

## Pall Aria™ System More Than Quadruples the Process Uptime of RO Units at a Sweetener Refining Plant

### Overview

The corn wet milling and refining industry requires high amounts of steam for a variety of purposes, including steeping, drying, various evaporation steps, maintaining process temperatures, as well as fermentation, extraction, ethanol recovery, and starch conversion. RO-purified, treated water is supplied to the steam boilers to ensure that scaling on the water side of the boilers is avoided, to maximize energy transfer. A CIPEC (2001a)<sup>1</sup> report indicates that 1 mm of scaling build-up on boiler surfaces can increase fuel use by 2 %. Measures to reduce energy use are a continual focus in this energy-intensive corn wet milling industry.

RO water is additionally used at the corn refining plant as source water for various washing and elution steps in ion exchange columns to avoid resin fouling with unwanted particles, metal ions and other contaminants. It is also required for cooling unit loops and other process areas within the plant.

RO membranes are sensitive to fouling due to inadequate feed water quality. Membrane fouling causes reduced performance, additional energy demand due to differential pressure increase, excessive need for cleaning, and premature membrane wear.

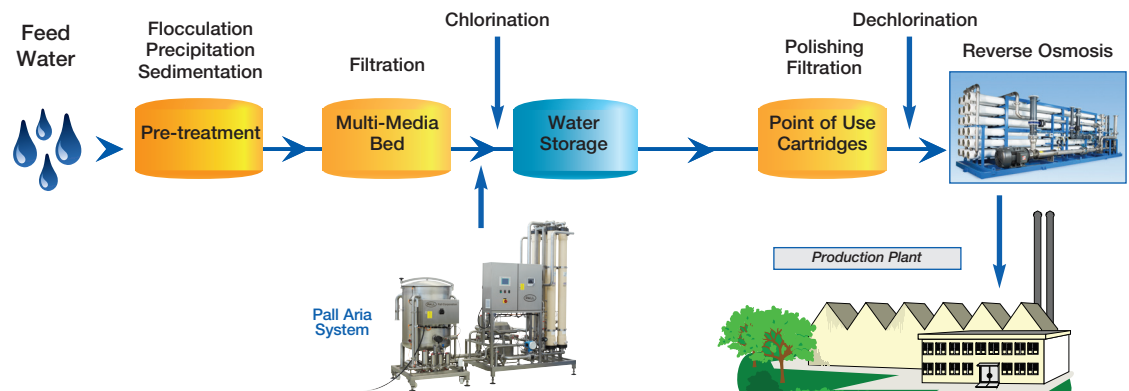
A Pall Aria microfiltration (MF) system provides a cost-effective and sustainable solution for optimally protecting downstream RO membranes.



Pall Aria system\*

### The Challenge

A corn refiner was equipped with a conventional clarification and sand filtration system for purifying the water sourced from an adjacent river. This system had been in use for years, and was supplying water to downstream RO units. CIP frequency for the RO system was approximately once every 20 days, in order to handle the frequent colloidal fouling and bio-fouling of the membranes. Average membrane replacement was every 18 months.



Integrating the Pall Aria system has resulted in substantial operating cost savings for the sweetener refining plant.

The traditional purification system included typical coagulation, flocculation, clarification, and sand filtration steps of the river water. Due to the use of storage tanks and long pipelines within the plant, disinfection was done prior to tank storage, and additional point of use disposable polishing filters were installed just prior to the RO units.

Seeking to improve feed water quality to their RO membranes, while minimizing capital investment costs, the corn refiner evaluated using membrane microfiltration as a final polishing step, to be used in conjunction with the conventional water treatment system.

### The Solution

A Pall Aria 6/28 was chosen to satisfy the customer's requirements.

The 28-module fully automated system, now located downstream of conventional clarification/multi-media filtration, utilizes robust polyvinylidene fluoride (PVDF) hollow fiber MF membranes to retain virtually all suspended contaminants. Water and its soluble components pass through the membranes as filtrate. Retained solids are excluded and concentrated on the membrane surface during direct ("dead-end") filtration; high system recovery is made possible by a unique automated air scrubbing and enhanced flux maintenance process that ensures constant flux and long membrane life. CIP of the membranes is carried out once quarterly.

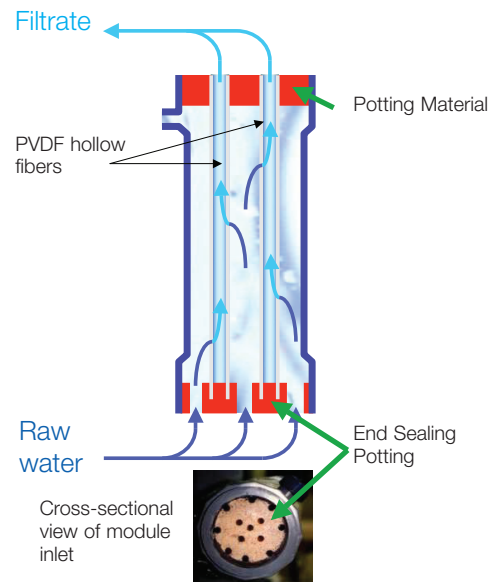
The unique advantage of MF hollow fiber membranes is their homogenous construction, which means their entire thickness has the same porosity and permeability. With a 0.1 micron removal performance, these membranes provide excellent particulate and microbial removal, regardless of feed water quality and turbidity spikes.

