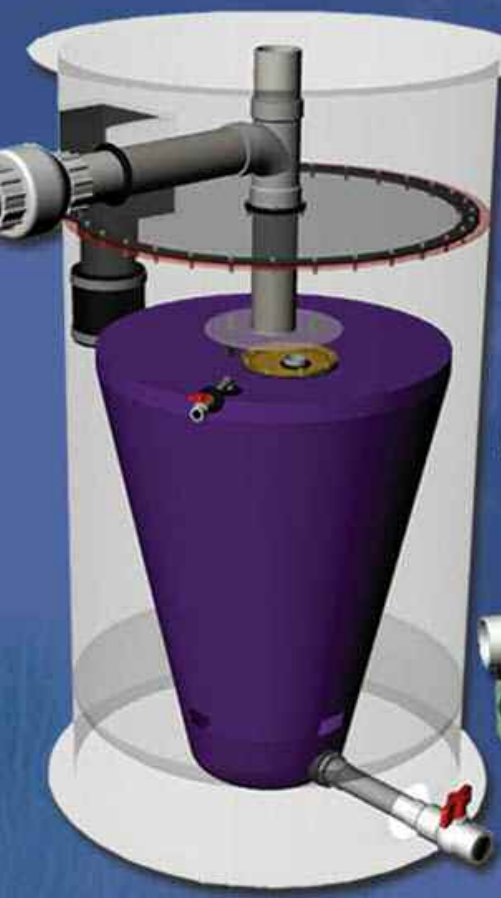
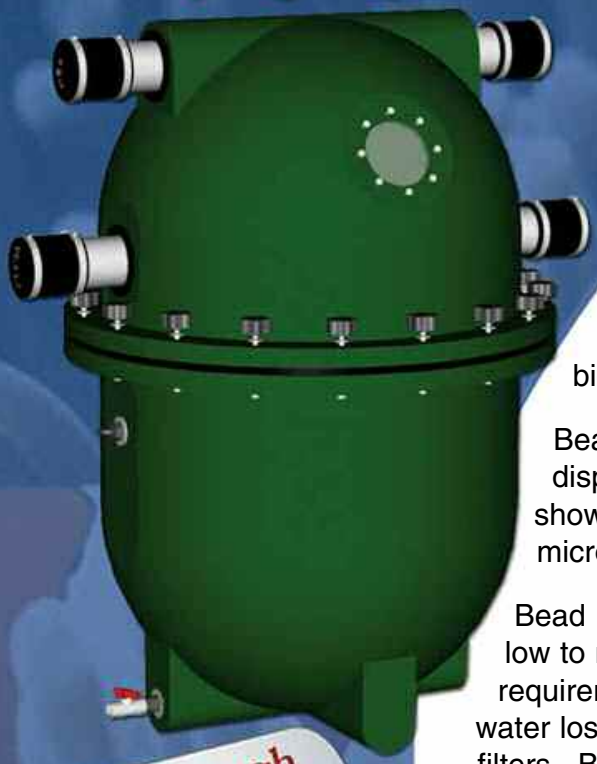
DEMAND PolyGeyser FILTER PERFORMANCE



- **SUPERIOR BIOLOGICAL FILTRATION** - *1.5X That of BBF Filters*
- **EXCELLENT SOLIDS CAPTURE** - *100% Of Particles > 50 Microns/Pass*
- **INNOVATIVE PNEUMATIC BACKWASH**
- **USES EXTREMELY LOW HEAD PUMP**- *Can Even Be Operated Airlift*
- **SIMPLE AND RELIABLE OPERATION**
- **TRIED AND TESTED FOR OVER 3 YEARS**

BEAD FILTER
Theory of Operation



Bead Filters are generally classified as "expandable granular biofilters" or EGB's. They are distinguished by the use of plastic buoyant granular media. Water from the aquatic system passes through the packed bed of plastic beads. The beads capture the solids, while simultaneously providing a large surface area (400 ft2 /ft3) for the attachment of nitrifying bacteria which remove dissolved nitrogenous wastes. Bead Filters are often referred to as Bioclarifiers for their ability to perform both biofiltration and clarification in a single unit.

