

Pall Aria™ Microfiltration System Consistently Clarifies River Water with High Turbidity Peaks

Overview

With the increasing complexity of dairy equipment and operations, there is a growing trend towards more reliable and higher quality water treatment processes. In addition, as utilization of our water resources becomes more intensive, meeting demand may require using water from more challenging sources. In many cases, the water supply comes from a surface water source, often a river which may experience high turbidity peaks during rainfall events.

In the past, conventional clarification and media filtration have been used in many of these situations. However as these systems age and regulations tighten, these plants can have difficulty coping with peak turbidity loads. In some cases additional water treatment chemicals are required to maintain supply during a turbidity event; in other cases operation of the treatment plant is suspended until the event passes, an approach which can require considerable storage volumes of treated water.

The Challenge

A leading dairy producer operating one of the world's largest ingredient plants sourced process water from two rivers nearby, which was then



Tangahoe River at intake site – New Zealand



Pall Aria FB system

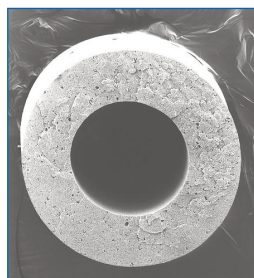
treated with conventional clarification/filtration systems. To support the production of more than 60 tons of products per hour, including powders, dry salt cheese, cream and mozzarella, a consistent and regular supply of high quality water is critical.

On general day to day river water turbidity, the existing water treatment plant meets the site water quality and capacity requirements. However during high turbidity events the site water treatment plant encountered problems in handling the higher solids loading and the site's water treatment capacity and quality decreases. Often the high turbidity events experienced at the site last for a few days. However the treated water storage capacity at the site is only a few hours. In extreme cases the high turbidity events can cause severe disruption and downtime for the production site due to the shortage of treated water.

The producer needed to review filtration requirements in order to constantly produce high quality water, regardless of the turbidity variations and spikes characterize their feed water.

The Solution: Pall Aria Microfiltration System

Pall Aria membrane systems are designed to meet the stringent requirements of dairy and other industries, producing high quality water irrespective from raw feed water variance. The Pall Aria modules use proprietary polyvinylidene fluoride (PVDF) hollow fiber membrane technology with advanced bonding techniques for an exceptionally strong module design.



(left) Module cutaway showing hollow fibers. (above) Cross section of a microfiltration hollow fiber membrane.

The membranes have a nominal pore size of $0.1 \mu\text{m}$ and can remove suspended solids, bacteria, cysts and oocysts, organics and other contaminants from surface and ground water sources.

The highly porous PVDF membrane is the heart of the system, which means a system can be designed at higher sustainable fluxes compared to other membranes, or it can be operated with lower fouling resistance, lower pumping head pressure, or increased intervals between regeneration sequences — all of which have substantial operational benefits including operational flexibility when confronted with turbidity events.

To ensure maximum efficiency and lowest total cost of ownership, Pall has developed techniques to keep the membranes free of fouling materials. These are integrated as specific operating modes within the automation software.

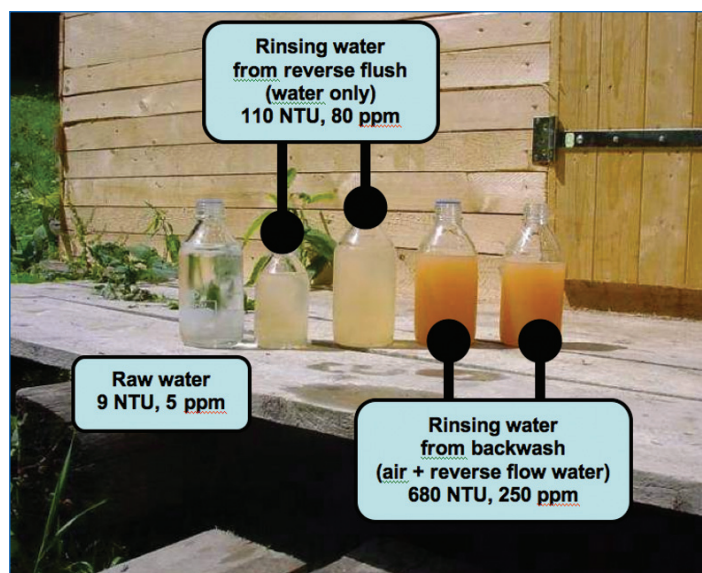
- In normal conditions, water is filtered in direct mode outside-in through the hollow fiber. Depending on water quality, a small amount of the fluid may be recirculated, resulting in lower accumulation of foulants and debris on the membrane surface.

