New Solution for Primary Wastewater Treatment: Cloth Media Filtration

John D. Dyson

Primary filtration and primary effluent cloth media filtration are both emerging technologies in wastewater treatment. The goal of these technologies is to reduce the organic loading to the secondary treatment process, which saves energy and can increase capacity. This is achieved by diverting biochemical oxygen demand (BOD_5) and volatile suspended solids (VSS) from raw wastewater prior to main biological treatment and the anaerobic digestion process, reducing activated sludge loading and increasing gas production in the digestion process. Figure 1 and Figure 2 show typical plant schematics for primary filtration and primary effluent filtration, respectively. In primary filtration, the cloth media filter replaces the primary clarifier; in primary effluent filtration, the cloth media filter follows the primary clarifier and before the secondary process.

An additional application may consist of filtration of gravity thickener overflow (GTO) and centrate sidestreams as a pretreatment step to remove solids and debris. This has the potential to decrease operation and maintenance costs by reducing the BOD_5 and total suspended solids (TSS)/VSS load. Capturing solids and diverting TSS/VSS and BOD_5 from the proposed sidestream biological treatment to the anaerobic digesters has the same potential to reduce aeration demand and operational costs.

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Background

Aqua-Aerobic Systems became involved

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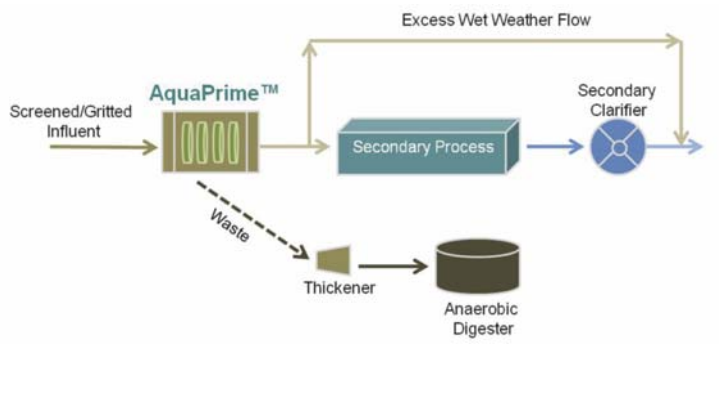

Figure 1. Plant Layout for Primary Filtration

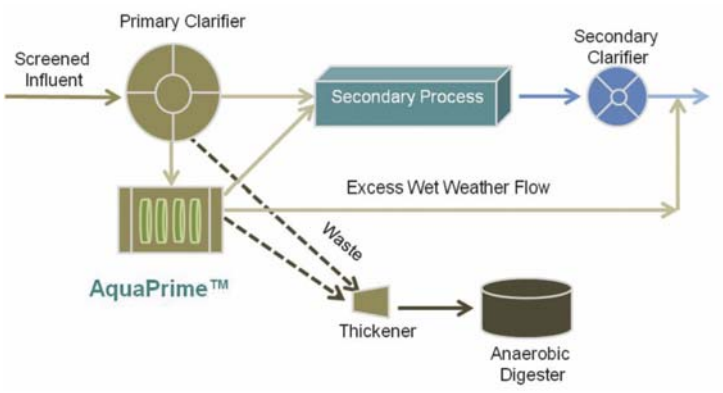

Figure 2. Plant Layout for Primary Effluent Filtration

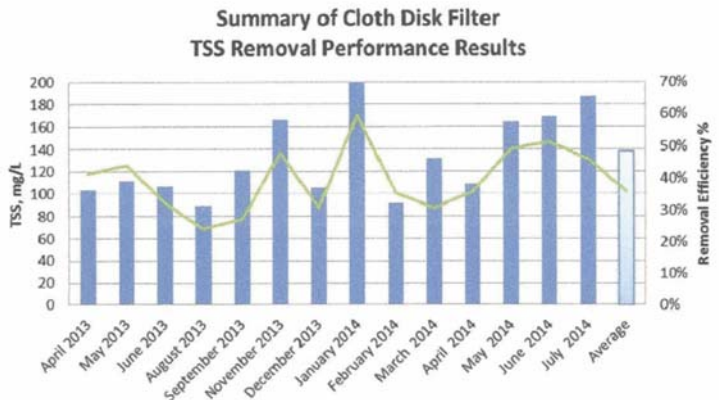

Figure 3. Total Suspended Solids Removal in California Energy Commission Study for Cloth Disk Filter