Table 1 compares the performance of conventional water treatment with the membrane microfiltration system. While the Pall Aria system in this application is used in conjunction with the prior-installed conventional treatment system, in hundreds of additional applications at food and beverage plants around the globe, Pall Aria systems are used as a stand-alone water purification technology.

Achieving 95 – 98 % recovery, the system at this corn refining plant produces 150 m<sup>3</sup>/hour (662 USgpm) of consistent and reliable effluent quality water. Quality measurements show turbidities achieved of <0.05 NTU, total suspended solids of <1 mg/liter, and SDI (Silt Density Index, which predicts colloidal fouling) <3 (normally <2).

The immediate result on the downstream RO membranes has been a more than quadrupling of their process availability, as the cleaning frequency of the membranes has now decreased from every 20 days to every 90 days or more. The need for the point of use disposable filters which protect the RO membranes has been reduced by over 50 %, equating to cost savings of €70,000 – €85,000/year (\$100,000 – \$120,000/year) depending on river water conditions and conventional clarification/multi-media system performance.

In piloting trials done over an extended time period, Pall Scientific and Laboratory Services demonstrated the level of filtrate quality which could be achieved and the resulting effect on the maintenance and upkeep of the downstream RO units.



Hollow fiber modules operated in conventional direct ("dead-end") flow mode

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

	Conventional Treatment	Pall Aria System
Filtrate Turbidity	>1 NTU variable	<0.1 NTU consistent
Pore Size Stability	Variable	Stable
Operating Flexibility	No Dependent on feed water loading variations	Yes Independent from feed water loading variations
Chemical Consumption	High (coagulants)	Low (disinfection)
Water Recovery	90 – 92 %	95 – 98 %
Energy Consumption	High	Low (0.2 kWh/m <sup>3</sup> or 0.76 kWh/1000 USgal)
Footprint	Large	Small, approximately 50 % of comparable conventional/multi-media filtration installation
Typical Operating Costs	>0.18 €/m <sup>3</sup> (\$0.94/1000 USgal)	0.029 €/m <sup>3</sup> (\$0.15/1000 USgal)

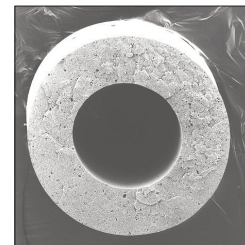
## The Benefits

The Pall Aria system has demonstrated many qualitative and economic benefits, including a large reduction in running costs for this corn refining operation.

- Conservative estimate to double membrane life equates to at least 50 % savings on membrane replacement over 3 years
- Consistent high quality water production, regardless of feed water quality and turbidity spikes, results in 50 % savings in point of use disposable filter cost, which is more than double the yearly running cost of the new Pall Aria system
- A minimum of 78 % reduction in CIP frequency results in reduced amounts of cleaning water and cleaning chemicals used, and reduced environmental impact due to lower water waste and energy use
- Minimal water losses due to efficient flux maintenance and mechanical cleaning results in 95 – 98 % water recovery
- Higher effluent quality has enabled the reduction in sodium hypochlorite consumption for downstream tankage and pipeline disinfection by 20 %
- Low energy consumption (typically at 0.2 kWh/m<sup>3</sup> / 0.76 kWh/1000 USgal filtered water) is negligible compared to improvements in energy use on RO unit cleaning and power consumption improvement during operation
- 28 m<sup>2</sup> (301 ft<sup>2</sup>) footprint, including flux maintenance and CIP skid ensures a compact installation



Module cutaway showing hollow fibers



Cross section of a microfiltration hollow fiber membrane

## References

- [1] Christina Galitsky, Ernst Worrell, and Michael Ruth, Energy Efficiency Improvement and Cost Saving Opportunities for the Corn Wet Milling Industry, Ernest Orlando Lawrence Berkeley National Laboratory (LBNL-52307 [1]), July 2003, p. 39.

## About Pall Corporation

Pall Corporation is the largest and most diverse filtration, separation, and purification company in the world. Pall serves the food and beverage industries with advanced membrane filtration technology and systems engineered for reliability and cost-effectiveness. Easy to install and simple to use, our systems satisfy a wide range of filtration requirements.

Our Total Fluid Management<sup>SM</sup> (TFM) approach offers customers solutions to address the needs of an entire process, encompassing filtration products, services, systems and training.



\* Pall offers a selection of Pall Aria system types, depending on the application requirements.



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