Purification And Reuse Of Pulp & Paper Industrial Effluent By Using Pall Aria™ Integrated MF/RO System

Shukla Bilson

ABSTRACT

The significant environmental impacts of the manufacture of pulp and paper result from the pulping and bleaching processes. In some processes, sulfur compounds and nitrogen oxides are emitted to the air, and chlorinated and organic compounds, nutrients, and metals are discharged to the wastewaters. Paper industrial wastewaters are high in biochemical oxygen demand (BOD), total suspended solids, chemical oxygen demand (COD), and chlorinated organic compounds, which may include dioxins, furans, and other adsorbable organic halides, AOX.

Membrane filtration is a pressure driven process that uses a semi-permeable (porous) membrane to separate particulate matter from soluble components in the carrier fluid, such as water. In Pall Aria systems, microfiltration or ultrafiltration membranes act much like a very fine sieve to retain particulate matter, while water and its soluble components pass through the membrane as filtrate, or filtered water. The retained solids are concentrated in a waste stream that is discharged from the membrane system. The pore size of the membrane and the integrity of the sealing mechanism control the fraction of the particulate matter that is removed. Microza membranes, with their fine pore size and absolute seal, remove virtually all of the fine matter, such as silica, bacteria, and parasite cysts.

By using best-in-class treatment chemicals with a combination of hollow-fiber microfiltration (MF) and reverse osmosis (RO), one can get the solution with a highly efficient system for reclaiming effluent water. Not only can the Pall Aria MF/RO system reduce the cost for purchased water, it can provide water that consistently meets critical water quality requirements while effectively protecting the environment. Pall Aria Integrated MF/RO system assures consistent production of high quality water from a reclaimed source. It provides an integrity testable, positive barrier to TSS and microbial contaminants.

Introduction

Paper manufacturing is a highly capital, energy and water intensive industry. It is also a highly polluting process and requires substantial investments in pollution control equipment. In India, around 905.8 million m^3 of water is consumed and around 695.7 million m^3 of wastewater is discharged annually by this sector. The large water requirements and consumption by the Indian pulp and paper industries has led to, water fast becoming a scarce commodity and lowering of the groundwater table and thus increased pumping costs and more importantly water shortage in many regions. Realizing the importance of water and excessive usages of water by pulp and paper sector, Central Pollution Control Board (CPCB) has taken initiative to develop the water conservation Guidelines. The high water consumption in Indian pulp and paper industry is mainly due to obsolete process technology, poor water management practices and inadequate wastewater treatment.

Membranes are used in the pulp and paper industry in a variety of applications, in particular for the purification and recovery of water and for the recovery of raw materials or energy. The intake of fresh water to the mills has decreased significantly during the last decades and the trend is today towards more and more closed water circulation systems in the mills. However, paper mills cannot operate without sufficiently clean water. To purify effluents for reuse, membrane filtration offers an attractive alternative (Mänttäri and Nyström, 2005).

Most of the pulp and paper mills treat their effluents by using an activated sludge process. After this process the effluents are not sufficiently clean for reuse in the production of most paper grades although this kind of water might be reused for production of packaging paper (Bülow et al., 2003). Biologically treated effluents still contain significant amounts of color compounds, micro-organisms, recalcitrant organics and a minor amount of biodegradable organics as well as suspended solids. Biological treatment does not significantly reduce the inorganic content in the effluent and desalting maybe needed before reuse of the effluents in the manufacturing processes. Some mill-scale Nano Filtration (NF) and RO membrane filtration plants have been installed in the pulp and paper industry to purify tertiary effluent from external biological treatment processes. In the middle of the 1990s two spiral wound nanofiltration plants were installed for the treatment of effluent from a paper mill. In both cases, the nanofiltration systems were installed to remove color, organic carbon and dissolved solids

Pall India Pvt. Ltd.,
6th Floor, Sumer Plaza CTS 419, Marol-Maroshi Road, Andheri (E), Mumbai -400059

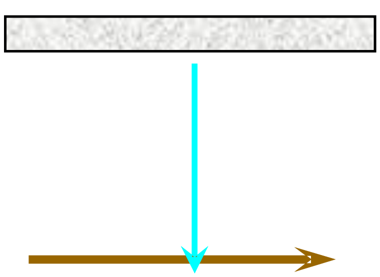
from effluents for reuse or for further processing (Lien and Simonis, 1995). In 1999 Eltmann newsprint mill of Papierfabrik Palm has installed spiral wound nanofiltration to reduce COD, AOX and color in their effluents. Prior to NF, the effluent is biologically treated (activated sludge plant) and prefiltered using sand filters. The NF plant capacity is 190 m^3 permeate per hour (84% recovery for purified water). The reported COD removal is 89%, AOX 61% and color 93%. Hardness measures divalent cations and is well retained in NF but the retention of conductivity is less than 40%, because of the negative retention of chloride ions. The reuse of NF permeate also decreased the need to heat fresh water to the mill process temperature (Schirm et al., 2001).