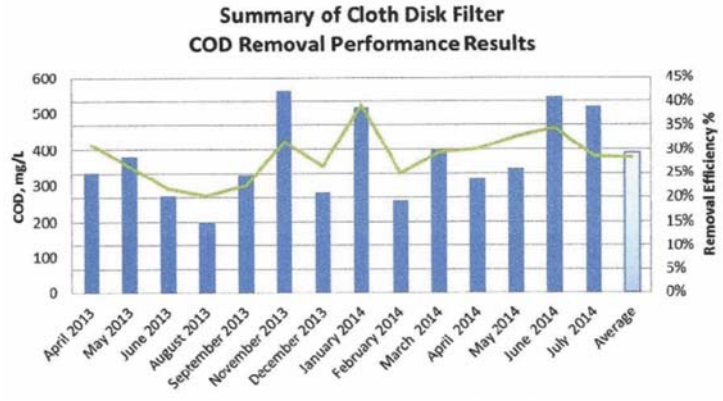

Figure 4. Chemical Oxygen Demand Removal in California Energy Commission Study for Cloth Disk Filter

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with primary effluent filtration in 2013 with a study funded by the California Energy Commission (CEC) and Kennedy Jenks Consultants. Five technologies were selected to participate in this study. The cloth media filter performance exceeded expectations; the unit ran the entire two years, with 99 percent uptime and no cloth wear. The TSS was reduced by 50 to 60 percent to the aeration basin. By the end of the study, the company's cloth media filter was one of only two technologies remaining.

Figures 3 and 4 show the TSS and chemical oxygen demand (COD) removal rates during the year, plus phase 1 of the CEC study.

Based on the success from the CEC study, independent testing of primary filtration was conducted at the Rock River Water Reclamation

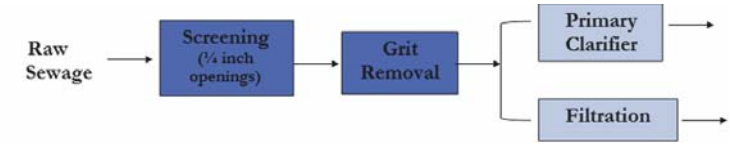

Figure 5. Rock River Water Reclamation District Primary Filtration Study Process Flow

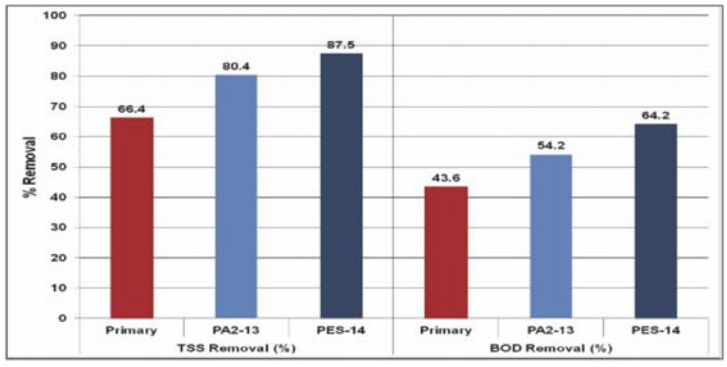

Figure 6. Total Suspended Solids and Biochemical Oxygen Demand Removal Across Primary Clarifier, PA2-13 Cloth, and PES-14 Cloth in Rock River Water Reclamation District Study

