2 Removal LRV[2]	E. Coli input Concentration CFU/mL[3]	E. Coli Removal LRV[2]
1	4	1.1x10^6	>6	1.8 x 10^6	7.6
2	4	1.1x10^6	>6	1.8 x 10^6	7.6
3	4	1.1x10^6	>6	1.8 x 10^6	7.4
Avg.	4	**1.1x10^6**	**>6**	**1.8 x 10^6**	**7.5**

1) Plaque Forming Units 2) Log Reduction Value 3) Colony Forming Units

Ordering Information

Part No:
P2.5-5DP
P2.5-10DP
P2.5-20DP
P4.5-10DP
P4.5-20DP

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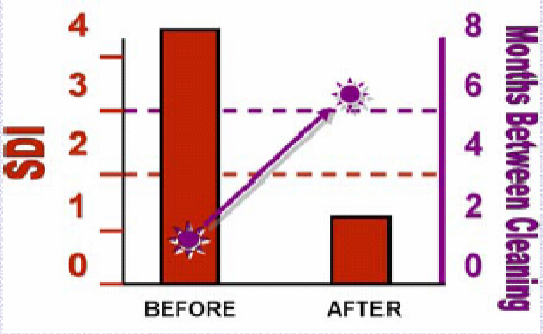
Protecting Your RO Membranes

Turbidity & SDI

NanoCeram® filter cartridges exhibit a significant advantage in removing submicron particulate when compared to other commercially available filter cartridges typically used as prefilters to RO membranes. Virtually all RO membrane manufacturers specify a minimum quality for the feed waters to their systems in order to maintain system integrity and an economical return on investment. Even under extreme loading, NanoCeram® yields NTU values BDL (below detectable limits) and extremely low SDI values (< 1.0) . . . providing long-lasting protection of RO and even UP membranes susceptible to premature fouling.

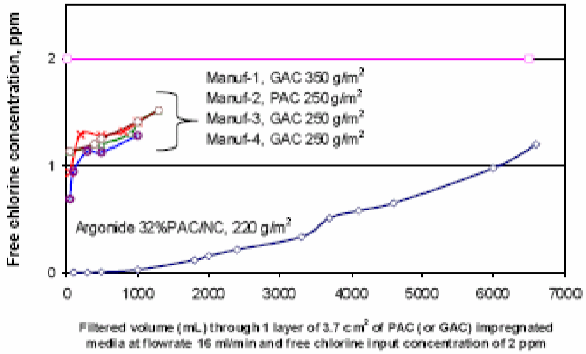
Toyota

NanoCeram® Pleated filter cartridges are currently in use at a Toyota Motor Manufacturing facility in North America as the final prefilter to RO membranes. Prior to installation of NanoCeram® filters, this system with particularly challenging source water, required membrane replacements 6 – 7 times/year! After installation of NanoCeram® filters in a HyFlo™ Stainless Housing from Argonide, the membranes have not only remained intact, but in over nine (9) months of operation, there has been negligible pressure drop increase across the membranes to signal the need for cleaning. According to Toyota, this so far represents a five-fold cost savings for that system.



Chlorine

NanoCeram-PAC™ Pleated filter cartridges combine high efficiency particulate filtration with a high efficiency (powdered) activated carbon (PAC) in a single depth media. The line of NanoCeram-PAC™ filter cartridges offer a unique combination of efficiency, capacity, flow-rate, low carbon-shedding & low pressure drop for both particulate and chemical adsorption or soluble contaminants such as soluble organics and chlorine. Their best use is in those applications where even low levels of chlorine can impact a membrane.



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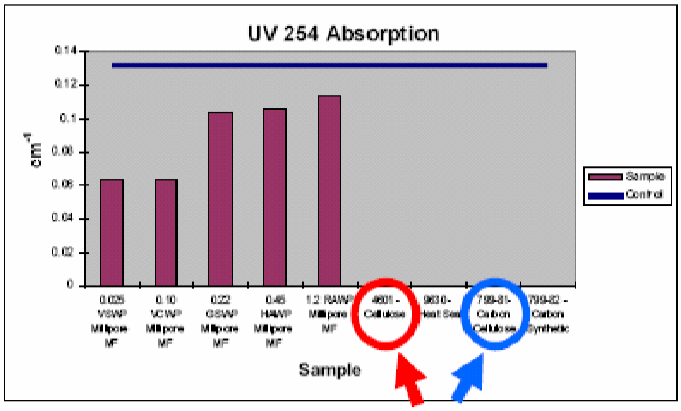


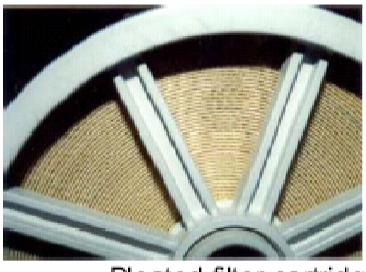
TOC (Humic Acid)

NanoCeram® and NanoCeram-PAC™ Pleated filter cartridges exhibit an extremely high efficiency for adsorption of TOC (total organic carbon) in the form of humic acid. In laboratory testing at Ahlstrom Filtration, NanoCeram filter media was tested against several commercially available membranes from Millipore Corporation. TOC represents a significant fouling potential for membranes. Not only do membranes have difficulty in removing such contaminants, there is a strong tendency for them to foul prematurely. The line of NanoCeram® and NanoCeram-PAC™ filter cartridges have the ability to reduce the levels of soluble & insoluble TOC with the capacity to remain effective for extended periods of time.

