

Fixing the Biofilm – An Alternative Approach to Address Operational and Maintenance Issues

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The City of Peterborough Wastewater Treatment Plant (WWTP) is located in Southern Ontario and has a rated capacity of 68,200 m³/day. Preliminary and primary treatment at the WWTP consists of mechanical screening, aerated grit tanks and primary clarifiers. Secondary treatment is provided by four trains of aeration tanks and their associated final clarifiers. The aeration tanks and final clarifiers are split into Plant 1 and Plant 2, each of which has two trains (Plant 1 includes trains 1 and 2, Plant 2 includes trains 3 and 4). Effluent is disinfected via a UV system prior to being discharged to the Otonabee River.

The four aeration tanks, originally designed as conventional tanks with suspended growth, were converted to Integrated Fixed Film Activated Sludge (IFAS) systems in 2006 (Plant 1) and 2011 (Plant 2). An IFAS system is generally comprised of media placed inside aeration tanks, which increase the amount of available biomass inventory within the bioreactors, thus allowing operation at a higher solids retention time (SRT) for nitrification within the existing footprint. The IFAS system takes a hybrid nitrification approach, combining a traditional mixed liquor suspended solids (MLSS) process with additional biofilm attached to media. The additional biomass for treatment is retained in the aeration tanks, thereby not posing additional solids loading to the downstream secondary clarifiers. IFAS is attractive for retrofit applications as it allows a plant to meet more stringent effluent criteria and/or increased capacity with existing tankage.

The retrofits saw the addition of loose media IFAS, which consisted of non-engineered plastic packing material, contained within metal cages. The system included approximately 190 m³ of loose media placed in a single cage in the first pass of the four aeration tanks.

The media was initially installed as a pilot study to examine the validity of the technology and determine the increase in biological treatment capacity. The IFAS system was evaluated with a process audit that confirmed improved nitrification and resulted in the WWTP's capacity being re-rated to 68,200 m³/day from a previous capacity of 60,000 m³/day (14% increase). A photograph of the former IFAS system is shown in Figure 1.

The IFAS system was operated over a period of approximately 15 years. During this time, it provided additional treatment capacity while meeting the effluent criteria for a higher capacity. Given the unique configuration of the system comprising loose media in fixed cages, the system had several operational challenges summarized below:

- **Containment:** During high flow events and through deterioration of the cages, the plant had experienced loss of media from the aeration

tanks which was able to pass through the plant and into the Otonabee River.

- **Non-Uniform Dispersion:** Media was unevenly dispersed across the containment cages, resulting in a “crunch” of media at the downstream end of the cages. During high flow events this problem was exacerbated.
- **Interrupted Flow:** Growth of film on the mesh located around the cages impeded flow and resulted in higher hydraulic head loss through the secondary treatment process. The mesh and film also caused difficult cleaning when aeration tanks were drained and brought offline.
- **Diffuser Maintenance:** The cages, placed about 1 meter above the fine bubble diffuser system located on the tank floors, resulted in difficulty maintaining the diffusers.

The City of Peterborough retained R.V. Anderson Associates Limited (RVA) to develop an alternate approach



Figure 1 – Previous IFAS system with media and cage.

for the existing IFAS system that would address the operational/maintenance problems. Various alternatives for media replacement and/or upgrades were evaluated per Table 1.

The options were evaluated in terms of retrofit requirements, operation and maintenance (O&M) requirements, operational flexibility, available process guarantees, life cycle costs, environmental compliance approval

(ECA) validation requirements, system familiarity and supplier installation references. Based on the evaluation, it was decided to remove the existing IFAS system and install a new fixed media IFAS system as an alternate system. Fixed media IFAS was chosen for the following reasons:

- Simple retrofit that will be fully compatible with the existing tanks and aeration system, thereby allowing easy installation and commissioning.
- Fixed media will eliminate problems of cage deterioration, media loss, operational/maintenance problems, screen plugging and hydraulic issues.
- Being located on medium sized frames that are above the fine bubble diffusers, the fixed media will allow access to the diffuser system for O&M activities.
- A low life-cycle cost will be achieved by reduced O&M costs from the elimination of media screens and media washout/replacement problems.

The selected fixed media IFAS system for the Peterborough WWTP was the WavTex™ woven media system by Entex Technologies Inc. (Entex). The system utilizes media sheets that are held by 304L stainless steel support frames. The stainless-steel frames also contain integral coarse bubble aeration piping to provide biomass scouring. The media sheets are tethered to the top of the support structure and are buoyant. They consist of two exterior protective sheets with 1 cm openings and interconnecting fibers to promote the growth of biofilm. A photograph of the new IFAS modules is shown in Figure 2.

To meet the WWTP’s Total Ammonia Nitrogen (TAN) effluent objectives of 2.98 mg/L (Summer) and 5.0 mg/L (Winter), eight IFAS modules were installed in each aeration tank for a total of 32 modules at the WWTP. Four modules were installed in the first pass of each aeration tank with the remaining four installed in the last pass. In the future, additional fixed media IFAS units can be considered to increase the biological systems capacity and treatment efficiency. A photograph of IFAS media in a filled aeration tank during a brief aeration shutdown is shown in Figure 3.