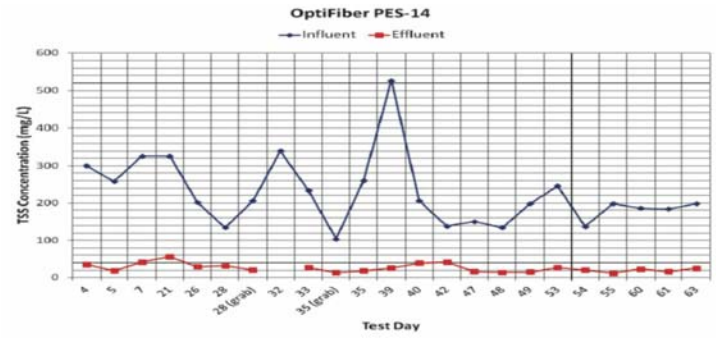

Figure 7. Total Suspended Solids Removal Across Primary Clarifier PES-14 Cloth in Rock River Water Reclamation District Study

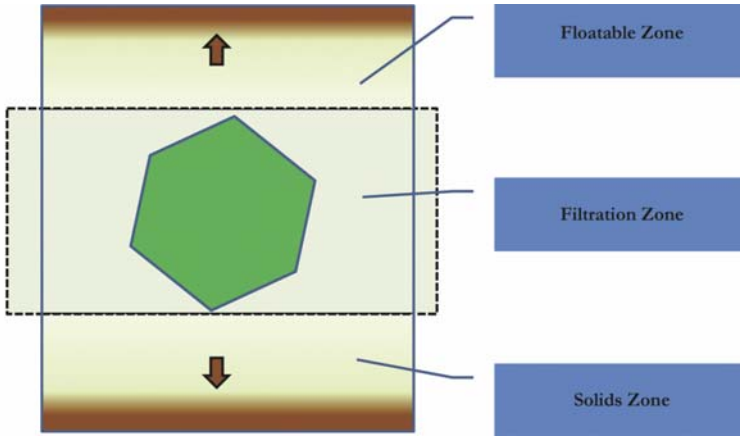

Figure 8. Three Zones for Solids Removal in Cloth Media Filter

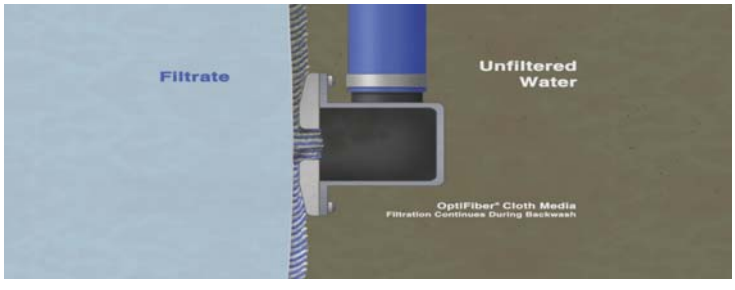

Figure 9. Backwashing of Cloth Media

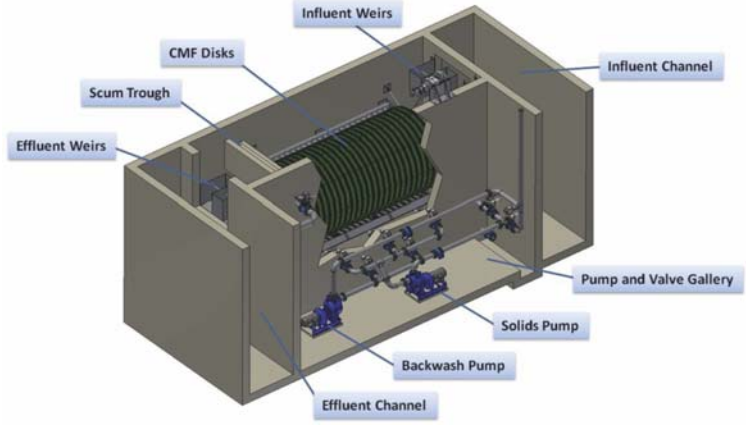

Figure 10. Cloth Media Filtration Package Unit – 108 ft² Disks

District in Rockford, Ill. This testing was conducted over six months using water pumped from before the primary clarifier, and the process schematic is shown in Figure 5. The performance of the primary clarifier was compared to the performance of the cloth media filter. OptiFiber PA2-13® cloth filtration media and OptiFiber PES-14® cloth filtration media were tested during this study with much success (Figures 6 and 7).

