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Clarifiers-No, Filtration-Yes: A Case Study

Problem

Twenty miles southeast of Coos Bay, Oregon situated at the conjunction of the North and South Forks of the Coquille River lays the town of Myrtle Point. Just five years ago this community of 2670 residents was facing a large potable water problem with an even larger price tag. The town feeds its water treatment plant from the North Fork Coquille River. Prior to the 1990s the water treatment plant (WTP) could take water from the river with turbidities as high as 400 NTU and still provide clean safe water to its customers in only 8 hours of operation per day. Coagulating chemicals were added to the raw water which was sent to a flash-flocculation basin and then to a sedimentation basin. The sedimentation basin was equipped with 45˚ tube settlers to reduce residence time and minimize the footprint. Gravity flow multimedia filters finished the polishing process followed by chlorination. Potable water was then sent to a three million gallon storage tank before distribution. All was well until the early 1990s when various environmental groups forced the Federal Government to passed laws prohibiting streamside logging. Such logging practices were to cease on a certain date in 1992. This legislation caused a flurry of streamside *clear-cutting* activity by landowners during the period from the law's announcement to its commencement date. Once-forested stream banks now lay bare allowing the movement of fine colloidal clays into both forks of the Coquille River. The existing flocculation and sedimentation basins at the WTP were overloaded causing some colloidal clays to migrate to the multimedia filters. Unlike the basins which just allow the excess material to pass on through, the multimedia filters stopped the clays but were quickly blinded in the process. Back flushing the filters could not be scheduled often enough to maintain the required potable water production to meet community demand. Some days when the turbidity was high the WTP would have to run 15-18 hours per day incurring large overtime costs. At other times when turbidity was very high the plant would actually have to shut down for a day or two until raw water quality improved.

Analysis

The community acquired the services of The Dyer Partnership, an engineering firm in Coos Bay, OR to design a solution to the dilemma at Myrtle Point. The customary design of a primary clarifier to handle 1200 gpm was suggested. The $600,000 installation cost was out of the question for this community. Not only was the installation cost prohibitive but clarifiers incur operational costs for chemicals and an operator. A more economical alternative had to be found. They decided to look into mechanical screen filtration. Questions quickly arose. Could screen filters reduce the turbidity sufficiently, if at all, to lighten the load of the multimedia filters? Would automatic self-cleaning filters really clean themselves under existing conditions? Are such filters reliable enough to not require constant attention? And if all these answers were "yes," would the system be economical?

A pilot testing was installed to determine the appropriate filtration degree to give ample turbidity reduction while maintaining the assurance that the filters would clean themselves in a dependable fashion. The pilot test concluded that a filtration degree of 100 microns would supply sufficient turbidity removal and completely dependable reliability.

Solution

Four fully automatic self-cleaning filters were installed and began operation in September 1999. A fifth filter was added soon after to handle the river's heavy dirt loads that occur in the spring due to snow melt and heavy rains. The multimedia filters now go three times longer between back flush cycles. Subsequent testing has shown that when the raw river water has turbidities around 230 NTU, the filters reduce turbidity by more than 50% (effluent values of approximately 111 NTU). As raw turbidity decreases to 20-40 NTU, the percent reduction by the filters generally drops to 20-40% as expected. During the warmer months when most of the total suspended solids (TSS) in the river are the result of algae, the filters remove a majority of this organic matter. Because the screen filters go through a cleaning cycle only as need, many times they only do so one time a day while at other times, such as during heavy springtime runoff events, the automatic flush cycles could be as close as every 5 minutes. Since their commissioning in 1999 the filters have performed flawlessly.

The screens are removed from the filter bodies annually and soaked in muriatic acid followed by a high pressure spray wash. This removes any encrusted material that may have mineralized onto the screen mesh during the year. Other routine maintenance includes checking monthly to make sure the threaded shaft on each filter is well greased and that there are no leaks.

Filter Operation

The following is a brief description of how each filter operates. Water from the river is pumped into the filter through the inlet flange of the filter body as shown in Figure 1. Water first passes through a coarse pre-screen to remove large hard object that can not pass through the cleaning mechanism discussed below. Water then proceeds through the multi-layer cylindrical 316L stainless steel weave-wire filter element (screen) from the inside out causing particulates larger than the filtration degree of the screen (100 microns) to accumulate on the inside surface. When a 7-psi (0.5 bar) pressure differential is reached across the screen due to debris build-up, the filter begins a cleaning cycle. During the cleaning cycle there is no interruption of flow downstream of the filter. The filter operation and cleaning cycle is controlled and monitored by a Programmable Logic Control (PLC) located inside a remote control panel.