Table 1

Alternative	Description
Enclosed cage media IFAS using existing media	Utilize the existing non-engineered media and install multiple smaller cages at various locations throughout the aeration tanks. Install coarse-bubble-scour piping at the cage locations to increase mixing efficiency.
Enclosed cage media IFAS using new media	Replace the existing non-engineered media with engineered media. Install multiple smaller cages at various locations throughout the aeration tanks with the new media. Install coarse-bubble-scour piping at the cage locations to increase mixing efficiency.
Fixed media IFAS	Install pre-framed free-standing IFAS modules with fixed media. The modules to be located at various locations in the tanks for optimal process efficiency. The IFAS frames will come with integrated coarse bubble aeration grids for additional air scouring.
Moving Bed Biofilm Reactor (MBBR) IFAS System	Install suspended/moving media uniformly distributed throughout the entire aeration tank volume. The existing fine-bubble diffuser grid would have to be replaced with a coarse bubble system to keep the media in suspension.
Membrane Aeration Biofilm Reactor (MABR)	MABR is a new technology that uses hollow core membranes as the attached media, while also using membranes for inside-out air diffusion to the attached biofilm. Due to the very low-pressure requirement for air-diffusion through the membranes, and non-reliance on fine bubbles for air transfer, the biological aeration energy requirements for system biology could be reduced.

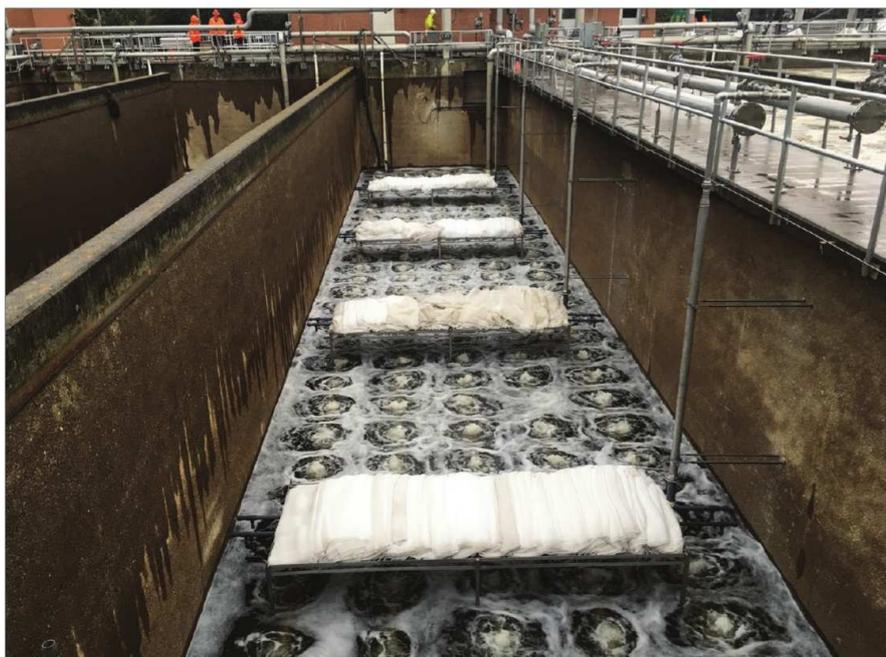


Figure 2 – New Fixed media IFAS system with frames, media sheets and coarse bubble aeration piping.

“The City of Peterborough WWTP was able to install an alternative IFAS system to address the operational and maintenance issues associated with a previous IFAS configuration of suspended media enclosed in cages.”

To expedite the IFAS replacement works, preliminary consultations were held with the Ontario Ministry of the Environment, Conservation and Parks (MECP). The replacement of the loose media IFAS system with a fixed media IFAS system was considered under the WWTP’s limited operational flexibility (LOF) criteria as this allows for the replacement of a piece of equipment with an equivalent set. A plan was developed and shared with the MECP to complete the IFAS replacement work on one aeration tank at a time to minimize disruption to the plant.

Construction began in April 2021 and the final aeration tank was brought into service with the new IFAS system in December 2021. To validate the performance of the new IFAS system and satisfy effluent objectives, a 180-day (6 month) process validation period which includes one full winter month and one full spring month is being conducted. The process validation period is estimated to be concluded in June 2022. Over this period RVA, Entex, and the City of Peterborough will be collaboratively reviewing the process data against the effluent objectives. Since the start-up of all the aeration tanks, the WWTP’s TAN numbers have been meeting the ECA objectives but the system is still under review.

The City of Peterborough WWTP was able to install an alternative IFAS system to address the operational and maintenance issues associated with a previous IFAS configuration of suspended media enclosed in cages. An expedited implementation of the alternate IFAS system was facilitated by performing the works under the LOF criteria. The ongoing process validation is scheduled to continue until June 2022 to cover low-temperature and wet-weather flow periods to prove the system’s efficacy for nitrification under these critical conditions. ♦



Figure 3 – New Fixed media IFAS sheets in operation.

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