MBR Technology Meeting the Demands of an Expanding Dairy Plant

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Tighter discharge regulations, increased capacity with a smaller footprint and higher effluent quality have made Membrane-Biological-Reactors (MBR) the leading innovation in wastewater treatment compared to conventional activated sludge processes. Traditionally, activated sludge treatment relies upon solids settling in a secondary sedimentation tank to separate the biomass from the treated wastewater. This process has the disadvantage of running at a lower biomass concentration between 3-5g/l, referred to as Mixed Liquor Suspended Solids (MLSS), which requires more space and produces lower quality effluent. With MBR technology, the sedimentation tank can be omitted and you can operate at a higher MLSS typically between 10-14g/L. This allows you to reduce the footprint by up to 50% compared to a conventional wastewater treatment plant. The superior effluent quality is attributable to the micro/ultrafiltration membranes that act as an absolute barrier to particles and bacteria.

Family owned and operated since 1970, Mullins Cheese is the largest family owned cheese factory in the state of Wisconsin. They make fresh natural American, Italian, and Hispanic cheeses produced in 40lb blocks as well as 640lb blocks in select cheeses. Mullins is also a worldwide exporter of whey products: whey protein isolate, procream, whey permeate, de-proteinized whey, and lactose.

Mullins Cheese treated its wastewater with a Sequencing Batch Reactor (SBR) and discharged directly into the Wisconsin River. SBR technology is a form of the activated sludge process that is a fill-and-draw system. The wastewater is added to a single batch reactor, treated to remove components and then discharged. Two or more batch reactors are often used to increase the performance of the system in a predetermined sequence of operations. MBRs compared to SBRs have several advantages in that MBRs have a smaller footprint (about 60-70% smaller) than SBRs because MBRs operate at 10-14g/L MLSS and SBRs operate at 3-5g/L. MBRs use membranes as a physical barrier for the separation of the biomass where SBRs rely on gravity settling. The membrane produces a higher effluent quality because you have a 6-log removal of bacteria and a 3-log removal of virus without disinfection. Even with tertiary filtration SBRs cannot achieve this because most tertiary filters are around 10µm compared to 0.1µm or smaller in a MBR. MBRs produce less sludge and are easier to operate by eliminating the gravity sludge settling step.

In 2013 Mullins Cheese started a plant expansion where they more than doubled their milk processing. The full expansion took almost 3 years to complete and increased their processing from about 2.5million pounds of milk a day to now processing about 6million pounds of milk per day. This increase in capacity also meant that their wastewater treatment plant had to increase its capacity. They were treating about 500,000gals of wastewater per day before the expansion and now treat about 1,000,000gals of wastewater per day (1 MGD).

Mullins Cheese chose submerged MBR technology over their current SBR technology because of the smaller footprint, higher effluent quality and they were able to better control their phosphorus discharge with the biology of the MBR and as a result were able to eliminate adding ferric and alum to remove the phosphorus in their process. Submerged modules for MBRs exist in a variety of different formats such as hollow fiber and plate and frame. The differentiation criteria are the packing density of membrane area, the hydraulic conditions which will influence the modules' tendency for braiding or silting, as well as the possibility to backwash the system.

Mullins Cheese selected MICRODYN-NADIR's BIO-CEL® MBR modules because it combines the best of two technologies – the plate and frame configurations as well as hollow fiber modules. It combines the hydraulics of plate and frame systems with the flexibility, high packing density and ability to backwash of hollow fiber systems. Even though the MBR module looks like a plate & frame system, the construction is based on a two-side polyether sulfone (PES) membrane which is laminated onto a spacer material in order to create a self-supporting sheet. The self-supporting membrane sheet is just 2 mm thick, resulting in an extremely high packing density and very low specific energy consumption. The membrane laminate sheets are integrated into the membrane stacks in a unique way so they can move gently with the crossflow. Due to their unique "hollow sheet structure" they are very stable and robust – even after potential damage of the membrane the "selfhealing mechanism" of the laminate will ensure high permeate qualities. The MBR module is unsusceptible to braiding and sludge deposition and is backwashable..

In the table below is the influent and effluent design basis for a design flow of 1.2 MGD.

Currently they treat and average of 1MGD with a MLSS of 11g/L. Their system has 2 trains of 14 MBR modules. Their process

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is: Influent ➔Screen ➔Anaerobic ➔ MBR basins with extended Aerobic section ➔Discharge of Effluent into the Wisconsin River. Their effluent is less than 2mg/L BOD, TSS less than 2mg/L and the phosphorus is less than 1mg/L

They perform an in-situ maintenance cleaning every 8-10 weeks with a short backwash of citric acid, rinse, backwash with NaOCl and let it soak for 4 hours, then rinse. They currently do not have to perform yearly intensive cleanings.

In summary, MBR plants have a lot to offer wastewater treatment plants in the Dairy industry. The smaller footprint with increased capacity is more efficient when upgrading existing plants or building new plants that may be limited on space. The higher effluent quality allows for a range of potential re-use applications while at the same time simplifying the treatment process by eliminating steps such as adding ferric and alum to remove the phosphorus and by eliminating the need for sedimentation/ clarifying tanks. ■

Design Flow: 1.2 MGD. The influent and effluent design basis:

Parameter	Influent	Effluent Limits
BOD	2037 mg/L	< 10 mg/L
TSS	300 mg/L	< 10 mg/L
NH^3	32 mg/L	< 1 mg/L
TP	39 mg/L	< 1 mg/L
TN	134 mg/L	< 7 mg/L
Alkalinity	300 mg/L	< 75 mg/L
Turbidity	N/A	2.0 NTU
Maximum Wastewater Temperature	37.7 °C	
Elevation	1,000 ft	

Josh Mullins

-Mullins Cheese is a family business that has been at the current location since 1970 and Josh is part of the 4th generation of the family business.

-Worked at the plant for 23yrs
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David Dickerson

-Graduated from North Carolina State University with a Bachelor of Science in Food Science and a Minor in Business Management

- Have 20yrs experience in the Food and Beverage Industry and have held positions in Research and Development, Corporate Quality Assurance, Pilot Plant Manager, Sales Manager for lab/pilot scale pasteurization/sterilization and process equipment

David Dickerson

-Served in the Army National Guard

-For the past 11yrs been the Sales Manager for MICRODYN-NADIR US, Inc. for applications in the Dairy, Food and Beverage Industry as well as Pharma and Wastewater Industries