INDUSTRY: DAIRY

Application: AnMBR and MBR

End-user: Grassland Dairy Products, Inc.

Project Details

Location:	Wisconsin
OEM Partner:	Complete Filtration Resources Inc.
Product:	AnMBR and MBR in parallel
Membrane Type:	8mm, PVDF, backwashable
Capacity:	1,900 m³/day (500,000 gallons/day)
COD load:	9,000 to 18,000 kg COD/day (20,000 – 40,300 lbs/day)

Project Overview

Family-owned since 1904 with roots in the Swiss Alps going back generations, Wisconsin-based Grassland Dairy Products, Inc. is a leading sustainable producer of high-quality butter products and dairy ingredients. It is the world's largest family-owned buttery.

The company processes up to 6 million pounds of milk per day (2,700 tons), sending 500,000 gallons of wastewater per day (approximately 1900 m³/d) to a custom-engineered retrofit of its existing wastewater treatment plant with membrane bioreactor technology. The dairy wastewater generated in Grassland facilities presents high organic loads: 9,000 to 18,000 kg COD/day are generated, with average COD concentration of 10 g/L. Due to the high variability in organic load, two parallel MBRs are currently in operation: the low waste is sent directly to an aerobic MBR while the high-strength waste is diverted directly to an anaerobic MBR. This diversion of high-strength wastewater significantly improves the efficiency of the overall treatment process.

The Challenge

Historically, the wastewater generated by Grassland was treated with a more conventional process that combined a DAF system for suspended solids and FOG removal, followed by a conventional activated sludge process (CASP) for removing the organic matter. However, this approach was shown to be not effective, both in terms of effluent quality and operational costs.

The main constraints reported by the operators were the difficulties of managing the wide swings in COD loading and flow, the significant cost of chemicals used in the DAF, and for phosphorus removal. The high costs of sludge disposal were also an issue of concern. These factors led Grassland to seek for a more efficient, robust and reliable technology for their on-site wastewater treatment plant.

Complete Filtration executed a multi-stage retrofit, implementing the external MBR technology based on Berghof tubular membranes. The conversion was done in two different phases, as described hereunder.

The Solution

Phase 1 – Conversion of the existing CASP into aerobic MBR

By providing skidded UF systems, five external tubular UF Membrane systems were coupled to the existing aerobic reactor. As reported by plant operators, the implementation of the MBR brought significant benefits: a stabilized effluent quality was achieved, even with the continued variability of the incoming organic load. After successful implementation of the aerobic MBR, Grassland addressed the second phase of the retrofitting four years later. The aim was to implement the most efficient and sustainable overall process for recovering as much resources as possible from the wastewater.

Phase 2 – Implementation of AnMBR for high-strength wastewater

During the four years when the MBR was in operation, it was possible to monitor the influent wastewater quality and it was verified that highly variable organic loads were entering the biological reactor. Complete Filtration integrated a real-time COD strength sensing system that allowed the detection of the high-strength (HS) and low-strength (LS) waste streams. Shortly after, the AnMBR system was installed. The AnMBR consisted of a one million gallon (~ 3800 m³) anaerobic digester coupled to the tubular UF filtration system. A 0.50 million gallon (~ 950 m³) equalization tank for HS wastewater was also constructed. The on-line organic strength monitoring system allowed diverting the LS wastewater to the aerobic MBR and the HS wastewater to the AnMBR (projected split was 50/50). This allowed for a reduced flow and organic load to be directed to the aerobic

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MBR, achieving much better performance in terms of effluent quality and filtration flux and stability. Moreover, two of the five filtration skids initially installed in the aerobic MBR were repurposed to be used in the AnMBR.

Figure1: UF system based on Berghof Membranes in Grassland facility.

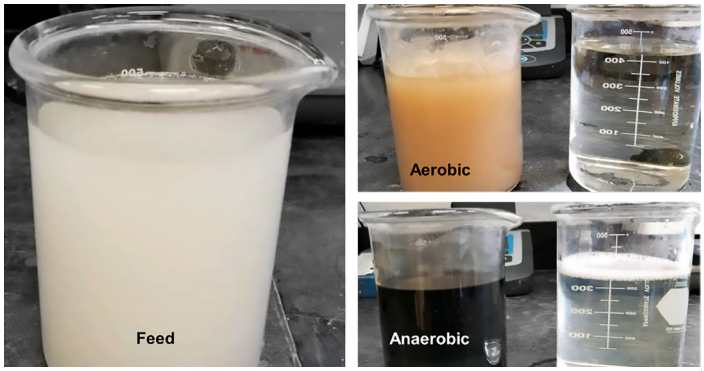

Figure 2. Pictures of the different samples: influent wastewater (left), aerobic and anaerobic sludges and their respective permeate samples.

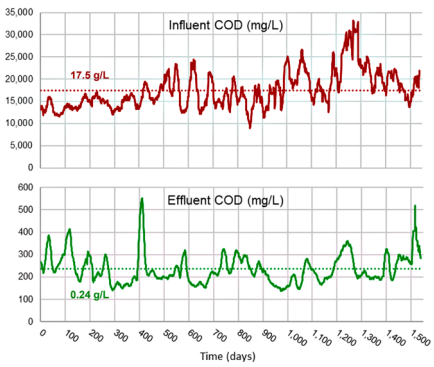

Figure 3. AnMBR Influent and effluent CODs during a 4-year operation period.

The result

The implementation of the AnMBR has resulted in major positive impacts in the overall performance of Grassland's wastewater treatment plant:

→ 40% of the flow and 70% of the organic load is currently diverted to the AnMBR. This means that a substantial amount of the organic contaminants are converted to recoverable energy in form of biogas.

→ The AnMBR is able to accommodate extreme loading variations, maintaining a smooth operation with stable permeate fluxes and average effluent COD values below 300 mg/L and average removal higher than 98% (Figure 3).

→ The overall performance of the aerobic MBR is much more stable and has greatly improved:

- The power requirements for aeration are now 60% lower.
- The permeate flux has increased 50%.
- The energy consumption in membranes is 50% lower.
- The membrane maintenance costs are estimated to be 90% lower.

→ The expenses for chemicals in the existing DAF pre-treatment have been removed. All fat content is sent to the AnMBR and converted into biogas.

→ The consumption of chemicals for phosphorus removal is now 60% lower.

The last stage of the project was implemented in 2018: once it had been proven that the AnMBR performed successfully with a high and stable high-quality biogas production, the energy recovery unit was installed (550 kW biogas engine). Since then, the anaerobically produced biogas fuels a generator that produces 4 million kWh per year, which covers more than twice the energy required for the AnMBR and allows saving $20,000 – 25,000 per month in energy costs.

With regards to the management of the treated water, significant achievements must be highlighted:

→ The effluent of the aerobic MBR is reused in Grassland facilities. After implementing a UV/RO system for polishing, 80,000 GPD (~300 m^3/d) are reused for cooling tower makeup and steam generation.

→ The treated water fully complies with the requirements for discharge and is sent to a nearby surface water body without requiring any post-treatment.

Customer benefits:

Overall, the company is saving up to $150,000 per month on costs they would otherwise incur without the MBR wastewater treatment plant. The return on investment is less than four years. The benefits reported by Grassland include water reuse, substantial energy cost savings, plus other sources of savings. The responsible, environmentally sound treatment of 500,000 gallons of wastewater a day is also a matter of pride for Grassland as it enhances one key brand attribute that Grassland is particularly proud of: an environmentally sustainable business model. In fact, the company produces three times more butter than it did 15 years ago, using less energy, water and land.

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