Bead filters are excellent clarification units capable of maintaining display-quality water at high waste loading rates. Studies have shownthat acclimated Bead Filters capture 100% of particles > 50 microns and 48% of particles in the 5-10 micron range per pass.

Bead Filters typically operate at 10-20 psi which facilitates the use of low to medium head pumps which reduces overall pump horsepower requirements, as well as energy consumption. Additionally, backwash water loss rates are as low as 1% of those experienced by typical sand filters. Bead Filters are also easily automated, never require replacement of the filter media and are immune to caking and channeling.

Breakthrough Technology!
U.S., European, & Canadian Patents

POLYGEYSER BEAD FILTERS

The patented (U.S. Patent # 5,770,080 and 6,517,724, European Patent # 0977713B, and Canadian Patent # 2,287,191) PolyGeyser Bead Filters are the newest addition to Aquaculture Systems Technologies' line of Bead Filters. Utilizing floating plastic beads as their filtration media to effect both biological and mechanical filtration, these "bioclarifiers" are capable of handling ammonia loads 50 to 100 percent higher than standard bead filters, at a fraction of the water loss and head loss! Under development for several years, the technology exploits the biofilm protection provided by our Enhanced Nitrification (EN) Bead Media. Additionally, the PolyGeyser Bead Filters offer a very high degree of reliability and are virtually resistant to clogging and caking by virtue of the fact that they backwash automatically using no moving parts or electronics.

The PolyGeyser Bead Filter stands apart from AST's other Bead Filter technologies primarily through its automatic pneumatic backwash mechanism. Water is introduced below a bed of packed EN bead media and travels upward through the filtration chamber where mechanical and biological filtration takes place. Simultaneously, air is introduced into the air charge chamber at a constant, predetermined rate to achieve the desired backwash frequency. Once the charge chamber has reached capacity, the pneumatic trigger fires, releasing the entrained air from the charge chamber below the media bed. The sudden release of air from the charge chamber causes the beads to mix, roll and "drop" as the air agitates the beads.

The pneumatic strategy breaks the linkage between backwash frequency and water loss and allows the nitrification capacity of the unit to be fully utilized. The elimination of water loss associated with backwash procedures is also a key element in this new technology. This is particularly advantageous in marine systems where the loss of saltwater is minimized.

Frequent backwash sequences have proven advantageous for optimizing the nitrification capacity of the unit. Numerous gentle scrubbing cycles promote high rates of nitrification by maintaining a healthy thin biofilm on the bead surfaces. Typical backwash cycles occur once every three to six hours.

Biofiltration depends on the attachment and growth of beneficial bacteria to the surface of the bead media. These bacteria extract dissolved chemicals from the water and convert them to particulate biomass or harmless dissolved compounds. Given a proper environment, the bacteria grow in a thin film covering the surface of our media. Each ft3 of our bead media contains approximately 600,000 beads that provide 400 ft2 of surface area for the propagation of bacterial films. There are literally hundreds of different species of bacteria at work in a biofilter. Most of the bacteria are classified as "heterotrophic" species, which actively break down organic materials into carbon dioxide and water. The most critical, however, are broadly described as nitrifying bacteria, consisting primarily of the genera Nitrosomonas and Nitrobacter. These bacteria are responsible for the conversion of the toxic nitrogen forms, ammonia and nitrite, to relatively harmless nitrate. Management of biofiltration is critical in aquatic systems.

Clarification is the process of removing suspended solids from water. Suspended solids in an aquatic system are generally small particles (< 100 microns) of undigested or partially digested food, bacteria, algae, clay, and silt, suspended in the water column. Fine suspended solids tend to reduce the clarity of the water, whereas larger organic particles create a serious waste load problem by consuming tremendous amounts of oxygen, thus adversely affecting the aquatic system's ecology.

