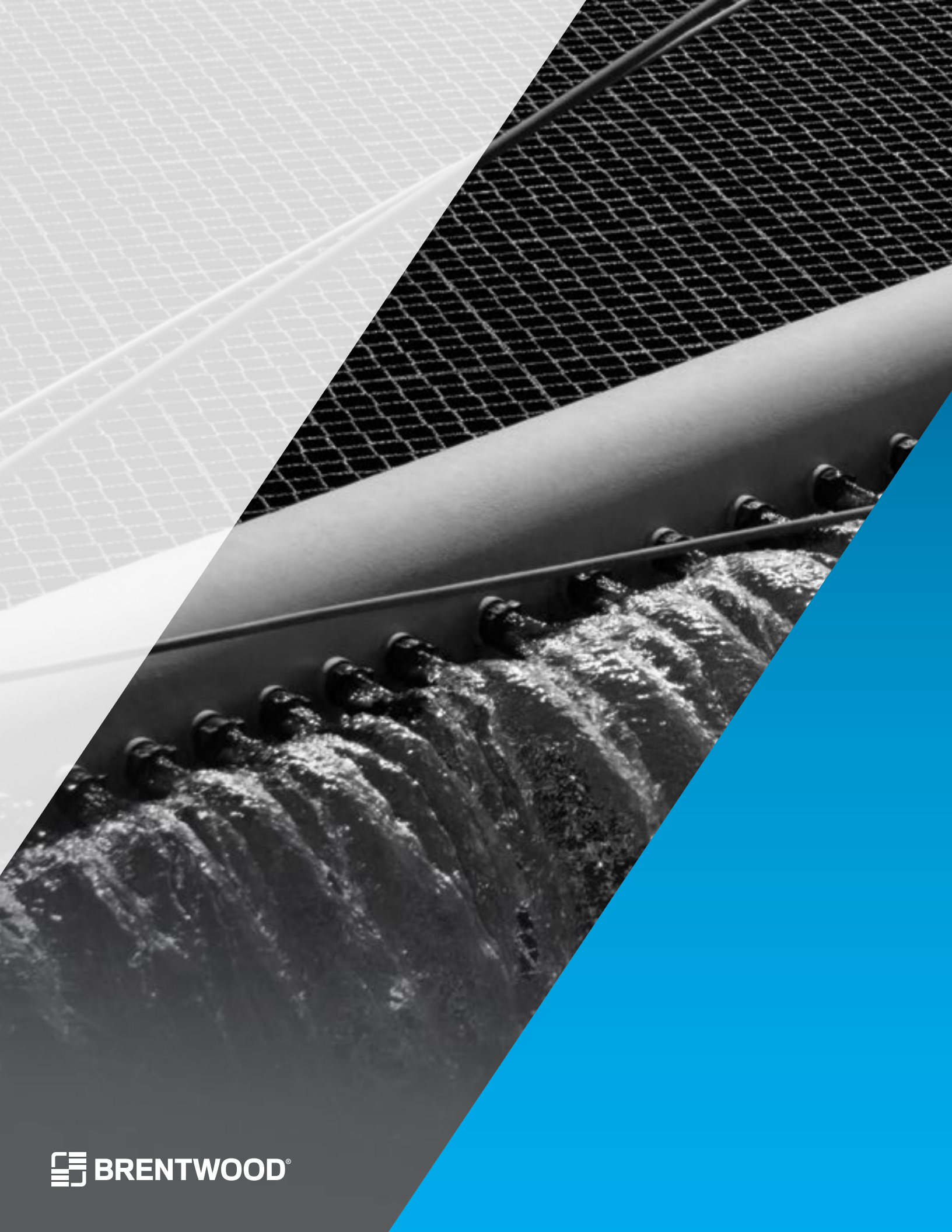




BIOLOGICAL TREATMENT

ATTACHED GROWTH PROCESSES





Innovative Wastewater Technologies

Most municipal and industrial wastewater plants rely on biological processes to improve treatment capacity, simplify operations, and remain compliant with stringent limits. Fixed-film systems offer solutions to those challenges by using structured-sheet media modules to deliver efficient and stable treatment, provide maximum energy efficiency, handle varying influent flows, and minimize the risk of upsets.

