FILMTEC Membranes

Nanofiltration Produces Sparkling Clean Water for Swedish Resort Community

Site Information

Location

Sweden

Purpose

- Meet peak demand potable water during tourist season.
- Improve variable water quality.
- Replace outdated manual flocculation process to save money.

The Lofsdalen nanofiltration plant consists of 10 pressure vessels, each containing four FILMTEC™ elements. The vertical metal cylinder is the housing for the cartridge filters. The two vertical boxes at the left are the frequency controllers for the recirculation pumps below. All pipework is stainless steel. (Photo courtesy of HOH Water Technology.)

For more than three years, the resort community of Lofsdalen, Sweden, has been supplying residents and visitors with sparkling clean drinking water from Lake Lofssjön. FILMTEC™ nanofiltration membranes remove color and iron and reduce chemical oxygen demand (COD). The membrane system saves energy by operating under low pressure and reduces maintenance costs because of the low fouling tendency and high chemical stability of the membranes.

Introduction

Lofsdalen is a small community in the middle of Sweden close to the Norwegian border. The beautiful mountain scenery and nearby Lake Lofssjön make Lofsdalen very attractive to tourists in the summer and winter seasons. However, the peak demand for potable water during these seasons, the variable water quality, and the outdated manual flocculation process made managing the waterworks difficult and expensive. These problems prompted the community to look for a new, safe supply of high-quality drinking water. The Swedish consultant VBB VIAK suggested that Lofsdalen purify raw water from the lake and remove color and iron with FILMTEC nanofiltration membranes.

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The Nanofiltration Plant

The plant was built by HOH Vattenteknik. Because demand varies daily, the capacity was designed to vary from 4 to 30 m^3/h (1,056 to 7,920 gal/h) at a recovery of 85%. The FILMTEC NF255-400 membrane was selected to meet the requirements above while removing color and iron and reducing COD. These elements have the added advantage of low operating pressure for energy savings, low fouling tendency, and high chemical stability to resist the effects of harsh cleaning compounds. FILMTEC NF255 membrane is the precursor to the current FILMTEC NF270 membrane. Both are thin-film composite membranes with a barrier layer of polypiperazine amide, a development that originated from the world's largest nanofiltration project (140,000 m^3/d) of Mery-sur-Oise near Paris, France. The Mery-sur-Oise project also uses FILMTEC elements.

The membrane system is a single-stage design with concentrate recirculation. Ten pressure vessels, each containing four membrane elements, are arranged in parallel. To minimize downtime, both the system feed pump and the concentrate recirculation pump are installed with a redundant pump in parallel. All pumps are controlled by frequency converters, so that they operate at just the required pressure. This is an important means of saving energy, given the varying output and a feed water temperature range of 1 to 20°C.

From an open, submerged intake in the level-regulated lake, the raw water is pretreated by rapid sand filtration and cartridge filtration. The permeate is stabilized by carbon dioxide injection and limestone filtration, with a low level of chlorination to further ensure water quality. The distribution net is widespread, covering many outlying areas inhabited only during resort seasons. There is an elevated tank that helps compensate for this varying instantaneous demand. The concentrate stream from the nanofiltration plant is returned to the lake.

Membrane Performance

The plant began operation in November 1998 and has been supplying high-quality drinking water to the community since then. All quality parameters are better than required. Regular checks at consumer intake points consistently show the absence of bacteria, although the dosage of chlorine is very low—the concentration of free chlorine in the distributed water ranges from 0.02 to 0.05 mg/L (0.02 to 0.05 ppm). The use of nanofiltration has generally decreased the need for chlorination of the distribution network.

Table 1 shows a typical example of a feed and permeate water analysis. The feed water has a very low salt concentration, mainly calcium bicarbonate. The rejection of organic matter, iron, and aluminum is very high. Divalent and monovalent ions are rejected to a lesser degree, and silica passes almost completely.

During the first two years, the operation of the plant was optimized to reduce the cost of the purified water. The permeate flow rate is now being kept constant at 27 m^3/h at 75% recovery with a concentrate recycle flow rate of 50 m^3/h. The daily water demand can change instantly from 50 to 550 m^3, and it is managed by taking the plant online and offline as needed.

Table 1. Separation performance of the nanofiltration system.

Analysis	Feed (mg/L)	Permeate (mg/L)	Rejection (%)
Color (Pt)	60-90	2	97-98
Chemical oxygen demand (COD) (Mn)	7-12	< 0.2	> 98
Total organic carbon (TOC)	13.3	0.05	99.6
UV absorbance at 254 nm, cm^{-1}	0.58	0.003	99.5
Iron	0.168	< 0.003	> 98
Aluminum	0.105	< 0.005	> 95
Calcium	6.15	0.95	84.6
Magnesium	0.84	0.161	80.8
Potassium	0.36	0.154	57.2
Sodium	0.96	0.47	51.0
Alkalinity, as HCO_3	12	5	58.7
pH	6.9	6.7	—
Conductivity, µS/cm	43.1	9.81	> 77
Silica, mg/L as Si	2.2	1.93	12.3

The cartridge filters are replaced every 6 months; the membranes are cleaned after every 400 hours of service at pH 11 and 40°C. Following this schedule keeps the membranes clean. The pressure drop is constant at about 1 bar (14.5 psi); a typical feed pressure at 3°C is 4.2 bar when the permeate back pressure is 0.5 bar.

Conclusions

Three years of efficient color and iron removal and reduced COD have shown that nanofiltration with FILMTEC membranes is a reliable technology for producing high-quality drinking water from surface lake water.

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