Based on successful testing, several pilot units were developed.

Cloth Media Filtration Unit Design

Cloth media filtration has been used in tertiary applications for over 20 years. Its proven performance and operational advantages model a viable solution for primary filtration or wet weather treatment applications.

The outside-in flow path in cloth media filters allows for three zones of solids removal. These three zones become even more critical in wet weather applications due to the high solids environment in primary filtration and wet weather treatment applications (Figure 8).

Floatable Zone

The top zone is the "floatable zone," where floatable scum is allowed to collect on the water surface. As the water level increases, the scum is removed by flowing over the scum removal weir, where it's then directed to the plant's waste han-

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Figure 11. Primary Filtration and Wet Weather Pilot System

Table 1. Total Suspended Solids Removal Using Primary Filtration

	Media	Influent (mg/L)	Effluent (mg/L)	Removal
RRWRD	PA2-13	253	44	80%
RRWRD	PES-14	221	26	88%
Oak Hill, WV	PES-14	176	31	81%
The Dalles, OR	PES-14	206	40	80%
Asheville, NC	PES-14	188	24	87%
TRA, TX	PES-14	273	33	87%
Prescott, AZ	PF-14	188	33	82%

Table 2. Biochemical Oxygen Demand Removal Using Primary Filtration

	Media	Influent (mg/L)	Effluent (mg/L)	Removal (%)
RRWRD	PA2-13	220	95	54%
RRWRD	PES-14	169	59	64%
Oak Hill, WV	PES-14	242	149	40%
The Dalles, OR	PES-14	168	65	59%
Asheville, NC	PES-14	184	112	40%
TRA, TX (COD)	PES-14	487	204	58%
Prescott, AZ	PF-14	225	112	50%