Brentwood has the ability to provide you with products and solutions that offer safe and effective biological treatment, while also addressing your most complex environmental, cost, and treatment concerns. Our media modules are engineered and manufactured to provide optimal treatment efficiency and an ideal environment for biofilm growth. Brentwood's innovative design, manufacturing standards, and product testing yield field-proven systems of the highest quality, recognized worldwide for superior performance and long-lasting service.

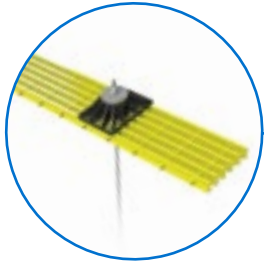
We know biofilm.

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AccuFAS[®] Submerged Fixed Film

The AccuFAS system incorporates structured-sheet media as a fixed-film surface to foster biomass growth, and in turn, enhance treatment and increase capacity. Brentwood's process engineers evaluate the site-specific needs of each treatment plant and utilize the flexible treatment capabilities of the AccuFAS system to provide low-cost, no-risk solutions for biological treatment.

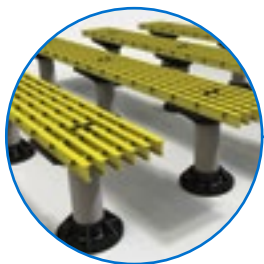
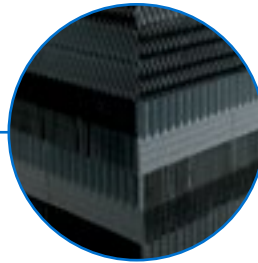


INTEGRATED RESTRAINTS

Designed to keep submerged film media in place during operation, restraints are engineered to integrate with AccuPier support components.

DISTRIBUTION & VERTICAL FLOW MEDIA

Distribution media minimizes aeration necking and provides even distribution of both liquid and air flow, while vertical flow media recirculates liquid by airlift pumping. When combined, the media evenly distributes liquid and air for continuous mixing and scouring of biofilm.