Bio-Fouling

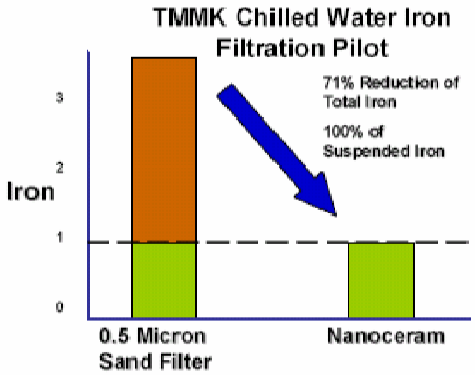
NanoCeram® and NanoCeram-PAC™ Pleated filter cartridges are highly efficient at reducing bacteria which normally lead to biofouling of membrane surfaces. Such biofouling can lead to reduced membrane flux and can also lead to reduced membrane life. Often the leading cause for cleaning of membranes, biological proliferation on a membrane's surface can increase "cost of ownership" for a membrane system. Reduction of this challenge to a membrane can provide cost savings for labor, chemicals, membrane replacement and wastewater disposal.

Media	Thickness, mm	Basic weight, g/m^2	Challenge water			B. Diminuta removal, %		
			pH	TDS g/L	BD, CFU/ml	0-10 ml	60-70 ml	130-14 ml
NanoCeram®	0.8	200	7.2	0	$7\cdot10^5$	99.997	99.97	99.93
			9.2	0	$1.3\cdot10^6$	99.99	99.9	
			7.2	30	$1.2\cdot10^6$	99.9	99.7	
			9.2	30	$5.1\cdot10^5$	99	98.5	
Other Electropositive media	0.8[a]	210[a]	7.2	0	$7\cdot10^5$	98.6	97.7	97.7
			9.2	0	$1.3\cdot10^6$	93.8	73	
			7.2	30	$1.2\cdot10^6$	92	72	
			9.2	30	$5.1\cdot10^5$	92	84	



Iron & Manganese

Iron and manganese commonly occur in groundwaters as soluble divalent ions. Should air or chlorine be introduced into these waters, the iron and manganese may be oxidized and precipitate onto membrane surfaces as hydrous oxides. NanoCeram® and NanoCeram-PAC™ Pleated filter cartridges are highly efficient at reducing both iron and manganese as oxides (as evidenced by work done at a Toyota manufacturing plant) before either contaminant has the chance to reach and foul the membrane; or before such contaminants can act as nutrients for iron reducing bacteria.



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Metal Adsorption by NanoCeram

Preparation of challenge solutions

Metal	Molecular weight, g/mol	Source salt	Amount of salt, mg/L	Metal ion input concentration, ppm		pH
				Target	Actual[a]	
Pb	207	$PbCl_2$	6.7	5.0	3.6±0.5	7.25
Hg	201	$HgCl_2$	6.8	5.0	3.0±0.5	
Au	197	$Na_3Au(S_2O_3)_2*2H_2O$	13.3	5.0	5.0±0.8	
Sn	119	$SnCl_2$	3.8	2.5	1.4±0.2	
Ag	108	$AgNO_3$	3.9	2.5	0.14[b]	
As III	74.9	As_2O_3	2.6	2.0	1.9±0.3	
As V	74.9	As_2O_5	3.1	2.0	2.4±0.4	
Cu	63.6	$CuCl_2*2H_2O$	3.6	1.36	1.3±0.2	
Ni	58.7	$NiCl_2$	3.3	1.5	1.4±0.2	
Fe	55.9	$FeCl_3$	7.3	1.5	1.7±0.3	7.25
Cr III	52.0	$Cr_2(SO_4)_3$	5.6	1.5	1.3±0.2	
Cr VI	52.0	CrO_3	2.9	1.5	1.8±0.3	
Al	27.0	$AlCl_3*6H_2O$	6.3	0.7	0.78±0.12	7.35

Notes: a) Measured by the ICP method; b) Possible problem – method of sample preservation.

Test Results on Metal Sorption by NanoCeram Filter media

Metal	MW, g/mol	Input concentration ppm	pressure drop, psi		Sorption capacity to 10 ppb		Sorption capacity to exhaustion		Sorption capacity to 99.997%
			Initial	Final	mg/g media	g/m^2 media	mg/g media	g/m^2 media	mg/g media[a]
Pb	207	3.6	4	3	>93	>18.7			>14
Hg	201	3.0	4	4	<0.1	<0.02			
Au	197	5.0	4	4	<0.1	<0.02			
Sn	119	1.4	4	7	>36	>7.27			>14
Ag	108	0.06	4	5					>14
As III	74.9	1.9	4	8	<0.1	<0.02			
As V	74.9	2.4	4	4	~1	~0.2			
Cu	63.6	1.3	4	4	19	3.9			
Ni	58.7	1.4	4	4	3.4	0.7			>14
Fe	55.9	1.7	5	42	23	4.6			>14
Cr III	52.0	1.3	4	8	~7	~1.4			
Cr VI	52.0	1.8	4	3	~0.2	~0.04			
Al	27.0	0.78	4	42	3.5	0.67			

Note: S. A. Wilson, NREL (2002), unpublished report.

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Test Results on Metal Sorption by NanoCeram Filter media

Metal	Sorption capacity to ~10 ppb			EPA regulations		POE 30,000 gall			
	Input concentration, ppm	mg(M) /g media	g(M)/ m^2 media	Former limit, ppb	New limit, ppb	Amount of metal to be removed, g	Required surface area, m^2	Cartridge configuration	Initial pressure drop @ 11GPM, psi
Pb	3.6	>93	>18.7	150	15[a]	17.0	<0.91	P4.5x10	4
Hg	3.0	<0.1	<0.02	0.002[a]	0.002[a]				4
Au									4
Sn	1.4	>36	>7.27						4
Ag									4
As III	1.9	<0.1	<0.02	50	10[c]				4
As V	2.4	~1	~0.2	50	10[c]	5.7	~30		4
Cu	1.3	19	3.9	NA[b]	1300[a]				4
Ni	1.4	3.4	0.7						4
Fe	1.7	23	4.6						5
Cr III	1.3	~7	~1.4	100[d]	100[d]				4
Cr VI	1.8	~0.2	~0.04	100[d]	100[d]				4
Al	0.78	11	2.3						4

