EXPANDING TREATMENT CAPACITY

Retrofitting IFAS systems in existing activated sludge plants

By Glenn Thesing

ARTICLE SUMMARY

Challenge: Wastewater treatment plants must contemplate their plans of action as they approach their maximum capacities or face tightening effluent restrictions.

Solution: Many municipalities and authorities have found retrofitting IFAS technology to be an effective alternative to demolition and new construction.

Conclusion: IFAS technology requires a comprehensive evaluation of many factors, but its ultimate benefits include minimized capital expenditures, small footprint and the advantages of activated sludge and other biofilm systems without the limitations.

As many wastewater treatment plants approach their maximum capacities or face stricter effluent limits, communities are weighing different options. Space limitations often constrain the available choices for expansion, and many activated sludge plants are incapable of meeting more stringent effluent requirements with their existing configurations.

Upgrading treatment capabilities and expanding capacities without the expense and complication of demolition and new construction is desirable wherever possible. Over the past decade, a growing number of communities have found that retrofitting integrated fixed-film active sludge (IFAS) technology can be an effective alternative for expanding treatment capacity. For site-constrained facilities or those wanting to reuse existing tanks, retrofitting IFAS technology can represent an especially attractive option.

The IFAS process combines both fixed-film and suspended growth (activated sludge) processes. Combining activated sludge and fixed-film media in the same reactor, along with proper aeration, provides control over solids retention time and the ability to manipulate the bacterial environment to facilitate various aspects of wastewater treatment.

Understanding IFAS

For municipalities and regional authorities making critical decisions regarding plant expansions and treatment upgrades, it is important to understand the capabilities and limitations of retrofitting IFAS systems as well as the specialized approach to an IFAS retrofit project.

In the AnoxKaldnes (AK) Hybrid Biofilm Activated Sludge (HYBAS) system, an IFAS process from Kruger, mixed liquor suspended solids (MLSS) continue to perform their job in activated sludge tanks, but the process is significantly augmented by the addition of moving plastic carrier elements. Biofilm grows on the media, which is retained in the reactor using media retention screens, and an aeration system provides oxygen to allow the bacteria/biofilm to provide the treatment required.

The free-moving plastic carriers in the tank provide an ideal environment for bacteria growth, with aeration providing the necessary oxygen for microbial growth and sufficient agitation to disperse the plastic carriers and wastewater fully throughout the tank. The agitation also serves to control the biofilm thickness on the plastic media.

Each tank is considered a continuous stirred tank reactor, so in order to achieve low outlet concentrations or differentiate between process conditions (e.g., biochemical oxygen demand, nitrification, denitrification), a number of reactors in series often are included in a design. Anaerobic selectors, pre-anoxic mixed liquor zones and post-anoxic mixed liquor zones can be designed into biological nutrient removal processes that include an aerated IFAS zone for enhanced nitrification.

By adding the media to a plant's aeration tanks, capacity is expanded and nitrification is achieved with less tank volume than would be required for a comparable activated sludge nitrification process. The fixed-film media provides substantial surface area for the growth of nitrifying bacteria without bringing about excessive solids loadings in the final clarifiers. In addition, plants retrofitted with this IFAS process often can increase treatment capacity significantly.

Retrofit Considerations

A number of factors must be considered and assessed before a decision is made to retrofit IFAS, including:

- Effluent requirements;
- Existing tank volume;
- Existing tank age and condition;
- Existing tank geometry;
- Existing secondary clarification capacity/performance;
- Headworks screening; and
- Plant hydraulic profile.

Where plants are striving to meet new total nitrogen removal limits, retrofitting a HYBAS system is highly effective if sufficient existing tank volume is available. Ideally, the process can be implemented in a plant's existing tanks with no need for additional tankage. In cases where the demand for increased capacity will overtax the system, new tankage may be required, although retrofitting the process minimizes the number and/or size of new tanks that must be installed, reducing capital costs compared to conventional systems and making efficient use of limited space for expansion.

Media of different shapes and sizes provide flexibility to use the most suitable type, depending on wastewater characteristics, discharge standards and available volumes. The effective surface area of AK K5 biomedia for biomass growth, for example, is 800 sq meters/cu meters (244 sq ft/cu ft) and is used in reactors at fill rates of up to 60%, giving a biofilm surface area of approximately 146 sq ft/cu ft of tank volume (480 sq meters/cu meters) of reactor. AK Biofilm Chip-M media provides an effective surface area for biomass growth of 366 sq ft/cu ft in bulk (1,200 sq meters/cu meters), making it an effective choice for highly constrained retrofit sites.