- Backwash, or simultaneous air scrubbing and reverse flow (SASRF) at regular intervals (every 15-120 minutes), results in sustained flux over a longer filtration time. Air is injected at low pressure into the feed side of the

module as a mechanical process to remove debris and decrease the rate of overall trans-membrane pressure (TMP) increase. At the same time, filtrate that has been collected in the dedicated reverse flow tank is pumped in the reverse direction into the module. After a 30 second SASRF cycle, most if not all of the accumulated debris has been swept away to drain. A forward flush circulating feed water or filtrate at high velocity across the external surface of the membrane fibers completes the SASRF cycle.

- Enhanced flux maintenance (EFM) is another automated cycle that uses warm water with mild chemical solutions tailored to specific foulants that may be present. The time interval between EFM is user-defined and depends on the running conditions of the membrane. EFM is used to reduce the frequency at which a partially fouled membrane results in the system operating at less than peak efficiency. By allowing the membranes to operate at high flux rates, EFM enables a smaller system footprint resulting in floor space and facility cost savings, as well as a lower average TMP, generating pumping energy savings. The durable, strong and chemically resistant PVDF hollow fibers make this possible. They can be subjected to thousands of EFM cycles with no reduction in service life.

- While SASRF and EFM are designed to remove particulate matter and routine foulants, it may be occasionally necessary to perform a complete CIP process (typically monthly). This 2-step protocol using an acidic solution and a caustic solution with chlorine returns the modules to “nearly new” condition and can be performed hundreds of times over the life of the modules. Due to the low frequency of CIP operation, the process is semi-automated.



Concentration of feed water particulate in Pall Aria System reject streams relative to turbidity (NTU) and TSS (ppm).

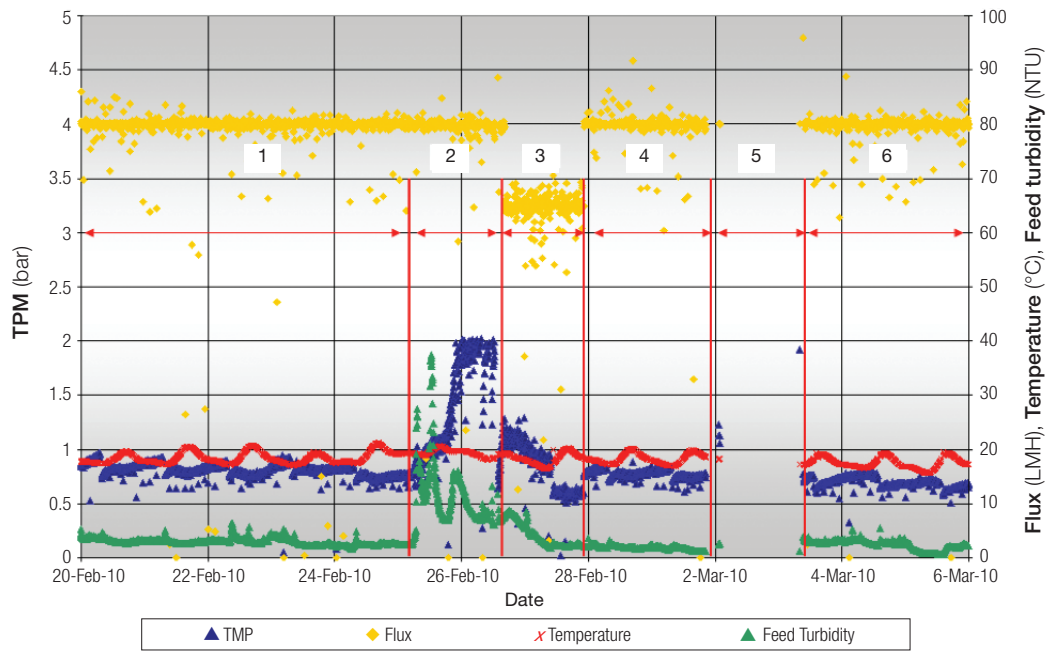


Pilot testing was performed at the dairy site over a period of 8 months to confirm the preliminary design parameters of the microfiltration (MF) system, including operating flux and flux maintenance processes. Pre-treatment with 2.5-5 ppm of polyaluminium chloride, selected from among flocculation chemicals used in the existing water treatment plant, directly injected into the pilot MF feed tank, was shown to be beneficial both during normal water conditions and high turbidity events.