Cross Flow Filtration

Cross-flow filtration is a continuous process in which the feed stream moves parallel to the membrane filtration surface and purified liquid passes through the membrane. The separation is driven by the pressure difference from one side of the membrane to the other referred to as transmembrane pressure (TMP). The parallel flow of the feed stream, combined with the boundary layer turbulence created by the cross-flow velocity, continually sweeps away particles and other substances that would otherwise build up on the membrane surface. As a result, cross-flow filters inherently maintain high permeate rates longer than conventional dead-end filters.

Cross-flow filtration streams are divided into three parts:

- Feed - solution that enters the



  filtration channels
- Permeate - solution that passes through the membrane
- Retentate - solution retained by the membrane

Clean Water, Clean System

Filtration

Feed water enters the bottom of the module and is distributed uniformly to the outside of the fibers. Since it is under pressure, the water passes through the hollow fiber membranes and filtered water exits from the top of the module. Under normal conditions, all of the feed water flows through the membranes and exits as filtered water. Depending on feed quality, a small amount of the feed water may be circulated past the membrane surface. This flow prevents the accumulation of foulants and debris on the surface of the membrane and helps evenly distribute flow though the membrane fibers.

Air Scrub

As water is filtered, rejected particulate accumulates in the module or on the membrane fiber's surface. The effect is a flow restriction in the module, resulting in an increase in trans-membrane pressure (TMP). Air Scrubbing (AS) is a mechanical process to remove the debris from the module and decrease the rate of overall increase in trans-membrane pressure. AS is usually initiated at a preset interval of water throughput. As a secondary trigger, AS is initiated if the rate of TMP increase exceeds a specified maximum. The air injection valve opens and air is injected at low pressure into the feed side of the module. At the same time, filtrate that has been collected in the Reverse Filtration (RF) tank is pumped in the reverse direction through the module and out through the main system drain. Air and RF flow are then stopped. At this point, most if not all of the accumulated debris in the module have been swept to drain. To complete the cycle, a forward flush (FL) is implemented, circulating feed water from the feed tank on the outside (feed side) of the membrane fibers at high velocity. This fast flow of liquid is directed through the excess recirculation port of the module to drain. This further dislodges and removes from the module debris that was captured by the membrane fibers. This fully automated cycle is included in every Pall Aria System and occurs every 20-120 minutes, and stops forward filtrate flow for about 1.5-2 minutes.

Fig 1. Pall Aria Water Treatment System with control panel and modules

Pall Aria™ Integrated MF/RO System

By using best-in-class treatment chemicals with a combination of hollow-fiber microfiltration (MF) and reverse osmosis (RO), we provide you with a highly efficient system for reclaiming effluent water. Not only can the Pall Aria MF/RO system reduce your cost for purchased water, it can provide water that consistently meets critical water quality requirements while effectively protecting the environment.

Fig 2. View of Fiber Membrane Module Cut-away.

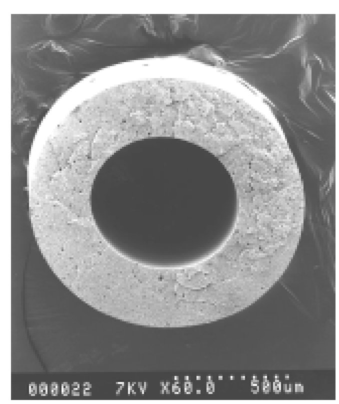


Fig 3. SEM of PVDF MF Fiber

Value

- Acquire a consistent, high-quality water source for as much as 50% less than the cost of purchased water.
- Decrease dependency on purchased water.
- Reduce wastewater discharge by as much as 80%.
- Reclaim a scarce water resource.
- Increase operating profit by reusing an existing resource.
- Obtain a source of high-quality water for critical plant and utility use.

Features

- Standard designs for trouble-free operation.
- Touch-screen controls for simple operation.
- Modular design for rapid integration.
- Multiple membrane barriers for process protection.

Aria AP-Series System Specifications

Aria AP-Series System Components

Standard system components consist of 1 to 60 membrane modules, a feed tank, one feed pump, one reverse filtration pump, manual on/off and automatic valving, filtrate flow meter, pressure and temperature sensors, and PLC control.

Aria AP-Series System Specifications

Module Housing: PVC, ABS or other
Gasket: EPDM
Potting Material: Silicone and Epoxy or Urethane
Panel: NEMA 4
Tanks: Polyethylene
Piping: Lower Manifold and Air: Stainless Steel
(other piping: PVC)
Hollow Fiber Membrane: PVDF
Pumps: Horizontal Stainless Steel Centrifugal

Conclusion

If paper industry needs an additional supply of pure water for critical and utility operations, it could benefit from a Pall Aria Integrated MF/RO system. By using best-in-class treatment chemicals with a combination of hollow-fiber microfiltration (MF) and reverse osmosis (RO), it can provide the industry with a highly efficient system for reclaiming effluent water. Not only can the Pall Aria MF/RO system reduce your cost for purchased water, it can provide water that consistently meets critical water quality requirements while effectively protecting the environment. It assures consistent production of high quality water from a reclaimed source and provides an integrity testable, positive barrier to TSS and microbial contaminants. The system protects downstream processes such as electro deionization (EDI) and delivers highly purified, low TDS water.

References

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