The cleaning cycle utilizes a device called a suction scanner consisting of a 316 stainless steel hollow tube that slowly rotates and moves linearly inside the cylindrical screen. A single 2" exhaust valve opens connecting the inside of the suction scanner to atmosphere. Nozzles branch from the central tube of the suction scanner with openings only a few millimeters from the screen surface. The differential pressure between the water inside the filter body and the atmosphere outside the filter body creates high suction forces at the openings of each of the suction scanner nozzles. This suction force causes water to flow backward through the screen at very high velocity in a small area at each nozzle pulling the filter cake off the screen and sucking it into the suction scanner and out the exhaust valve to waste. This "focused-backflushing" cleans less than 1 square inch of screen area at any one time. This small cleaning area is then moved across every square inch of filtration area in about 20 seconds. A differential pressure of at least 35 psi (2.4 bars) at the nozzle opening is required for efficient screen cleaning. At the Myrtle Point WTP the operating pressure of the system is maintained at 44 psi giving sufficient cleaning performance under all conditions.

The electric driving mechanism rotates the suction scanner at a slow, fixed rotation while simultaneously moving the scanner linearly at a fixed speed by the action of a threaded shaft and fixed threaded bearing. The combination of rotation and linear movement gives each suction scanner nozzle a spiral path along the inside surface of the filter screen. The cleaning cycle is completed for each filter in 20 seconds during which time the nozzles remove the captured debris from the entire filtration area of the screen element.

The Myrtle Point installation of five filters includes a single differential pressure switch across the inlet and outlet manifolds of the system. When a differential of 7 psi (0.5 bars) is sensed, the cleaning cycle begins by initiating focused-backflushing in two of the filters simultaneously. After their 20 second cleaning cycle is completed, two more filters flush together. Then the final filter goes through its cycle. This method assured that all filters are cleaned completely during the same cycle and all are doing their share of the work.

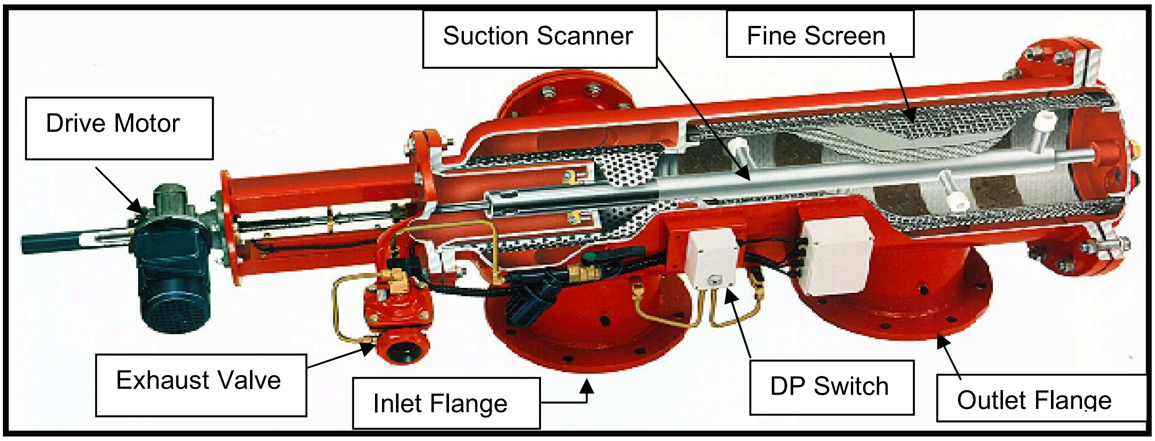

Figure 1

Economics

The pretreatment budget estimate for a clarifier designed to handle 1200 gpm was $600,000. In addition to this installation cost would be annual operating costs for coagulating chemicals and an operator. The purchase cost of the five automatic self-cleaning filters was $135,000. When all costs for such items as a concrete building to house the filters, electrical equipment, installation costs and engineering fees were combined, the entire system cost the people of Myrtle Point $277,000. That's a 54% savings that has proven itself over the past five years plus there are no annual operating costs. Now the WTP operates only 8 hours per day even when the river turbidity is at its highest. There is no longer the need for overtime salaries and the plant never has to shut down because of water quality conditions in the river.

Summary

Upstream conditions can change. And when they do, downstream municipalities who utilize the river as a source of water must make changes to accommodate those changes. Not accepting traditional answers as the only recourse, the people of Myrtle Point found an acceptable alternative while saving over 50% in the process. After five years of continuous operation, the five Amiad SAF-6000 Filters with 100 micron screens have provided the city with pretreated water under widely varied river quality conditions while extending the interval between multimedia flushing by three times. Not only were the initial purchase and installation costs low but annual operational costs are nearly zero. Screen filtration is a proven alternative to clarifiers for river water pretreatment.

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