NOTES: a) Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L (see EPA List of Drinking Water Contaminants & MCLs in EPA Ground Water & Drinking Water); b) Not Available -Maximum Contaminant Level Goals (MCLGs) were not established before the 1986 Amendments to the Safe Drinking Water Act. Therefore, there is no MCLG for this contaminant; c) as of 01/23/06; d) total chromium;

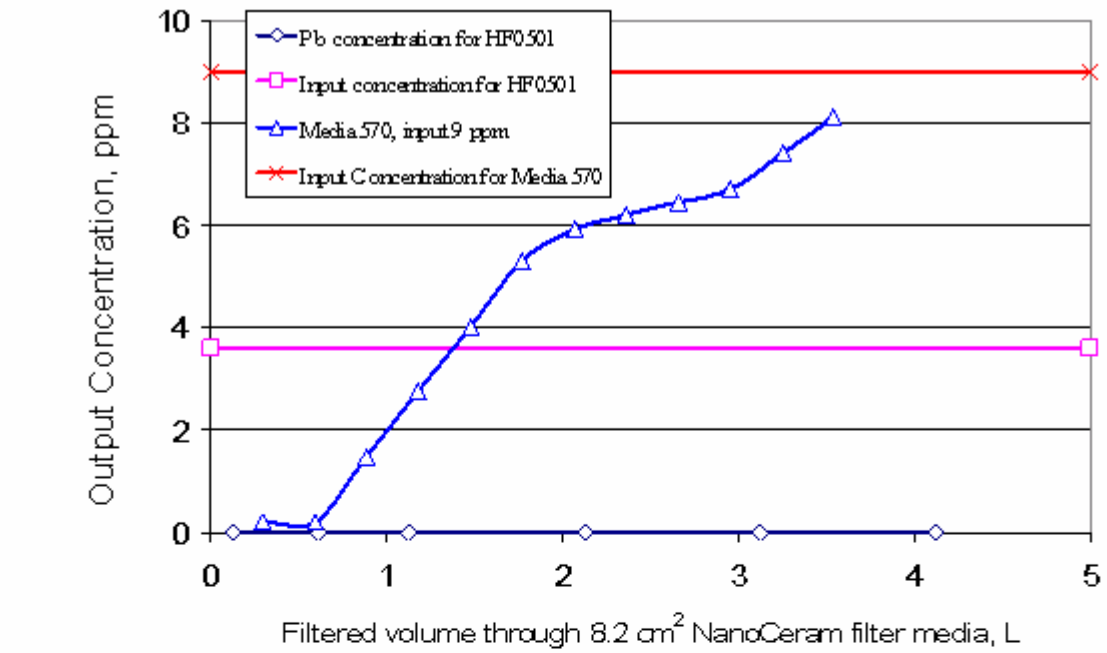

Figure 1

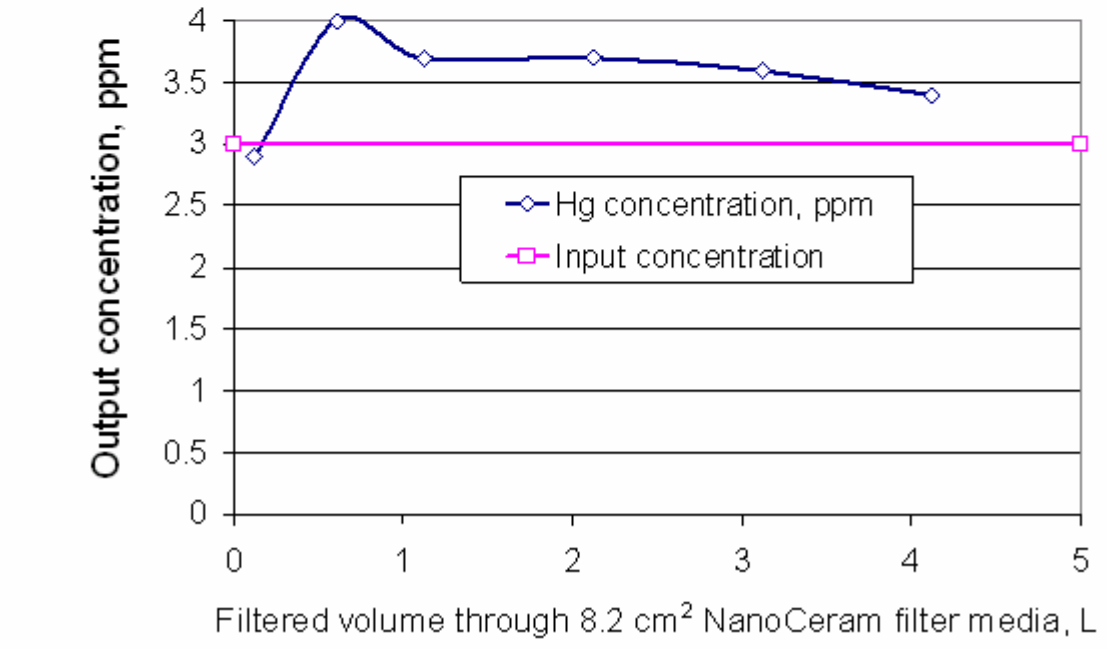

Figure 2

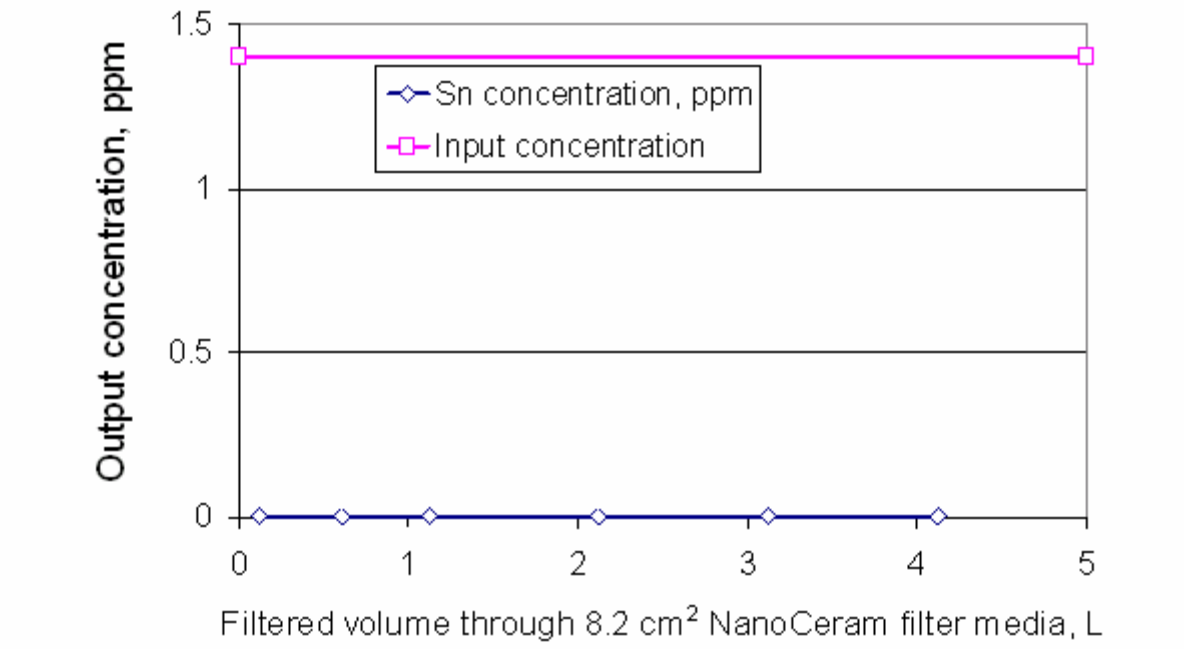

Figure 3

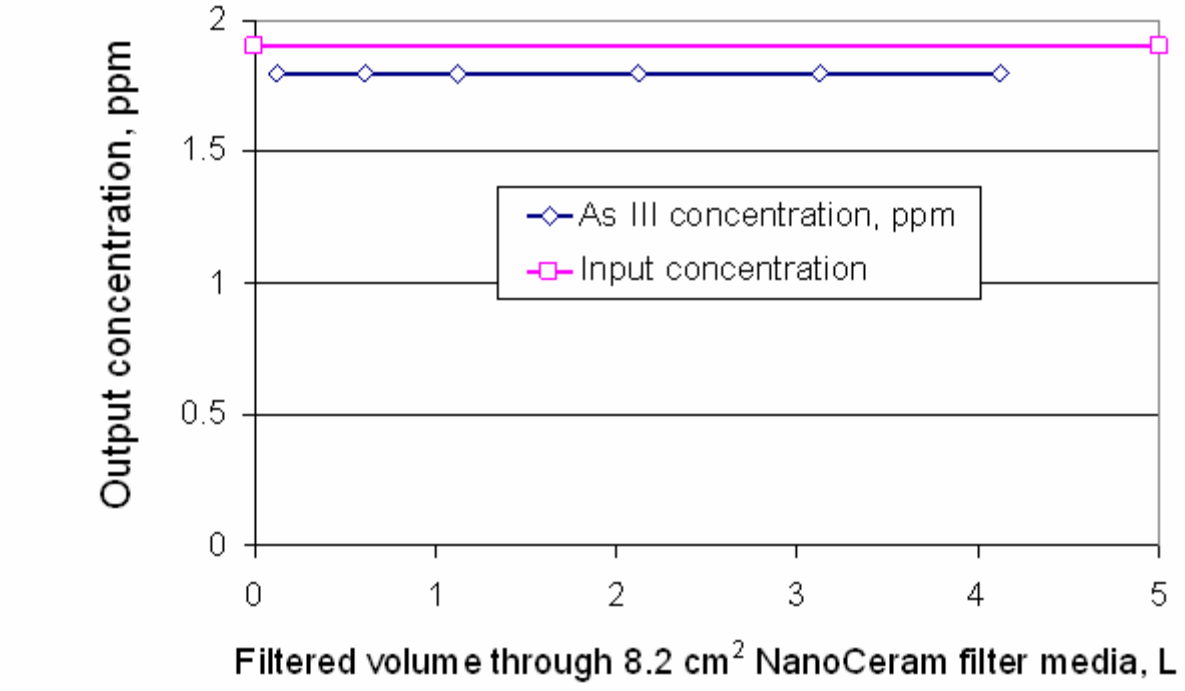

Figure 4

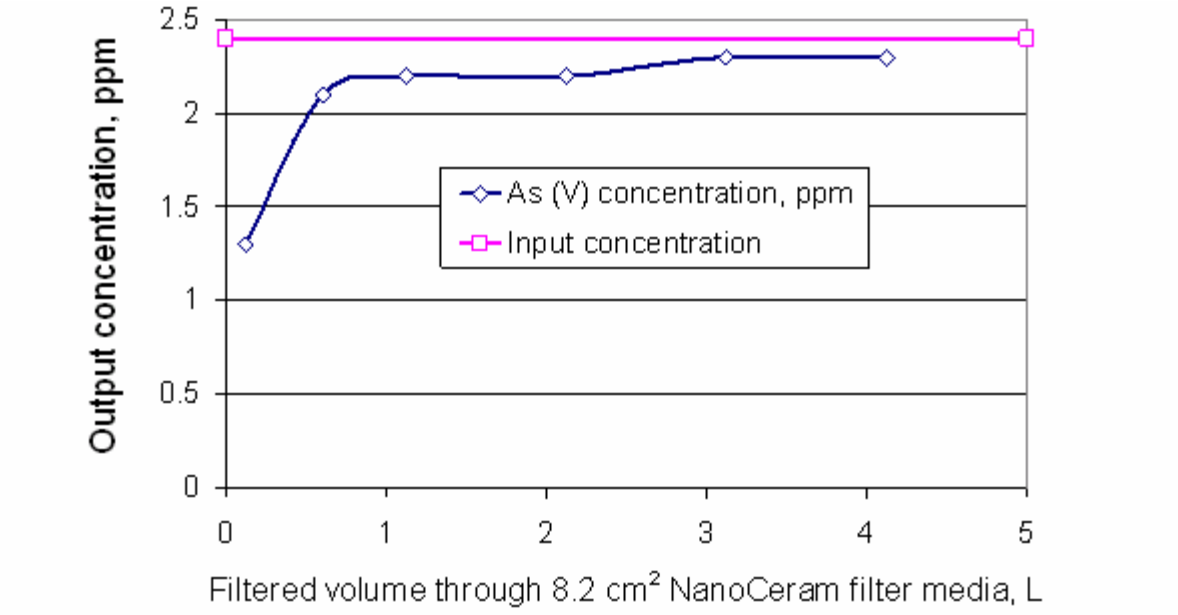

Figure 5

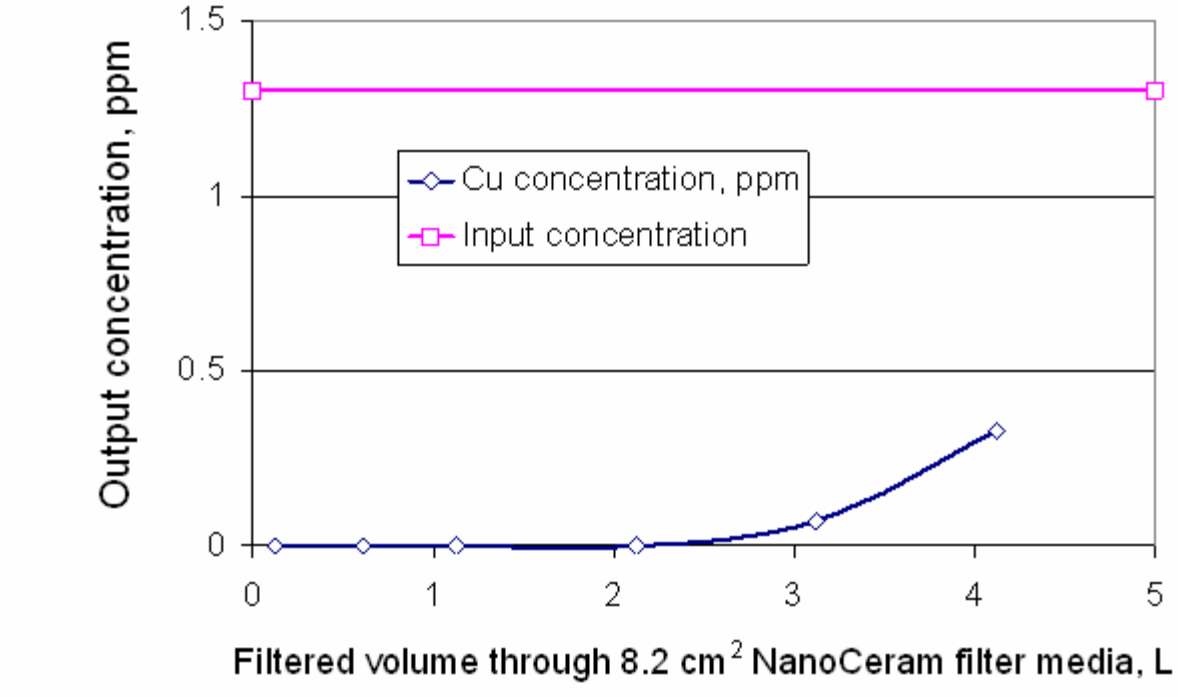

Figure 6

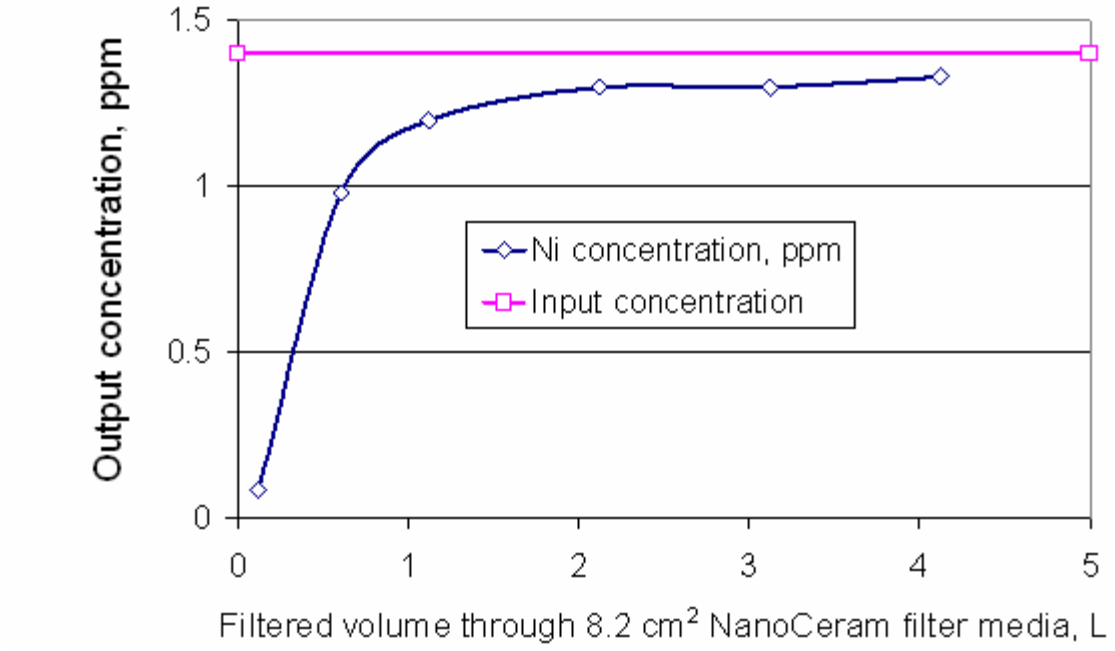

Figure 7

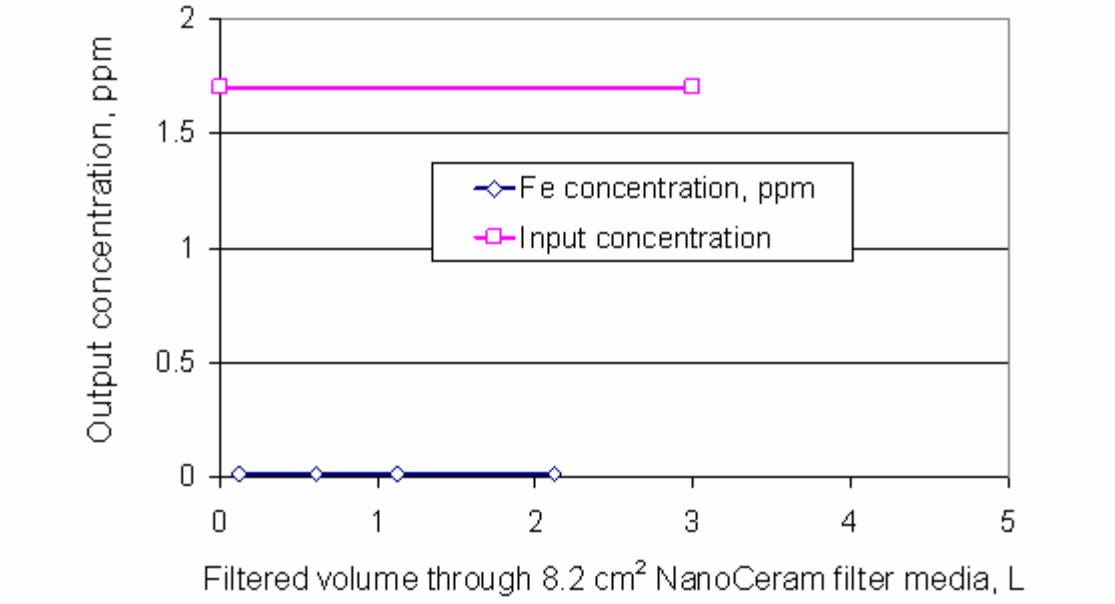

Figure 8

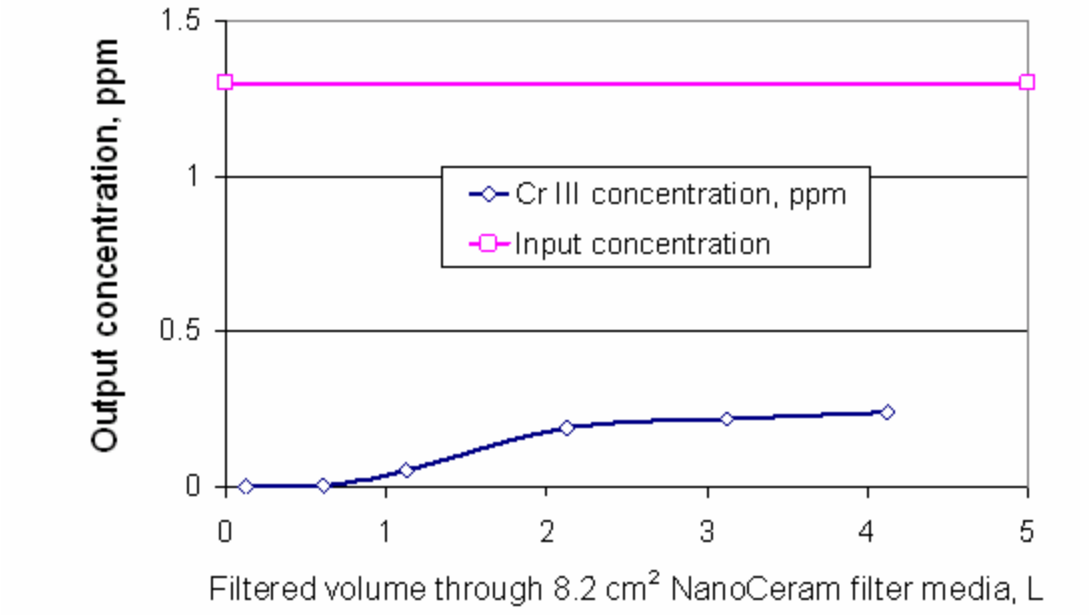

Figure 9

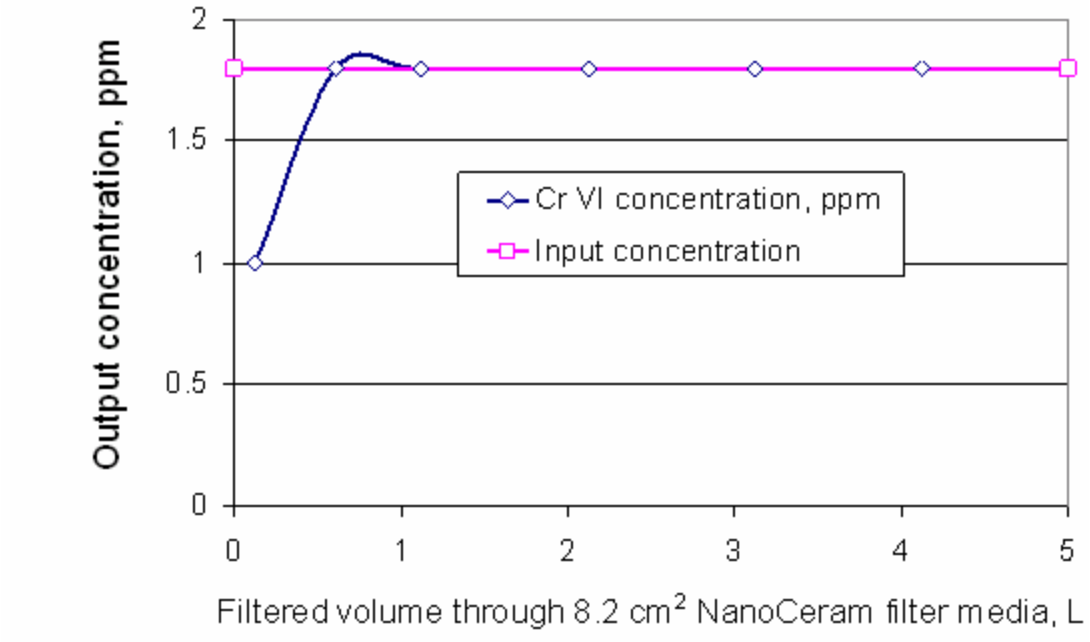

Figure 10

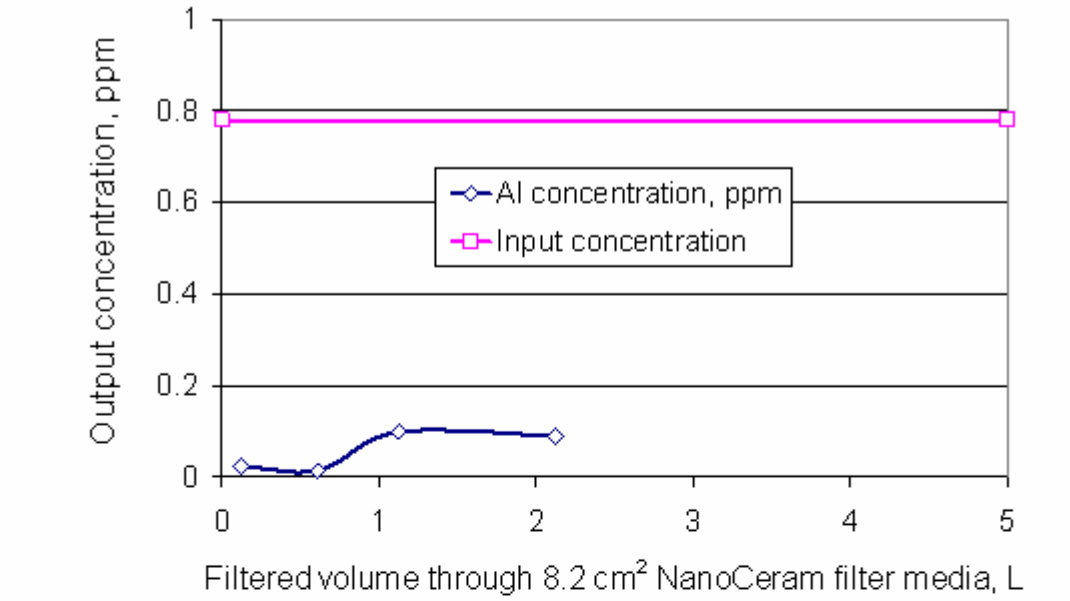

Figure 11

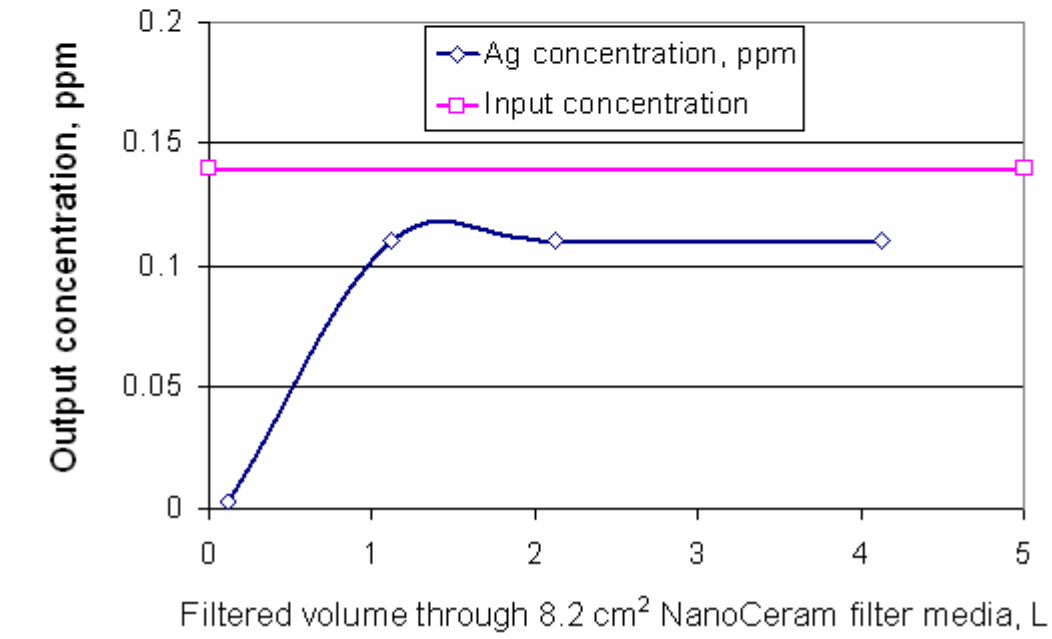

Figure 12

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NEXT GENERATION

LENTICULAR FILTER CARTRIDGE