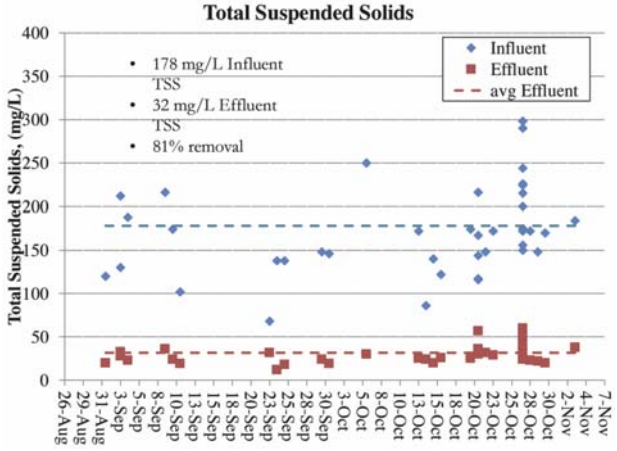

Figure 12. Oak Hill, W.V. – Primary Filtration: Total Suspended Solids

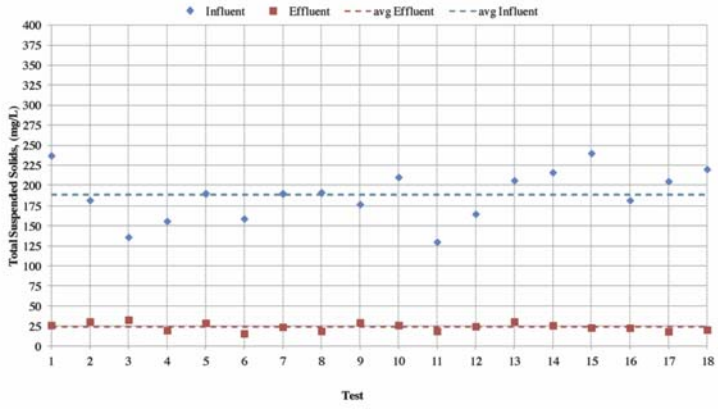

Figure 13. Asheville, N.C. – Primary Filtration: Total Suspended Solids

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dling facilities. The floatable scum is removed typically one to three times per day by opening a floatable valve.

Filtration Zone

The middle zone is the "filtration zone," where the majority of solids are removed through filtration. Here, solids deposit on the outside of the cloth media, forming a mat as filtrate flows through the media. Once a predetermined liquid level or time is met, the backwash shoe contacts the media directly and solids are removed by vacuum pressure using the backwash pump. During backwash, fibers fluidize to provide an efficient release of stored solids deep within the fiber (Figure 9).

Solids Zone

The bottom zone is the "solids zone," when heavier solids collected on the bottom of the tank are removed on an intermittent basis. The solids are removed from the hopper with collection laterals and the backwash pump.

Cloth Media Filtration Arrangement

With knowledge of the three zones, ways to further improve solids removal were considered (Figure 10):

- A floatable baffle and valve were added to remove floatable scum that accumulates in the floatable zone of the tank.
- The solids zone was enhanced by improving the hopper bottom design and adding an improved solids collection manifold.
- Other enhancements included elevating the tank height, moving the influent baffle, and raising the center tube.

Pilot Testing and Case Studies

A pilot trailer and three stand-alone units were constructed and specifically designed for primary filtration and wet weather filtration applications; the unit is shown in Figure 11. The cloth media filter in this pilot unit features the modifications that were previously described. The unit is currently traveling around the United States and is collecting data at various plants.

Pilot Results

Primary filtration studies were completed at five sites. The results from these studies are summarized in Tables 1 and 2, and the percent of TSS removal is consistently between 80 and 88 percent. Variations in BOD_5 removal are due to differences in the fraction of BOD_5 that is soluble among these sites.

