Food and Beverage

Application Bulletin

Pall Aria™ System Rescues Bottled Spring Water Producer from Plant Closure

Overview

Spring water is a valuable natural resource, which requires good purification treatment before appearing on grocery store shelves as high purity, visually pleasing bottled product.

Filtration is a key process step required to achieve consistently high product quality. The costs associated with filtration may be substantial, depending on source water quality. Disposable filters are a technically sound solution but their use may become economically unsustainable in the face of difficult or variable quality source water.

When operational costs related to disposable filter spend, process downtime, and labor expenditures become too high, a backwashable water purification system boasting substantially lower cost of ownership for water treatment becomes very attractive. The Pall Aria FB system for the food and beverage industry is an exceptional solution for providing high purity water, and it has been implemented across the globe to reduce water filtration costs and achieve brand protection.

The Challenge

A bottled water company markets a variety of consumer water products, including spring water. They have procured the spring water for many years from a third party supplier, who draws it from an aquifer and transports it by tanker truck to them[1]. The spring water producer's business depends to a great extent on continued relationship and supply to the bottled water company, their main customer.

Once received at the bottled water plant, the spring water requires purification treatment, including extensive filtration. Figure 1 illustrates the treatment process.

As bottled water quality requirements had continually risen over the years in a very competitive environment, the bottled water company found that their filtration spend had grown to unsustainable levels. In addition, variable incoming spring water quality resulted in frequent filter blocking and high cleaning costs, frequent filter change-out, substantial water costs associated with backwashing the activated carbon bed, and related labor

Pall Aria FB-4 Water Filtration System

expenditure, process downtime, and operational inefficiency. A yearly disposable filter spend of US $2.16 / m^3 (US $0.82 / 100 US gal) of bottled spring water was not uncommon, and this figure did not include all the additional process-related costs. The economics of the situation were so difficult that there was a real risk of plant closure with shift of operations to other sister plants, which would also have directly impacted the viability of the spring water supplier.

The Solution

A Pall Aria FB-4 system provided the win-win solution for the problem. The spring water supplier, who had instituted only minimal water filtration previously, saw an opportunity to provide added value to its customers by improving the water quality at the spring water source. They rented the Pall system for a trial. In an overwhelmingly positive outcome, the water filtrate quality was so markedly improved that a purchase decision was made one month into the trial. To enable a speedy implementation of the improved solution, the rental unit was left in place until a new system was delivered.

Pall Advanced Separations Systems (PASS) Applications Support assisted with rental system

Figure 1: Spring Water Treatment Process at Bottled Water Plant[1]

The solution to improving raw water quality to the bottled water plant was the installation of a Pall Aria FB-4 water purification system at the spring water source.

set up and installation, operator training, and final system commissioning. Over the course of the rental period, guidance was provided to ensure proper operation and an understanding of system capability based on the application.

The Pall Aria FB unit is an automated, back-washable system designed to meet the stringent water requirements of the food and beverage industry. At the heart of the system are robust PVDF (polyvinylidene fluoride) hollow fiber microfiltration (MF) membranes (Figure 2). The unique advantage of these membranes is their homogenous construction, which means their entire thickness has the same porosity and permeability, thus ensuring consistent removal performance. These 0.1 micron membranes provide excellent particulate, organic material (colloids) and other contaminant removal, regardless of feed water quality and turbidity spikes (within specified limits covering the most typical water treatment applications).

The system provides water quality far superior to conventional treatment, with typical filtrate values at < 0.1 NTU turbidity, total suspended solids (TSS) at 0.1 mg/liter, and silt density index (SDI, a predictor for colloidal fouling) at < 3. A gross failure test can be performed on a daily basis to ensure consistent and reliable filtration performance of the membranes.