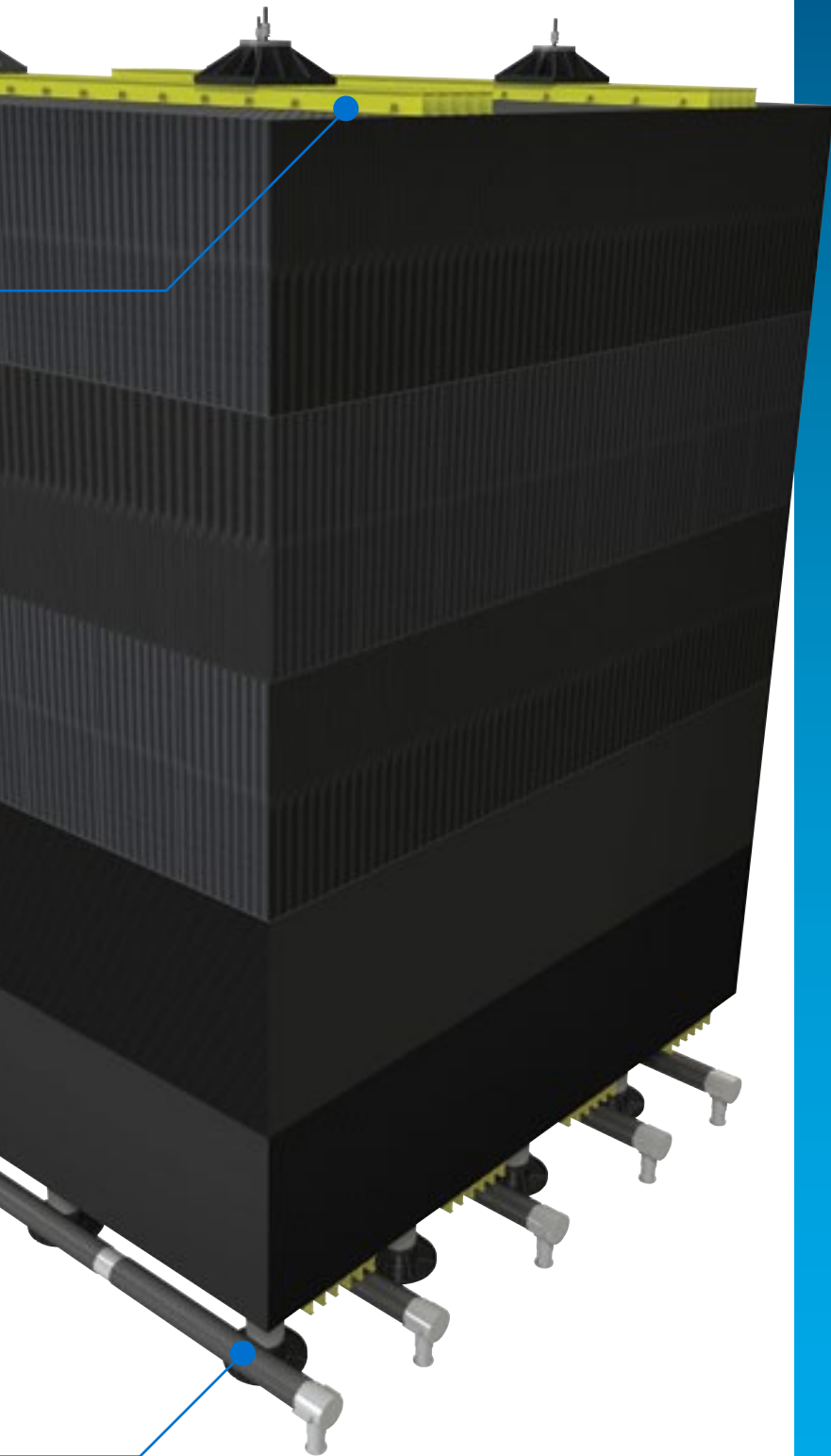
ACCUPIER[®] SUPPORT SYSTEM

A pre-engineered support system for structured-sheet media, AccuPier is a lightweight and robust system that includes field-adjustable bases and cut-to-length stanchions to allow for installation in a variety of tank configurations.

ENGINEERED AERATION

The easily maintained aeration system uses cost-effective diffusers mounted under the media towers to provide a high level of oxygen transfer efficiency and to circulate the wastewater by airlift pumping.





How It Works

A submerged fixed-film system increases treatment capacity and efficiency by adding to the biomass inventory of the system as bacteria grow on the surface of the media.

The unique design of Brentwood's AccuFAS system combines aeration, proprietary distribution media, and vertical flow media to create an airlift pumping mechanism that not only provides sufficient substrate and oxygen to the bacteria in the biofilm, but also maintains thin film thicknesses. The continuous scouring provided by the airlift pumping prevents overgrowth of bacteria in the biofilm and maximizes contaminant removal by maintaining a highly effective biofilm.

The AccuFAS system is simple and reliable because it eliminates the need for the moving parts and screens required in other submerged systems to retain media. Because the media is stationary, the system does not require extra energy for mixing or floating, which translates to significant operational energy savings. Depending on the treatment goals and specific design requirements, the AccuFAS system can be incorporated in various treatment processes, including secondary treatment, biological nutrient removal, and lagoons.



AccuFAS[®] Applications

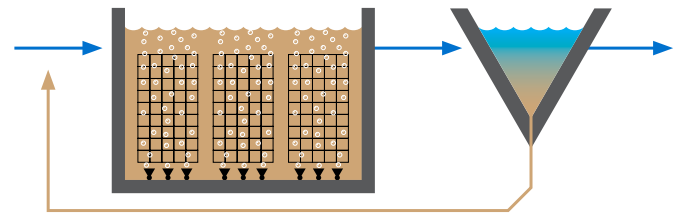
Brentwood's AccuFAS Submerged Fixed-Film system offers a flexible solution for municipal and industrial wastewater treatment plants to achieve their site-specific treatment objectives: BOD reduction, nitrification, and total nitrogen (TN) removal. Our engineers can custom design submerged fixed-film solutions for every application. AccuFAS is configured as either an Integrated Fixed-film Activated Sludge (IFAS) or Fixed-bed Bioreactor (FBBR) system. Typical applications include:

Enhanced Nitrification Capability

Achieve full nitrification in an activated sludge basin (<1 mg/L). The plant hydraulic profile remains and operations are not changed.

Upgrade to TN Removal

Activated sludge plants can be converted to MLE processes using the existing aeration basins by adding AccuFAS and internal recycle. This modification is normally possible within the existing hydraulic profile.