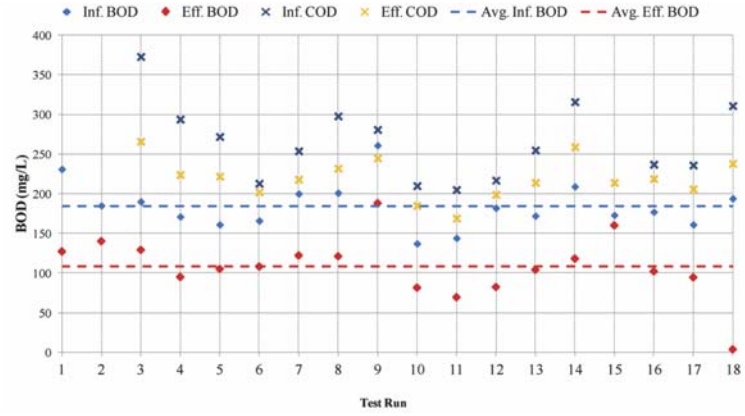

Figure 14. Asheville, N.C. – Primary Filtration: Biochemical Oxygen Demand

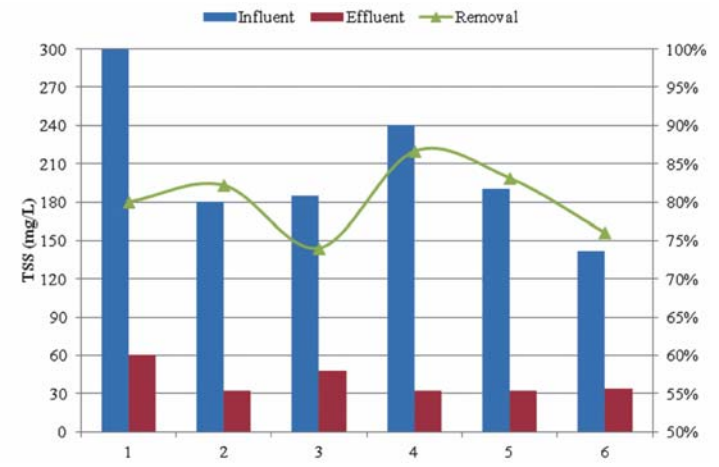

Figure 15. Dalles, Ore. – Primary Filtration: Total Suspended Solids

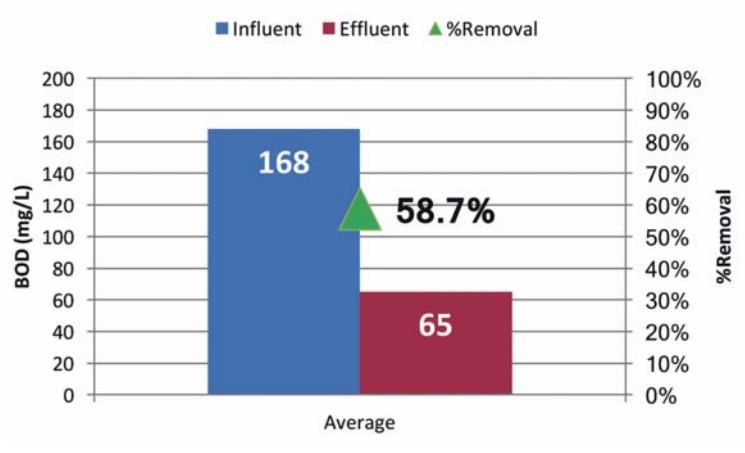

Figure 16. Dalles, Ore. – Primary Filtration: Biochemical Oxygen Demand Reduction

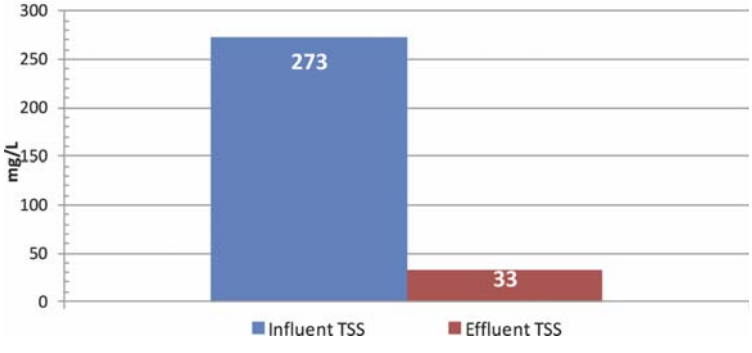

Figure 17. TRA Central, Texas – Primary Filtration

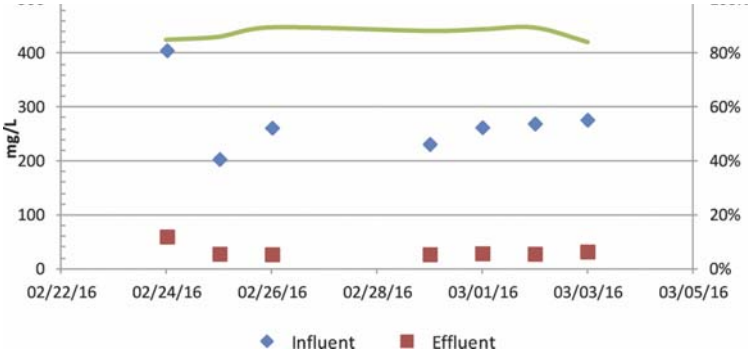

Figure 18. TRA Central, Texas – Primary Filtration: Total Suspended Solids Removal