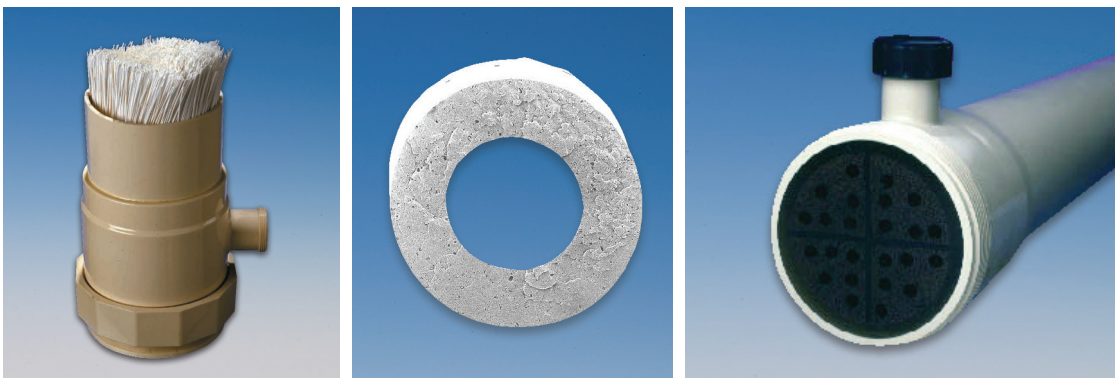

Figure 2: Module cutaway showing hollow fibers *(left)*, cross section of a microfiltration hollow fiber membrane *(middle)*, and view of Pall Aria module *(right)*

Water and its soluble components pass through the membranes as filtrate, in an “out to in” flow configuration. Retained solids are excluded and concentrated on the membrane surface during direct (“dead-end”) filtration (Figure 3), and are discharged from the system in a low volume waste stream. High microbiological safety is additionally achieved due to the system’s hygienic, stainless steel design with automatic disinfection when the system is out of operation for more than 24 hours.

High system recovery (water yield) of 95-98% is made possible by application of a unique three-step approach on this fully automated system:

- periodic and automated air scrubbing and reverse flow mechanical backwash (AS/RF), programmed for 2-3 minutes in between 45 minute filtration cycles
- short enhanced flux maintenance (EFM) process, with caustic, acid, and sanitization, carried out every 7 days
- CIP regime, with caustic, acid, and sanitization, applied every month.

This approach ensures constant flux during operation and long membrane life typically over three years. Many end users have reported problem-free membrane life of 5-10 years, depending on proper system operation and maintenance.

During the life of the membranes the only consumable costs are energy costs linked to providing power to the pump on the system and compressed air for air scrubbing, and chemical costs for cleaning and sanitizing the equipment. Both consumables are minimal expenses. The spring water producer’s total energy and cleaning chemical costs, plus the expected cost of membrane replacement in this application are estimated at US $0.03 / m^3 (US $0.01 / 100 US gal)[2].

The Pall Aria FB-4 system at the spring water producer now supplies up to 22.7 m^3/ hour (100 US gal /min) of consistent and high quality water from the source for end users[3].

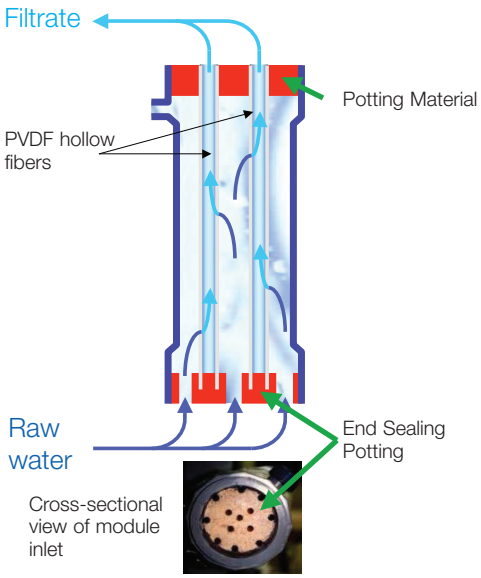

Figure 3: Hollow Fiber Modules Operated in Conventional (“Dead-End”) Filtration Mode

With a system footprint of approximately 22 m^2 (237 ft^2) the system is compact and stand alone. It includes 4 filtration modules, a control panel, pre-filter strainer, pump, pipework, valves, flow, pressure and temperature transmitters, and a CIP station. Each hollow fiber module features 50 m^2 (538 ft^2) of filtration area for a total of 200 m^2 (2152 ft^2).

In this application, there had been no significant water treatment previously carried out at the spring water source. In other applications where conventional water treatment approaches are in use, such as sand and multi-media filters, Pall Aria systems provide superior filtrate quality and have proven themselves to be cost-effective, with typical payback achieved at approximately 1-2.5 years, depending on size and type. Table 1 provides an overview comparison.