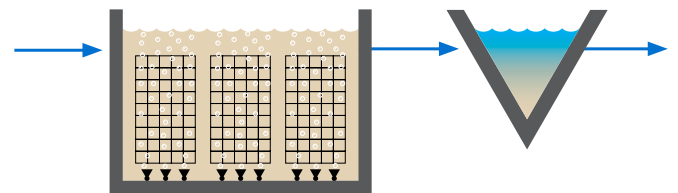
AccuFAS IFAS

Industrial Wastewater Treatment

Pretreat industrial waste to domestic sewage levels, eliminating surcharges or for direct discharge. Uses either an FBFR or IFAS configuration.

Post-Lagoon Polishing

Upgrade lagoons to meet seasonal nitrification limits. Configured as an FBFR, minimal additional operator attention is required.



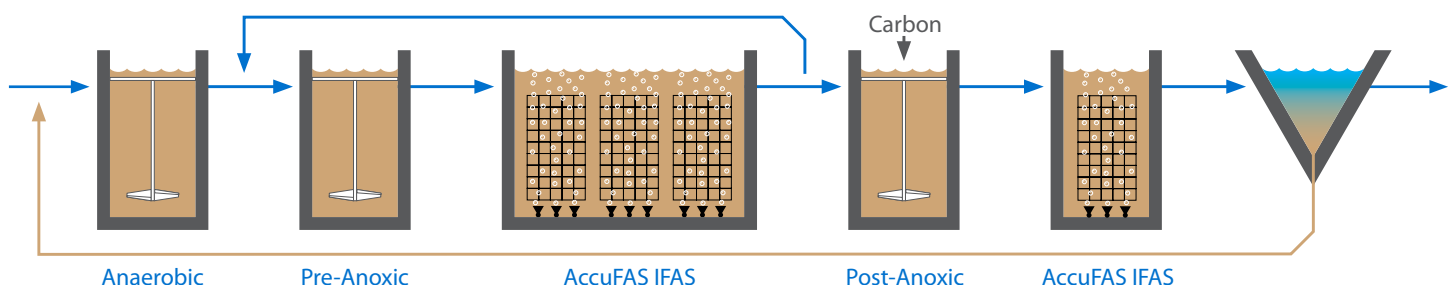
AccuFAS FBFR

Upgrade Lagoons

Remove BOD and denitrify with a pre-anoxic-zone reactor and FBFR. The lagoon is used as a settling basin and for sludge storage. The simple system only requires a pump and blower.

Flexible Integration

AccuFas can be applied as part of complex processes such as enhanced nutrient removal (ENR).



Coldwater, MI, Case Study

In August of 2007, the Michigan Department of Environmental Quality issued seasonal ammonia discharge limits for the Coldwater Wastewater Treatment Plant (WWTP), which included a daily maximum ammonia concentration of 2.0 mg/L between the months of May and November. The WWTP began to routinely exceed the new limits in the spring and summer of 2008, and as a result, the Coldwater Board of Public Utilities (CBPU) hired an engineering firm—Fishbeck, Thompson, Carr & Huber (FTC&H)—to investigate possible upgrades to the facility that would ensure compliance.

However, the existing upstream trickling filters could not be easily enlarged, and expansion of existing aeration basins or addition of new tanks would have been costly due to high groundwater levels and other constraints.

The engineered solution was to provide a system that would integrate fixed film with the existing activated sludge basin footprint, creating an integrated fixed-film activated sludge (IFAS) process. An IFAS system provides the best of both worlds: it combines the energy efficiency and stability of fixed film with the improved

