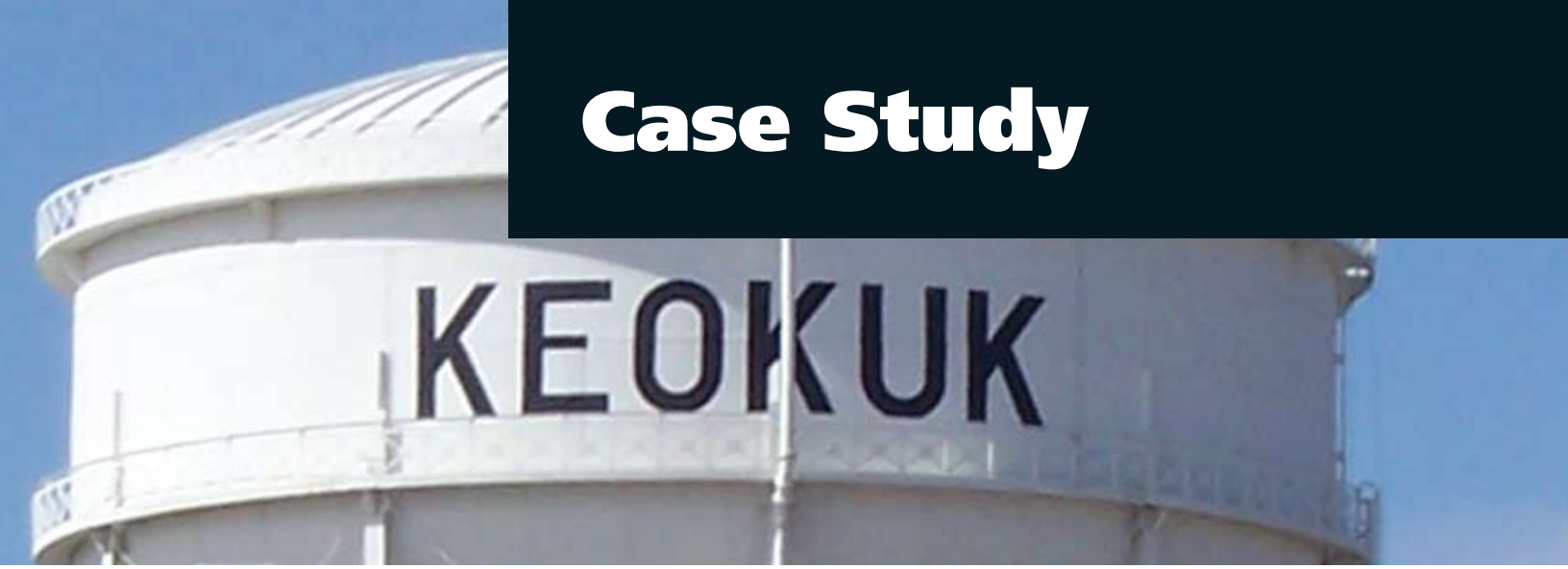

Case Study

Keokuk Municipal Water Works - First UF treatment of drinking water in Iowa

Norit X-Flow Aquaflex

Application: Integrating UF membranes into an existing water treatment plant
Capacity: 5 MGD
Location: Keokuk, IA
Commissioned: September 2006

The Challenge

Keokuk Municipal Water Works (KMWW) has been providing drinking water from the Mississippi River for the citizens and industries of Keokuk, IA since 1877. Over the years, improvements have been made to the conventional treatment facility. In 1994, anticipating compliance requirements of the enhanced Surface Water Treatment rule and increased demand, KMWW initiated a multi-phased approach to upgrade its aging drinking water treatment plants. The challenge was how to do this with the limited available space, as the plant is situated between a limestone bluff and the Mississippi River.

The Solution

Optimization of the conventional lime-softening process and introduction of low-pressure membrane filtration was the optimal solution for the city. The first phase of the project involved the replacement of the conventional softening/ settling process with improved clarifiers to increase capacity and improve water quality. This was completed in 1996. After completion, KMWW investigated adoption of hollow fiber membrane filtration. Ultrafiltration (UF) was selected over microfiltration because of its superior filtration capabilities.

After pilot testing two UF membranes in 2002 and 2003, KMWW installed the first full-scale UF treatment skid in September 2006. This skid, equipped with Norit X-Flow's SXL-225 Aquaflex modules, was the first drinking water UF treatment skid in the state of Iowa. A second skid was added in September 2007 and other skids are planned for the future.

In 2007, after more than one year of consistent performance, excellent permeate water quality and membrane integrity, Norit X-Flow's SXL-225 membrane became the first UF technology approved for potable water production by Iowa's Department of Natural Resources.

Keokuk Municipal Water Works

Norit X-Flow
leading in purification

Case Study

"We never dreamed we would be able to operate the system the way we have," says Bill Cole, general manager of Keokuk Municipal Waterworks. "The Norit membrane has exceeded our expectations."

Process Overview

KMWW treats raw Mississippi River water upstream of Lock and Dam 19. Inside the plant, the raw water is pumped to a head tank where it flows by gravity through a cold-lime softening process and then through a re-carbonation tank where the pH is adjusted to stabilize the water. Once the pH has been adjusted, chlorine is added prior to feeding the treated water to the UF plant.

The UF Plant

The UF plant consists of two skids of 100 Norit X-Flow's SXL-225 modules each. Each skid is rated for 2.5 MGD. The UF process utilizes dead-end filtration. To maintain permeability, the membranes are periodically backwashed and/or chemically cleaned. UF backwash water is recycled to the head of the plant and the chemical waste from CIP is neutralized and discharged to the local treatment plant.

The SXL-225 membrane has been awarded the highest Pathogen Log Removal Credits from the CA-DHS – 4-log for viruses, *Giardia* and *Cryptosporidium*. The UF system acts as an absolute barrier to waterborne pathogens. To ensure the membranes' absolute barrier is not compromised, the system is integrity-tested daily using pressure decay tests. This ensures the UF membranes provide the highest level of protection against waterborne contaminants. Following final filtration, the chlorine and fluoride concentrations are adjusted prior to distribution to the city.

Plant Performance

The Norit X-Flow UF system performance has exceeded all expectations by KMWW. The Norit X-Flow system provides excellent fiber reliability. After more than 22 months of continuous service, only 11 fiber repairs have been completed to date on Skid 1, which equals a reliability rating of 99.999%. There have been just three fibers repaired on Skid 2 after more than 10 months of continuous service for a 99.999% percent reliability rating to date. The UF plant consistently produces filtered water with less than 0.015 NTU.

Membrane Summary

Module type	Aquaflex version of the SXL-225 UFC M5LE
Membrane type	Hollow fine fiber, PES/PVP blend
Fiber ID	0.8 mm
Membrane pore-size rating	0.03 micron absolute (0.25-0.28 average)
Area per module	430 ft^2
Flow path	Inside-out
Certifications	Title 22, NSF61 (others outside the US)
CA-DHS LRV Rating	4-log *Cryptosporidium, Giardia* and virus

Membrane Skid Design

Skids	2	Installed area per skid	43,000 ft^2
Modules per skid	100	Capacity	2.5 MGD

System Performance

Typical UF permeate turbidity	<15 mNTU
Typical trans membrane pressure	<2-5 psid
Typical calculated 3-micron LRV from direct integrity testing, (ave/max)	5.0-log/6.2-log

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