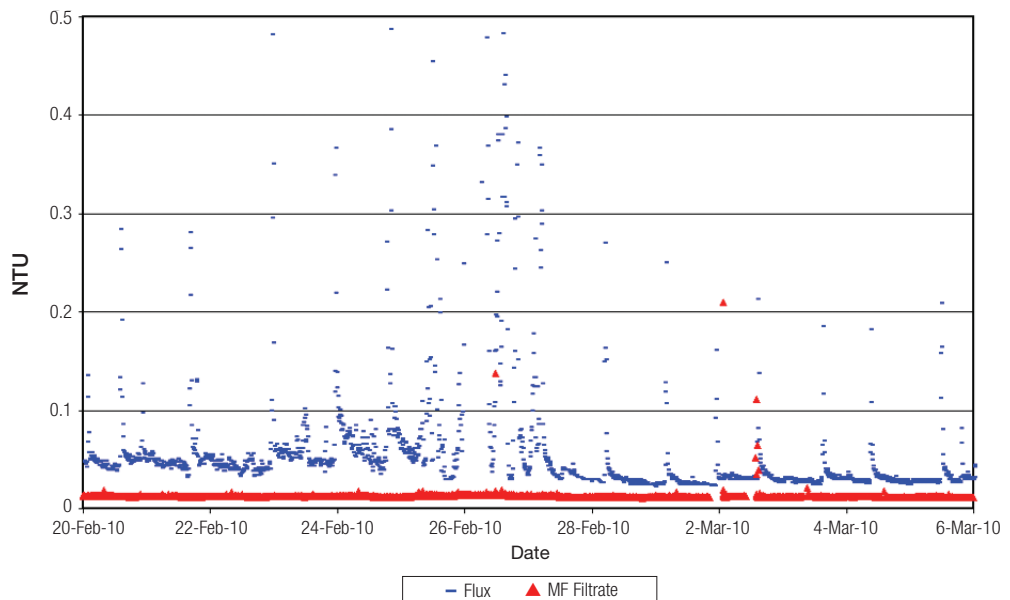
SASRF cycles, every 15 to 20 minutes, and a daily EFM with 500 ppm of sodium hypochlorite

proved to be highly efficient in maintaining the TMP below 1.5 bar during the turbidity events, with a flux of 65 l/h. The Pall MF pilot system was able to continue operating with feed water turbidity as high as 450 NTU. There was no need to shut down the MF system due to any high feed water turbidity events that were experienced during the trial period. At all times during the trial the MF filtrate turbidity remained below 0.1 NTU.

The Pall Aria microfiltration system demonstrated it could provide an uninterrupted supply of high quality water to the dairy site, from both river sources, during normal and high-turbidity events.



Pall Aria Microfiltration System Performance



Filtrate turbidity from Pall Aria microfiltration system and from filtration plant in place



The Benefits

The Pall Aria water treatment system demonstrated its ability to produce the required volumes of high quality water even during high turbidity events, replacing traditional clarification techniques cost-effectively.

- 80% operating cost savings, based on chemical and electrical use, was provided by the Pall Aria system. Consistent high filtrate quality regardless of raw water quality and turbidity spikes can generate further savings in downstream water processing, with reduced hypochlorite consumption for pipeline disinfection and reduced fouling of membrane filters at point of use.
- Consistent >95% recovery rate was demonstrated on all types of feed water quality, compared to <90% on low turbidity water and down to 20% on higher turbidity water with the conventional system.
- Sustained productivity during high turbidity events significantly reduces the need for increased water storage and can prevent shortage of high quality water.
- High degree of microbial control, typically 6 log removal for *Cryptosporidium* and *Giardia* cysts, provides process security.
- Automation, operational simplicity, compact footprint and modular design ease system integration into existing installations. Significantly less operator inputs were required to operate the Pall Aria system.
- Long module life, low energy consumption (typically 0.09 kWh per m³ filtered water), low chemical consumption, minimal water losses (up to 98 % water recovery) and overall cost improvement ensures a low cost of ownership.

Reference:

Peter Stark, Tony Foskett, Mike Thompson and Ben McSweeney – Pall Corporation, Membrane treatment of high turbidity water – Pilot studies on New Zealand river water

About Pall Corporation

Pall Corporation is a global filtration, separation and purification leader providing solutions to meet the critical fluid management needs of customers across the broad spectrum of life sciences and industry. We work with our customers to advance health, safety and environmentally responsible technologies.

Pall Food and Beverage provides products and services to ensure product quality and maintain process reliability in beverage and food production. Our solutions also assist in consumer protection, the reduction of operating costs and waste minimization.



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