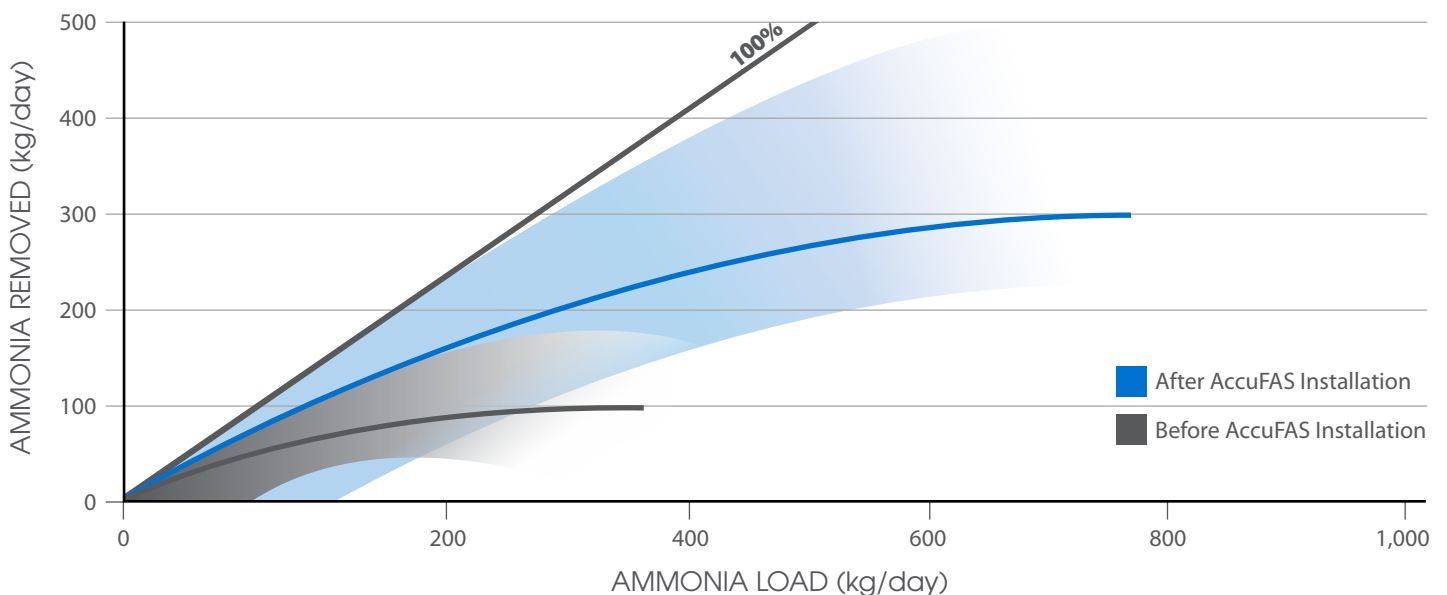
settling characteristics and superior effluent quality of activated sludge. FTC&H and CBPU selected the Brentwood AccuFAS system as the lowest capital and operational cost IFAS solution available on the market.

Installation began in the first of two parallel aeration tanks in March of 2010, with both tanks being fully operational and providing effluent within permit by June 2010. The actual installation of pier supports, diffusers, media, and restraints was performed by a small crew and was completed within just a few weeks. The resulting Brentwood AccuFAS installation was the first structured-sheet media system installed in the state of Michigan and one of the largest in the world.

Shortly after startup, the Coldwater WWTP began to receive shock loading of industrial discharge, which often sent the daily ammonia influent above 40 mg/L—and yet the plant continued to provide effluent within permit. Performance of the plant before and after the AccuFAS upgrade indicates that the AccuFAS system doubled the ammonia removal capacity of the facility (see below).

Performance

Results show that ammonia removal capacity doubled after the AccuFAS upgrade.



Engineered for Performance

Brentwood's structured-sheet media modules begin with thermoformed PVC sheets, which are solvent bonded using our dedicated glue joints to create rigid, self-supporting media modules. These bonding points ensure accurate assembly for maximum module strength.

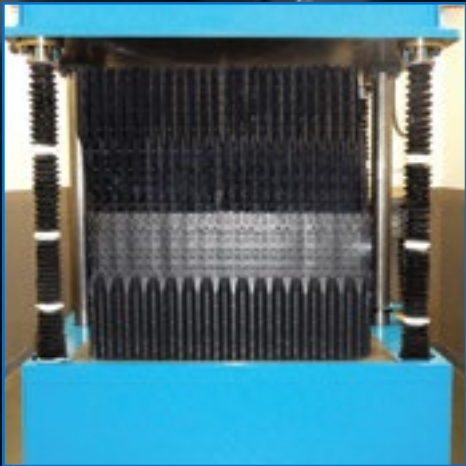
Our manufacturing facilities produce modules that span a wide range of specific surface areas, flute openings, and flow configurations:

- Surface areas range from 30 to 96 ft²/ft³ (98 to 315 m²/m³).

- Flute openings range from 12 to 50 mm.

- Media types include cross flow, vertical flow, and distribution media.

Brentwood's process engineers capitalize on experience with numerous treatment processes to provide the best structured-sheet module for your application.