Pleated Electropositive Filter Replaces Stacked Disc Filters

NanoCeram-LR™ (NCLR) pleated cartridges use Argonide's patented electropositive non-woven filter media. NCLR's are engineered and designed as drop-in replacements to fit into most commercially available lenticular housings. Results have shown a ***greater dirt-holding capacity, higher efficiency*** (> 6LRV for virus, > 7LRV for bacteria), and ***wider operating pH range*** versus other charged lenticular filters.

NCLR has a ***lower shipping weight*** to help reduce shipping costs. And, since each NCLR ***holds less water***, it eases the process of filter replacement for the operator.

In addition to NanoCeram-LR™, Argonide manufactures a full line of conventionally-sized pleated filter cartridges…all from our NanoCeram® electropositive filter media.

Give us a call for your filtration needs.

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MAXIMIZE YOUR MEMBRANE'S PERFORMANCE

NanoCeram® continues to re-write the rules of filtration.

Even when compared to a typical ultraporous membrane, NanoCeram® pleated filters provide:

- ***Much Higher Flowrate***
- ***Greater Particle Retention, including Colloids***
- ***Superior Dirt-holding Capacity***
- ***Reliability***

NanoCeram's® ultra-low SDI values and its' extraordinary turbidity reduction and adsorption capacity can significantly reduce the energy & maintenance costs for your membranes. And, by using standard equipment already installed in your plant, NanoCeram's® many benefits include a very low capital investment.

FDA Compliant Components

All NanoCeram® and NanoCeram-PAC™ Filter Cartridge products are manufactured with FDA compliant components and/or materials.

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Model # HBB-240

NanoCeram® HyFlo™

Multi-Round Big Blue Cartridge Housings

Many industrial and commercial settings have limited floorspace and it is often impractical to install and service multiple filter housings in order to gain higher flow capacity. The costs associated with the time and labor to service multiple housings creates an additional burden for many organizations. A HyFlo™ housing provides