Biological Wastewater Treatment for Poultry Farms using MBBR Process and Dissolved Air Flotation system

MBBR processes designed for today’s wastewater flows can be easily expanded to meet tomorrow’s increased flow or concentration levels

By Mark Fosshage, Indra N. Mitra and Jody Wells

Abstract
A turkey-kill and processing facility in New York State, USA has demonstrated local environmental stewardship through designing a direct discharge wastewater system using advanced treatment technology. Beyond robustness, ease of operation, and high performance, the design is flexible offering expansion and backup systems. These features assure long term direct discharge success.

Background
Plainville Farms produce turkeys using all natural ingredients, no antibiotics, and no animal by-products as feed. Plainville Farms has been producing healthy and responsible food products since 1835. Traditionally, the wastewater generated from the facility has been directed to a marsh field. The marsh field naturally treated the wastewater to remove the impurities. However, as the facility grew, proactive environmental impact studies demonstrated that this procedure had its limits. In 2004, Plainville invested in an Internal Rotary Screen and Hydrocal CAF system for wastewater treatment. The intention of this system was to reduce the Fats, Oils, and Greases (FOG), Total Suspended Solids (TSS), and Biochemical Oxygen Demand (BOD) load in the wastewater discharge. Although there was a significant investment made, this system really did not provide significant reduction in the load.

Plainville Farms’ philosophy is to care about their customers, team members, the animals they raise and their community. Thus, the President, Mark Bitz felt that it was very important to develop a more comprehensive plan to address this problem both on a short-term basis as well as on a long-term basis.

Developing Clear Goals
Plainville Farms hired Plumley Engineers, USA, an environmental consulting firm, to evaluate Plainville’s options and recommend a course of action with the following parameters:

1) Achieve high effluent quality
2) Provide adequate system scalability for the future
3) Incorporate a backup plan into the design
4) Select a System which is intuitive and user friendly

With these four criteria, it was felt that Plainville would assure the highest quality discharge water for a long-time into the future.

Craig Brunning, from Plumley Engineers, was assigned the project. Plainville’s property was assessed in order to develop a long-term storage lagoon. This would become the backup plan, as there were reasons this would not serve well as the main option.

Plainville and Plumley worked to develop a complete characterization of the wastewater. The regulatory authority (State Department of Environmental Protection) set the discharge effluent limits as shown below:
greatly scalable, easy to operate, and complete with backup capabilities. Beyond these features, WWW demonstrated the ability to listen and adjust the design to assure complete satisfaction of all the goals set forth. For instance, a design was developed to utilize the existing concrete in-ground EQ tank through adding height to it, providing additional EQ capacity. Mark Bitz confirmed WWW experience through checking several references, who all lauded WWW’s technology. One notable reference was for a system at a Poultry plant in Arkansas, USA, which would soon be treating over 1 MGD of wastewater with MBBR and DAF to meet potable water drinking standards and achieve ~50% reuse. Coupling all of these features and this experience with one of the most economical solutions, WWW was selected as the vendor.

**Selecting the Technology**

Several wastewater companies were invited to submit proposals. World Water Works (WWW) submitted a design proposal that addressed all of the needs: High performance, compact yet

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>BOD</td>
<td>5 ppm</td>
</tr>
<tr>
<td>TSS</td>
<td>10 ppm</td>
</tr>
<tr>
<td>FOG</td>
<td>15 ppm</td>
</tr>
<tr>
<td>NH3-N</td>
<td>1.5 ppm</td>
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These stringent requirements dictated the need for nitrification. Nitrification is the process of biologically converting NH3 to nitrates. However, Plainville and Plumley decided not to develop a traditional design and have companies bid that exact design. Instead, they wanted to allow the technology providers develop the designs that they felt were ideal. They hoped that this would allow the implementation of the best, most innovative design at the best value.

**Detailed Design**

WWW design utilized the existing rotary screen to remove coarse particulate to protect downstream equipment and
specified the increase in the EQ tank capacity to allow for proper equalization and pH control. The next unit operation would be to use the WWW/RESOURCE DAF to remove FOG from the wastewater. The RESOURCE DAF is a highly efficient dissolved air flotation system. It is constructed of Polypropylene to allow flexibility in treatment and maximum FOG removal. The system incorporates several proprietary design features: Progressive Water Extraction, Cross Flow, Plate Packs, Nikuni Dissolved Air, and Cone Bottom Sludge Removal.

These features each maximize Archimedes Principal and Stoke’s Law of liquid/solids separation. The result is a highly efficient separation system that has demonstrated higher performance at lower costs through head-to-head competition, technology upgrades and competitor system replacements.

Once the FOG is removed, the wastewater can be treated biologically. WWW utilizes Moving Bed Biofilm Reactors (MBBRs) for this step. The MBBR process utilizes a polyethylene media to provide a ‘home’ for the bacteria to grow and cultivate. This media is placed inside a tank that has a blower manifold at the bottom. The wastewater continuously flows into and out of the reactor. The blower provides oxygen as well as mixing energy to assure interaction between the biofilm on the media with the wastewater. The design of this system offers several important advantages: (i) it requires small footprint, (ii) the biofilm provides protection of the bacteria from toxic infiltrations, (iii) the process is continuous and has one control point (Dissolved Oxygen - DO), meaning that it is very easy to operate, and (iv) the system is scalable – more media can be added down the road to provide increased loading capacity.

The MBBR process has been designed in two stages (two reactors) at this location. The reason for the two reactors is due to the high removal rates necessary and the nitrification requirement. Nitrification occurs when the organic load in the water is at its minimum. Thus, the first reactor removes the bulk of the BOD and the second reactor will remove the remaining BOD and achieve the nitrification process. The next unit operation will be separation of the biomass from the water. Again, a WWW/RESOURCE DAF is the system

Plainville Farms’ wastewater treatment unit
of choice for its efficiency and compactness. In fact, many of the existing WWW/RESOURCE DAF's that are after the MBBR process utilize between 0 and 5 ppm of flocculant to achieve the required results. Thus, the operational costs of the system are extremely low. The anticipated effluent from this process will often meet the performance requirements of the system. However, to assure continuous compliance, a final unit operation will be employed – media filtration.

Media Filtration provides fine filtration of any “carry-over” of solids from the DAF clarification process. Four media filters have been incorporated into the design to provide continuous operation while backwashing is cycled through the system. The filtered water will provide the source of the backwash process. After the media filters, the water will be discharged by gravity to the marsh field in accordance with permit limits.

Results

The system has been in operation since 2007 and meeting the stringent effluent limits for BOD, TSS, FOG and NH3-N presented earlier. Performance data for COD from June 2007 to February 2008 is presented below to provide a comprehensive picture of the wastewater and its variability during changes in production.

Summary

The system has been a terrific success and allowed the Turkey processing facility to achieve all the goals set forth.

About the Authors

Mark Fosshage is the founder and CEO of World Water Works. He is also involved in process design, ongoing company R&D, developing cost-effective system design solutions. Mark has presented and published numerous technical papers. Mark has an Environmental Engineering degree from the Rensselaer Polytechnic Institute.

Indra N. Mitra is currently, the Vice-President of World Water Works, India. He received his B.Tech from IIT Kharagpur, MS from Vanderbilt University, USA, PhD from Lehigh University, USA, and MBA from Virginia Tech, USA. He has authored several books and papers and is a member of CII, IIChe, American Academy of Environmental Engineers, USA and several other international and national professional organisations. He can be contacted at indra.mitra@worldwaterworks.com