Confidence in Strength

Brentwood performs compression testing to ensure the structural integrity of all media types. The industry-standard test procedure uses four modules in two layers placed at right angles to each other in a hydraulic test apparatus. The module deflection is measured as a function of the load applied and should not exceed 1 percent at the design load. Brentwood supplies media to the stringent 1 percent deflection criterion, which has allowed us to maintain a record of zero failures throughout our 25-year history.

Trickling Filter

A time-tested technology, trickling filters offer a simple, cost-effective, energy-efficient treatment solution. With more than 500 trickling filter installations worldwide, Brentwood's media and components have been optimized to guarantee the best performance for any application. By optimizing surface area in a given volume while maintaining the structural integrity required for deep towers, Brentwood's structured-sheet media provides an ideal environment for microorganism growth.

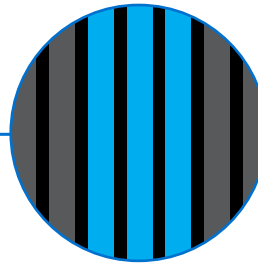


CROSS FLOW MEDIA

By combining high surface area with a maximum number of mixing points per unit volume of media, cross flow media facilitates superior process performance across a wide range of hydraulic wetting rates. The cross-corrugated modules provide continuous and uniform horizontal distribution of both air and water throughout the full media depth.

VERTICAL FLOW MEDIA

Media is also available in vertical flow configurations, which can be combined with cross flow media for superior solids flushing. Vertical flow media allows a thinner biofilm to be retained and minimizes biomass accumulation.