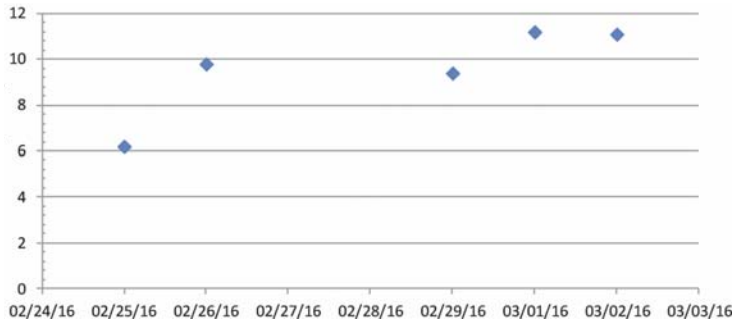

Figure 19. TRA Central, Texas – Primary Filtration: Solids Loading Rate

Figure 20. TRA Central, Texas – Primary Effluent Filtration: Total Suspended Solids

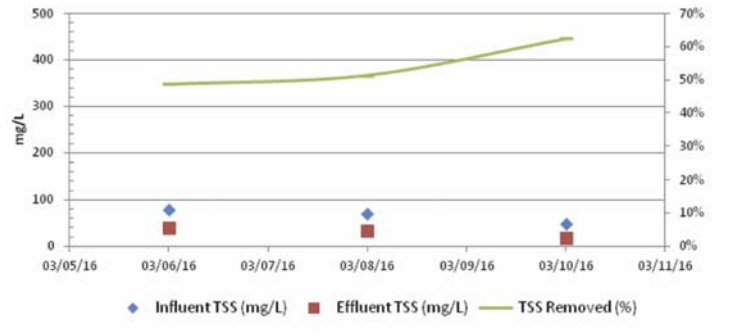

Figure 21. TRA Central, Texas – Primary Effluent Filtration: Total Suspended Solids

Primary Filtration Pilot Results

Some primary influent results from some of the studies are shown in Figures 12-19.

Primary Effluent Filtration Pilot Results

Some primary influent results from some of the studies are shown in Figures 20 and 21.

Full-Scale Testing

Following the success of the first CEC study, a second study has been approved to assess the full-scale impact of primary filtration over a three-year period in Linda County, Calif. The current plant has two trains designed for 1 mil gal per day (mgd) each. During the study, the primary clarifier in one of the two trains will be replaced with the company's cloth media filter. These two trains will be operated independently and carefully monitored for differences in performance and microorganism populations. The biological process has a Modified Ludzak-Ettinger (MLE) configuration for nitrogen removal, which will help to answer how primary filtration impacts nutrient removal.

Conclusions

The cloth media filtration technology is viable for treating many different primary and primary effluent applications. The technology provides a high-quality effluent, easy operation, and major operating savings in reduced energy consumption in the treatment facility. The energy saving is achieved in a treatment facility due to carbon diversion principles. Due to the high removal percentages demonstrated by cloth media filtration, which are generally from TSS (75 to 85 percent removal) and BOD_5 (45 to 60 percent removal), these numbers are general 20 to 30 percent greater than conventional primary sedimentation.

Cloth media filtration produces significant energy and capital cost savings due to carbon diversion, as compared to conventional primary sedimentation. The advantages of the cloth media filtration process are:

1. Reduced electrical energy required for aeration in secondary treatment due to reduced organic loading
2. More biogas energy production in the anaerobic digestion process due to the high organic energy content of the VSS removed in cloth media filtration
3. Potential expanded plant capacity by reducing the organic loading upstream of the secondary process
4. Reduction of footprint required for primary treatment to 10 to 20 percent of conventional sedimentation solutions

References

- Caliskaner, Onder; Tchobanoglous, George; Young, Ryan; and Laybourne, Sarah (2014). "Demonstration of Primary Effluent Filtration for Carbon Diversion to Save Energy and Increase Plant Capacity." Proceedings, WEFTEC 2014; New Orleans, La.