Tank Age & Geometry

When considering retrofitting an IFAS system, the age and usage history of the existing tanks must be factored into the IFAS design. It is advisable for plants to consult with a structures or materials group to ensure the integrity of the tanks. The surface of concrete walls should not be rough from exposed aggregate or other sharp, angular protrusions.

The geometry of the plant's existing tanks also plays a significant role in retrofit design. Square and wide tanks are the simplest to work with, but long, narrow tanks can be made suitable given the proper design. Round tanks also require a careful design approach because the IFAS system typically has three to five different zones divided by partition walls.

Regardless of their geometry, ideal depths for tanks are between 16 and 24 ft, which maximizes oxygen transfer efficiency while making choice of blower simple. Aeration is by a medium-bubble system that typically uses 4-mm holes in 1- to 2-in.-diameter lateral pipes.

A cutaway illustration of a HYBAS system reactor tank.

Biofilm carrier elements form the basis of the IFAS process.

HYBAS system retrofitted into a circular basin at Dry Creek Wastewater Treatment Plant in Cheyenne, Wyo.

Secondary Clarification

Although the fixed-film media provides substantial surface area for the growth of nitrifying bacteria without increasing mixed liquor loadings on the final clarifiers, in some cases there is need for additional clarifier capacity. These include cases where IFAS permits an increase in hydraulic capacity and where a higher mixed liquor concentration is required to achieve stricter treatment goals.

Where new discharge requirements are adding strict total nitrogen limits, another factor is overall clarifier performance. The clarifiers must be able to deliver a high-quality effluent in terms of suspended solids removal.

Headworks Screening & Head Loss

Headworks screening is another important factor in project design. A 3-mm headworks screen is recommended if there are no primary clarifiers upstream of the IFAS zone, and 6-mm screens are adequate if primary clarification is in place.

Sieves, or media retention screens, in the IFAS zone effluent wall are used to retain the media. In the IFAS application, the movement of the media in the reactor and the agitation by air bubbles from the aeration diffusers keep the sieves from fouling with biological growth or other debris.

Some head loss can be expected with retrofitting a HYBAS system. Typically, plants that are retrofitted have no more than two IFAS zones, and sometimes only one. Each zone adds 2 to 4 in. of head loss, so two IFAS zones will contribute an additional 4 to 8 in. of head loss to the overall system. A plant that cannot tolerate much head loss in its existing hydraulic profile may need additional sieves. Sieves are designed to handle peak instantaneous flows, including recycled activated sludge and internal nitrate recycle streams, if present.

Scum & Foam Control

Foam and scum generation is an activated sludge issue, not an IFAS media issue. However, in a conventional system there typically are no submerged sieves covering the ports from one tank to another. Most of the flow exits an IFAS tank below the water surface. If the system is prone to produce or accumulate scum or foam, it can float on the surface of the IFAS tank and accumulate. IFAS zones, therefore, are designed with screened ports at the top of the downstream walls, allowing foam to pass from one tank to the other.

Retrofitting Into a Circular Basin

At the Dry Creek Wastewater Treatment Plant in Cheyenne, Wyo., a HYBAS system has been retrofitted into a circular basin. The design concept was to incorporate two process trains with an anoxic zone for pre-denitrification followed by two HYBAS aerobic reactors in series. The system was based on data generated from a pilot study conducted on site.

An existing circular basin was converted into two reactors in series and retrofitted with IFAS media. The second train was a new construction and uses the two-stage IFAS concept in rectangular basins. Effluent from the reactors is either recycled to the anoxic reactors to allow some pre-denitrification to occur, or it flows into the final clarifiers to settle the MLSS. The improvements to the Dry Creek facility have boosted its capacity to 8 mgd and 10.5 mgd.

IFAS Retrofit: A Recap

The technology provides the advantages of both activated sludge and other biofilm systems without being constrained by their limitations. In addition to often minimizing capital expenditures, IFAS advantages include a small footprint; familiarity for operation of activated sludge plants; reliable nitrification in cold temperatures; adaptability to various tank configurations; and, perhaps most importantly, the ability to handle significant changes in flow and loading without sacrificing effluent quality. WWD

Glenn Thesing is product manager of AnoxKaldnes IFAS Systems for Kruger Inc., a Veolia Water Solutions & Technologies Co. Thesing can be reached at glenn.thesing@veoliawater.com or 919.677.8310.

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