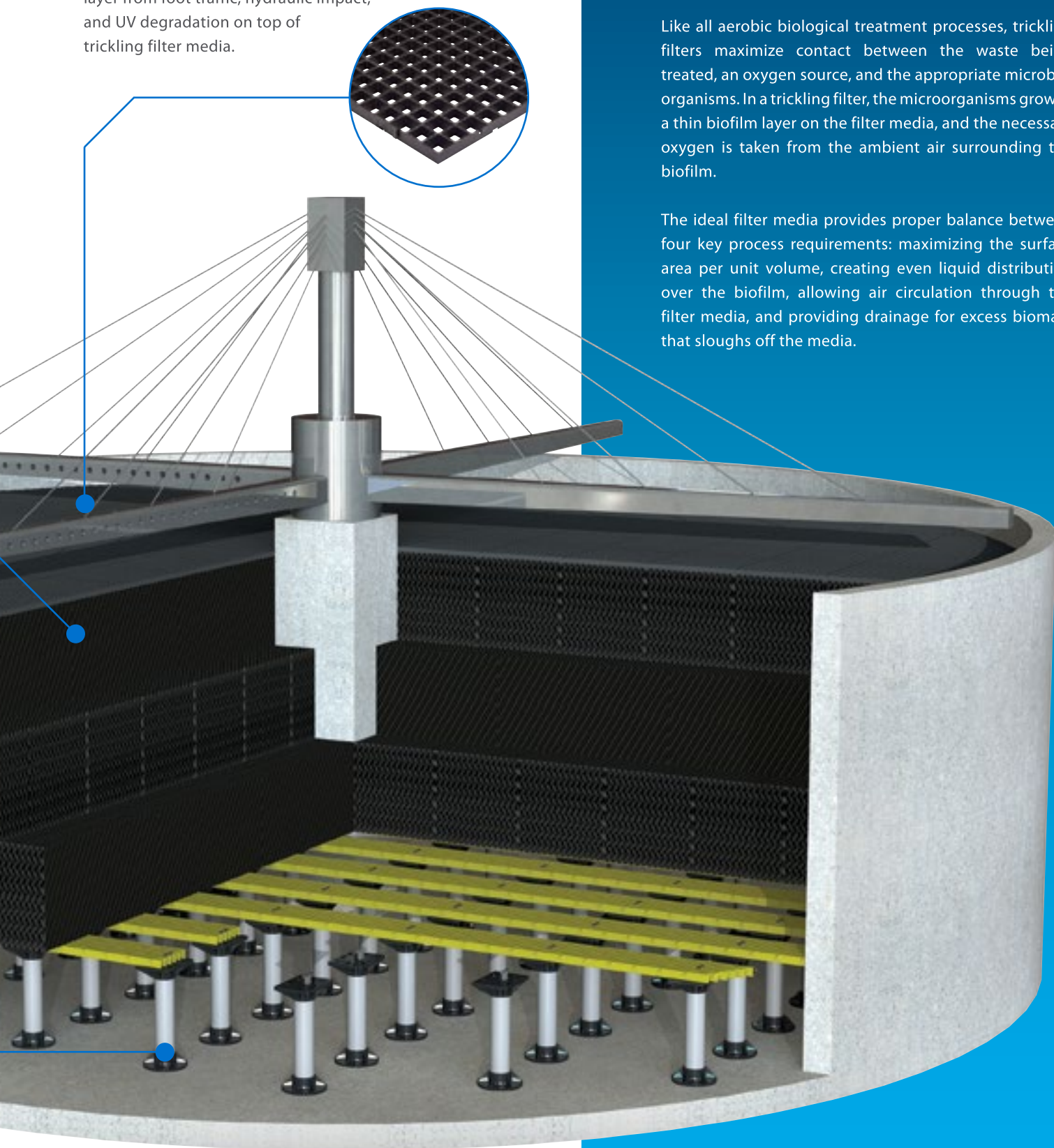
ACCUPIER® SUPPORT SYSTEM

Fixed-film media is elevated above the concrete tower floors with a corrosion-resistant support system that can be customized for any application and engineered to maximize ventilation and drainage.



ACCUGRID® BIO-GRATING

Interlocking panels provide a protective layer from foot traffic, hydraulic impact, and UV degradation on top of trickling filter media.



How It Works

Like all aerobic biological treatment processes, trickling filters maximize contact between the waste being treated, an oxygen source, and the appropriate microbial organisms. In a trickling filter, the microorganisms grow in a thin biofilm layer on the filter media, and the necessary oxygen is taken from the ambient air surrounding the biofilm.

The ideal filter media provides proper balance between four key process requirements: maximizing the surface area per unit volume, creating even liquid distribution over the biofilm, allowing air circulation through the filter media, and providing drainage for excess biomass that sloughs off the media.

Trickling Filter Applications

Trickling filters offer application flexibility based on media selection. Brentwood offers a variety of structured-sheet, plastic media configurations with differing flow patterns and surface areas to meet site-specific treatment objectives: BOD roughing, BOD removal, nitrification, and combined BOD removal and nitrification.

TRICKLING FILTER CLASSIFICATION	WASTEWATER STRENGTH	EFFLUENT QUALITY	MEDIA USED
BOD ROUGHING	High	40-80% BOD Conversion	Vertical Flow or Mixed Media
BOD REMOVAL	Medium	15-30 mg/L	Cross Flow Media with Large Flutes
BOD & NITRIFICATION	Low	BOD < 10mg/L NH ₃ -N < 3mg/L	Cross Flow Media with Medium Flutes
NITRIFICATION	Extra Low	0.5-3mg/L NH ₃ -N	Cross Flow Media with Small or Medium Flutes

ANAEROBIC FILTERS

Submerged anaerobic filters using structured-sheet media are ideal for treating high-strength, carbonaceous waste and typically operate in an up-flow configuration with a sludge blanket below the media in the tank. Advantageous features and benefits include:

Low energy use

Methane gas is typically produced in excess of the energy required to operate the system.

Small reactor surface area

Anaerobic systems yield a significantly smaller footprint than aerobic treatment processes.

Simple maintenance

All moving equipment required can be located adjacent to the process tank. No submerged mechanical equipment is required.

Minimal odor potential

The sealed reactor significantly reduces any noxious odors typically associated with high-strength waste.

Stockton, CA, Case Study

The City of Stockton, California, needed to upgrade its 55-MGD wastewater treatment plant (WWTP) to meet National Pollutant Discharge Elimination System (NPDES) regulations for tertiary treatment. The goal of this upgrade was to select a reliable, yet economical, technology that would achieve tertiary nitrification, especially during the winter months.

After a comprehensive evaluation, nitrifying trickling filters were selected based on low energy consumption, process stability, and operational simplicity. Brentwood's high-density, structured-sheet media proved to be a cost-effective solution for achieving optimal nitrification. The chosen media modules yield a 40 percent higher specific surface area than that of traditional media used in nitrification applications and allowed for maximum treatment capacity within the smallest footprint.