Bead Filters remove suspended solids by at least four different mechanisms as water is passed through the packed bed of plastic beads. Particles >100 microns are subjected to **Physical Straining**. For slightly smaller particles (50-100 microns) the most dominant mechanism is **Settling**. Suspended particles (5-50 microns) are removed by **Interception,** a subtle process caused by collisions between the particle and the bead media surface. Finer particles (<20 microns) are removed through **Bioabsorption**, the capture of particles by the bacterial biofilm. Bead filters are excellent clarification units, capable of maintaining display quality water at high waste loading rates. Studies have shown that Bead Filters capture 100% of particles > 50 microns and 48% of particles in the 5-10 micron range per pass.

PolyGeyser Bead Filter Specifications

Model	Media Volume (ft^3)	Surface Area (ft^2)	Max Flow Rate (gpm)	Max Pressure (psi)	Charge Volume (ft^3)	Inlet/ Outlet Ports (inches)	Height/ Diameter (inches)	Recommended UV Sterilizer
DF-3	3	1,200	45	10	4.5	(2)x3/(2)x3	47/33	80-HO
DF-6	6	2,400	90	10	8.2	(2)x4/(2)x4	54/41	120-HO
DF-10	10	4,000	150	10	13.5	4/6	78/48	150-HO
DF-15	15	6,000	225	10	26.3	6/(2)x4	92.5/54	(2)x150-HO
DF-25	25	10,000	375	10	32.5	8/(2)x6	93/66	(2)x450-HO
DF-50	50	20,000	750	10	65	12/(2)x10	94/90	(2)x750-HO

POLYGEYSER BEAD FILTER SIZING CRITERIA

Bead filter sizing criteria are highly dependent on the application in which the filter will be utilized. For assistance in selecting the appropriate Bead Filter for your application you can visit our website at www.BeadFilters.com to download a copy of the Bead Filter Sizing Worksheet or you can use our Electronic Bead Filter Sizing Calculator. Worksheets should be faxed or e-mailed to AST for review and/or sizing recommendations.

Filter Application

Aquaculture

Bioclarification: In applications where bead filters are acting as bioclarifiers providing both solids capture and biological filtration, they are sized according to the maximum amount of feed (35% protein dry pellets) that will be introduced into the system per day. Bead Filter Sizing recommendations are presented in Table 1 for Enhanced Nitrification Bead Media (Figure 1). All PolyGeyser units come standard with EN Media or "shaped beads". PolyGeyser Bead Filters were specifically designed to take advantage of the biofilm protection offered by EN Media. Increased biofilm protection allows us to increase the frequency of the backwash sequences without over abrasion of the biofilm which facilitates a thinner, healthier biofilm allowing more rapid nitrification. By reducing abrasion of the bacterial biofilm during backwashing, the use of EN Media can boost nitrification rates by up to 50% over standard bead media.

Figure 1. Enhanced Nitrification Bead Media

Solids Capture Only: In applications where the PolyGeyser Filter will be used as a clarifier we size the filter according to either the maximum daily feed input or simply choose a filter size with a flow rate compatible with the biological filter. Our estimated size assumes you will backwash the filter at least twice per day. Increased loading can be obtained with increased backwash frequency.

Display

Koi / Display Ponds: In applications where bead filters are installed on Koi Ponds as bioclarifiers, we utilize a hydraulic sizing criteria whereby we like to obtain a 2 hour turnover of the entire pond through the filter. This rate is dictated by the algae reproduction rate, which is estimated to be 4-6 hours and coincides with the recommended pond turnover rate through
a UV Sterilizer required to kill algae faster than it can reproduce.

Displays with "Underwater Viewing": In applications where the display will have "underwater viewing", we also use a hydraulic sizing criteria to estimate the required filter size needed to perform bioclarification. Our experience is that zoos and aquariums demand their systems turnover every 30 minutes. We also recommend the use of a properly sized and installed ozone system on displays with underwater viewing.