The immediate result at the spring water producer’s main customer, the bottled water plant, was a substantial process improvement and filtration cost reduction, as the incoming water to their plant is now of higher and more consistent quality. The

Table 1 - Comparison of Conventional Water Treatment and Pall Aria FB System

	Conventional Treatment	Pall Aria FB System
Filtrate (Water) Turbidity	>1 NTU variable, SDI >>3	<0.1 NTU consistent, SDI <3
Pore Size	>30 micron, variable	0.1 micron, stable
Operating Flexibility	No Dependent on feed water loading variability	Yes Independent from feed water loading variability
Chemical Consumption	High (Filter performance enhanced by use of coagulants)	Low (Efficient mechanical backwash reduces need for chemicals)
Water Recovery	90 – 92 %	95 – 98 %
Energy Consumption	Can be high in pressurized systems	0.08 kWh/m^3 (0.03 kWh/100 US gal)[4]
Footprint	Large	Small
Typical Operating Costs (energy, cleaning chemicals, membrane replacement cost)	> $0.25 / m^3 (>$0.1/100 US gal)	<$0.05 / m^3 (<$0.02/100 US gal)[5]

plant's disposable filter spend was reduced by half. In addition, while the carbon bed had previously required backwashing 4 times per week, with a water usage of 34 – 38 m^3 (9,000-10,000 US gal) per backwash, the backwash frequency has been reduced to only once every 2 weeks, resulting in a water use reduction of 87.5% or $54,600/year of water cost savings related to this operation. Finally, overall cost savings including labor, cleaning chemicals, and related operations have shifted the economic equation to enable the plant to continue operations.

In effect, the value gained by the bottled water plant due to the installation of the Pall Aria FB-4 system at the spring water supplier represented a system cost offset within less than 1.5 years.

The Benefits

The Pall Aria FB-4 system has made it possible for both the spring water producer and the bottled water plant to maintain and continue operations into the future.

The spring water producer experiences these benefits:

- New value-add for its customers due to production of consistent and high quality spring water, largely irrespective of source water variability or turbidity spikes
- Low operating costs (energy, cleaning chemical consumption) of the Pall Aria system
- Efficient operation with high process uptimes
- Simple and easy operation due to full system automation, ensuring consistent and reliable flux, predictable performance, minimal maintenance and negligible manpower cost
- Confirmation of filtration performance with simple gross failure test
- Easy and space-savings installation due to compact 22 m^2 (237 ft^2) Pall Aria system footprint

The bottled water plant experiences these benefits:

- Operational economics much improved, with disposable filter spend cut in half, and substantial water, cleaning chemical and labor cost savings realized
- Positive environmental impact due to water usage reduction of 87.5% on carbon bed cleaning
- Profitability has risen such that the plant can continue its operations and maintain its current employment

In hundreds of additional applications at food and beverage plants around the globe, Pall Aria systems are used to purify varied types of incoming source water (spring, surface, well, municipal), enable in-process water recycling, and provide direct filtration of bottled water, blending water or base water in food and beverage production. These systems are exceptional due to reduced risk of product contamination and associated losses, low cost of ownership for water treatment, and minimal operator intervention requirements.

Due to the improved water quality provided by the Pall Aria FB system, the bottled water plant's disposable filter spend was reduced by half, and its water usage for carbon bed backwashing was reduced by 87.5%. Overall cost savings have resulted in continued economic sustainability for this plant.

Footnotes

[1] Regulations in different geographies vary with regard to methods used for bottled spring water sourcing, transport, and production. The steps shown in the process flow diagram represent one manufacturer's approach to water treatment.

[2] Based on energy cost of $0.11/kWh

[3] Capacity varies based on raw water quality.

[4] Figure is based on monthly CIP. Daily EFM, usually only in secondary effluent treatment applications would require additional 0.1 kWh/ m^3 (0.038 kWh/ 100 US gal).

[5] Figure is based on Pall Aria FB treatment of raw water from typical sources, energy cost of $0.11/kWh and typical membrane life, based on application.

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, waste minimization and reduction of operating costs.

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