Additionally, because of the WWTP's California location, seismic hazards needed to be taken into consideration. The project engineers directed the

WWTP to select media based on compression test deflection in order to protect against catastrophic structural failures. Brentwood's media modules, which are built to a tight deflection standard of 1 percent, were combined with the AccuPier media support system to meet strength requirements.

In 2006, two nitrifying towers, each with a diameter of 166 feet and a media depth of 22 feet, were constructed. The towers began receiving effluent from oxidation ponds and engineered wetlands, which were designed to decrease solids loading and maintain stable ammonia loading. From there, effluent was discharged to a dissolved air flotation (DAF) tank and tertiary filter for polishing.

The resulting Brentwood trickling filter installation allowed the Stockton WWTP to maintain an ammonia removal rate consistently in excess of 94 percent, easily meeting the required ammonia discharge permit of 2 mg/L.



Brentwood Capabilities

At Brentwood, it's our job to make sure that you get maximum treatment performance out of the biological treatment systems we supply. We emphasize customer service and support by partnering with you to extend the process beyond physical equipment supply and by utilizing a custom approach to carefully assess each project. With a comprehensive knowledge of the wastewater treatment process and an in-depth understanding of diverse applications, Brentwood's process engineers are capable of evaluating your plant's current process, permit requirements, and site-specific goals to provide optimal treatment at the lowest capital and operational costs.

Process Design Assistance

Brentwood can provide complete process modeling assistance for trickling filter and AccuFAS submerged media systems. Brentwood's proprietary trickling filter models have been developed based on industry-standard methodologies and carefully calibrated for each type of structured-sheet media. Our process assistance has supported hundreds of successful trickling filter installations worldwide.

For AccuFAS system design, Brentwood combines two modeling methods to accommodate site-specific applications. Our kinetic design models have been developed based on extensive pilot studies and full-scale installations, which accurately predict treatment performance. Our commercial BioWin™ models are constructed based on IWA ASM models and incorporate a sophisticated biofilm module for IFAS. These models have also been calibrated specifically for Brentwood's submerged media systems.

Installation Support

Brentwood's systems and components are engineered not only for performance, but for ease of installation. With a dedicated team of site technicians who have assisted in over 500 installations, you can be assured not only that the system will run properly, but that your employees will be educated and prepared to operate the system. Additionally, Brentwood's process team is available for consultation throughout the lifetime of the trickling filter or AccuFAS system to provide maintenance advice and to ensure continued performance results.

Piloting

Our experienced engineers can develop pilot protocols, size the pilot equipment, and analyze performance data to help our clients optimize system design. Brentwood can supply either skid-mounted pilot units to your site, or we can send our mobile testing lab—equipped with advanced instrumentation and PLC control—to run full, sidestream pilot tests.



Process Guarantee

At Brentwood, we are dedicated to quality and committed to your facility's success from initial system design through manufacturing and installation support. This approach allows us to utilize our team's collective experience to help you choose the best system for your needs and ensure that your site-specific goals are met upon project completion. By maintaining a high level of involvement and supplying reliable products, we are able to guarantee our process.



Clarification

Whether a plant wants to increase capacity, meet lower effluent limits, or reduce operating costs, Brentwood can provide solutions for efficient water clarification, including Polychem® chain & flight systems, SedVac™ sediment dredge, tube settlers, and scum removers.



Stormwater Management

Brentwood's StormTank® modules, devices, and accessories have been designed to provide strong, affordable stormwater management solutions. By allowing for pretreatment and offering an underground storage option, this product line helps protect the environment and create developable space.



Cooling Tower

With years of experience and extensive knowledge of the cooling process and droplet separation, Brentwood designs and manufactures cost-effective cooling tower products that optimize cooling, reduce drift and windage loss, and improve tower performance.



About Brentwood

Brentwood is a global manufacturer of custom and proprietary products and systems for the construction, consumer, medical, power, transportation, and water industries. A focus on plastics innovation, coupled with diverse production capabilities and engineering expertise, has allowed Brentwood to build a strong reputation for thermoplastic molding and solutions development.

Brentwood's product and service offerings continue to grow with an ever-increasing manufacturing presence. By emphasizing customer service and working closely with clients throughout the design, engineering, and manufacturing phases of each project, Brentwood develops forward-thinking strategies to create targeted, tailored solutions.





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