the user with all the NanoCeram® technological advantages, but in a single stainless steel unit. Each HyFlo™ provides the flowrates, ultra-high efficiencies and large capacity of NanoCeram® Filters without the disadvantages of multiple housings. The user also avoids the installation complexity and increased maintenance time and costs to service multiple housings.

Argonide's custom-built stainless steel housings are available in five sizes. All hold multiple 4.5" x 20" Big Blue cartridge filters and can attain peak flowrates up to 1,330 gpm (836 gpm using nominal flow rates) per housing. Manufactured from high quality 304 or 316 Stainless Steel, every HyFlo™ housing is 150 psi-rated and utilizes either clamp or swing-bolt closures depending on the model. The HBB-60 and HBB-120 models incorporate a 3" flange and the HBB-240 model uses a 4" flange. The HBB-380 & HBB-760 models incorporate 6" flanges. Depending on the customer's needs, Argonide can supply other sizes for the inlet and/or outlet ports.

Specifications

NanoCeram® HyFlo™ (Model #)	HBB-60	HBB-120	HBB-240	HBB-380	HBB-760
Peak Flow Rate * gpm (lpm)	105 (400)	210 (800)	420 (1,600)	665 (2,520)	1,330 (5,040)
Nominal Flow Rate gpm (lpm)	66 (250)	132 (500)	264 (1,000)	418 (1,580)	836 (3,170)
Dimensions inches (Circumference x Height) (cm)	16.7 x 39.5 (42.4 x 100.3)	16.7 x 59.5 (42.4 x 151)	21 x 60.2 (53.3 x 153)	30 x 59 (76 x 150)	30 x 69 (76 x 175)
Cartridge Capacity (4.5" x 20" or Part# P4.5-20)	3	6	12	19	38

* Peak Flow Rate based on initial flow using new filter cartridges and clean water during laboratory testing.

Summary

NanoCeram® HyFlo™ advantages include:

- A single housing to service versus multiple standard housings minimizes labor costs
- Simpler installation
- A stainless steel housing is more durable than typical plastic housings
- Greater pressure rating versus plastic housings
- Minimized footprint saves floor space
- Most cost efficient use of NanoCeram® Filter Cartridges

MAXIMIZE YOUR MEMBRANE'S PERFORMANCE

The Ultimate Advancement in Turbidity Reduction

HyFlo™ HBB-240

NanoCeram® from Argonide continues to re-write the rules of filtration.

Even when compared to a typical ultraporous membrane, NanoCeram® pleated filters provide a much higher flowrate, greater particle retention, and superior dirt-holding capacity...all at the same time. But also with the reliability of a true depth filter.

NanoCeram's ultra-low SDI values and its' extraordinary turbidity reduction and adsorption capacity can significantly reduce the energy & maintenance costs for your membranes. And, by using standard equipment already installed in your plant, NanoCeram's® many benefits include a very low capital investment.

Listen to one of our customers, a water bottler:

"After installing NanoCeram pleated cartridges as a prefilter for my RO membrane, I saw a substantial increase of permeate through my water bottling line. It was as simple as replacing the manufacturer's suggested prefilter with a NanoCeram filter cartridge."

Paul Wilke - World of Water, Regina, SK Canada

NanoCeram® filters are available in five standard cartridge sizes. Please ask us about our new HyFlo™ Filter Housings for higher flow applications.

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