Table 1 represents the filtration capacities for PolyGeyser Bead Filters for several applications. The criteria presented already have a substantial safety factor included. The units can be used as a solids capture device, as an aquaculture bioclarifier (providing complete solids capture and nitrification) or in support of display tanks and ponds. The bioclarifier category is divided into three sub-categories reflecting changes in water quality objectives. For aquaculture fingerling/ ornamental growout two separate loading guidelines are provided for warm water and cold water conditions. In both cases, the criteria are designed to ensure that a TAN level below 0.5 mg-N/L can be achieved. These are peak sustainable loading guidelines meaning that a filter can sustain the indicated TAN concentration at the peak loading for an indefinite period. Finally, a set of criteria is provided for broodstock and fry systems that provides very pristine water quality with a maximum TAN below 0.3 mg-N/L. The safety factors on these later criteria are high and no adjustment for cold water is required. Criteria for Koi ponds and display systems are limited by fine solids capture, and not nitrification. Criteria for these applications are expressed by the total volume of the pond or tank. These criteria are set to ensure a high degree of water clarity.

The table assumes that the units are backwashed regularly as demanded by the application. Less frequent washing decreases the peak capacity of these units, whereas, more frequent washing can substantially increase their peak capacities. Pond and display criteria are not subject to peak loading conditions and are not as sensitive to backwash frequency.

POLYGEYSER BEAD FILTER SIZING CRITERIA (Cont.)

Table 1. PolyGeyser Bead Filter Sizing Recommendations. *Assumes PolyGeysers Are Equipped With EN Media.*

Filter Model	DF-3	DF-6	DF-10	DF-15	DF-25	DF-50
Flow Rate (gpm)	45	90	150	225	375	750
Max Loading – Lbs 35% Protein Feed Per Day for Aquaculture Grow-out	4.5	9.0	15.0	22.5	37.5	75.0
Max Loading – Lbs 35% Protein Feed Per Day for Aquaculture Bioclarification Fingerling/Ornamental Grow-out @ >15 deg C	3.0	6.0	10.0	15.0	25.0	50.0
Max Loading – Lbs 35% Protein Feed Per Day for Aquaculture Bioclarification Fingerling/Ornamental Grow-out @ <15 deg C	2.25	4.5	7.5	11.25	18.75	37.5
Max Loading – Lbs 35% Protein Feed Per Day for Aquaculture Bioclarification Broodstock/Fry/Holding/ Conditioning	1.5	3.0	5.0	7.5	12.5	25.0
Max Koi Load (lbs)	45	150	250	375	625	1,250
Outdoor Koi Ponds Size (gallons)	6,000	12,000	20,000	30,000	50,000	100,000
Display w/Under-Water Viewing (gallons)	1,350	2,700	4,500	6,750	11,250	22,500
*Solids Only (*Lbs Feed per Day*)	15	30	50	75	125	250

* Best estimate based on our experience with Propeller and Bubble-Washed Bead Filters, yet to be confirmed. Assumes backwash frequency of 2-3 hours.

AST "POLYGEYSER" BEAD FILTER PUMP CONFIGURATION

- Water enters through the Filter Inlets (A) and Diffuser (B) continuously.
- Simultaneously, air is injected into Charge Chamber (C).
- Water passes through Bead Bed (D) for bioclarification and exists exits through Screen (E).
- Filtered water is returned through Outlet Pipe (F).
- The Pneumatic Trigger (G) fires once the Charge Chamber has reached capacity, effecting backwash as entrained air is released under the Bead Bed. Note during backwash air and water inputs are not interrupted.
- The Bead Bed rolls and "Drops" down the cone (H) as the air agitates the beads. Backwash waters flow into the air charge chamber.
- As water refills the top chamber, the beads float upwards, reforming the filtration bed.
- The solids in the backwash waters settle into the Sludge Chambers (I), while the supernatant is passed through the bead bed again as the air chamber is re-charged with air.
- Sludge is drained periodically (every 2-3 days) through the Sludge Drain (J).

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