Maximizing Site Production
at New Membrane Plant

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The growing scarcity and cost of high-quality water supplies in California have put pressure on water purveyors, engineers and treatment process equipment suppliers to design highly efficient water treatment systems. The Eastern Municipal Water District (EMWD), Carollo Engineers, and GE-Zenon responded to this pressure in the design of the 12 mgd Hemet Water Filtration Plant (HWFP).

The plant treatment process includes coagulation, pre-stage coagulation, ultrafiltration (UF), chlorine disinfection, and chloramine residual. The plant is the first 98% recovery membrane filtration plant to receive the maximum 4-log disinfection credit for cryptosporidium from the California Department of Public Health (CDPH). The facility was designed to achieve these high numbers without the use of a backwash wastewater recovery system in order to minimize the building footprint on the five-acre project site and control the initial project cost.

The three main features that were developed and implemented to optimize process efficiency, maximize site capacity, and enhance system availability include minimizing waste wash water, re-rating the plant to 12 mgd, and minimizing reliance on space intensive equalization tanks.

Minimizing Waste Wash Water
Previously approved California membrane treatment systems had recoveries of 85% or less. For the initial Hemet plant capacity of 10 mgd, the increase in recovery from 95% to 98% reduced wastewater volume by 390 acre-foot (117 million gallons) annually.

However, the innovative process raised a new regulatory challenge. Increasing the recovery of the membranesystem increased the maximum solids concentration or Volumetric Concentration Factor (VCF) and therefore the maximum pathogen concentration from 20 to 50 in each of the six membrane tanks. Consequently, this higher recovery makes it more challenging to get the full 4-log cryptosporidium removal credit that is usually awarded to a membrane system in the state of California.

To minimize the solids concentration in the membrane feed water while maintaining 98% recovery, a specific membrane tank design was developed based upon guidelines from the USEPA Membrane Filtration Guidance Manual (MFGM). The high recovery is achieved by using a two-zone membrane tank and a periodic partial concentrate drain.

The end part of the membrane tank exhibits maximum solids concentration that is 10 times the solids concentration in the front part of the tank. In order to enhance the efficiency of the deconcentration phase, the end part (i.e., zone 2) of each tank can be isolated and drained separately while the low solids concentration feed water in the front part (i.e., zone 1) is saved for further filtration.

A six-month pilot test and a full-scale sampling campaign were performed respectively during construction and start-up to obtain CDPH approval and confirmed the solids concentration in the membrane tank over time. Pilot testing protocol and sampling protocol were based on the MFGM. The two and a half years of operation confirmed the sustainability of the approach by allowing EMWD to extend the chemical cleaning interval from one month up to three months.

Re-rating to 12 mgd
Because the facility was designed for an ultimate capacity of 40 mgd on a small site, some of the infrastructure and equipment built into the initial phase of the project have capacity in excess of the rated 10 mgd. Once the membrane system had been demonstrated to reliably produce its design capacity, efforts
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Figure 2. VCF sampling shows that design and actual task maximum VCF agree well.

Minimizing Reliance On Equalization Tanks

Membrane processes are characterized by periods of production at flows higher than the rated capacity followed by short periods of downtime for backwashing and cleaning. In many cases, flow equalization either upstream as pretreatment or downstream as on-site storage capacity is used to minimize variability in flows from finished water pumps. Site constraints did not allow this approach at Hemet. Instead, a combination of the use of a raw water sleeve valve and careful tuning of production and cleaning cycle sequencing was used to minimize flow variations from the six membrane tanks.

Figure 4 depicts the distribution basin and high service pump arrangement. Figures 5 and 6 illustrate the differences in performance prior to and following tuning of the membrane system sequencing.

Figure 3. CT basin and FWPS capacity evaluation.
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The 280,000-gallon CT basin includes an inlet and outlet control structure ensuring adequate water volume to meet disinfection goals at 40 mgd build out our capacity. The overflow from the disinfection zone of the tank feeds a forebay from which the high servicio (distribution system) pumps are stationed. The limited volume of water above the inlet weir and in the forebay provides the equalization volume available to accommodate periods of downtime for all the membrane trains.

Initial testing at 12 mgd demonstrated that when multiple trains were offline for cleaning operations, water levels in the forebay dropped below critical levels, initiating an automated shut-down sequence provided to protect the pumps from running dry. This prevented the plant from meeting the goal of 12 mgd of production.

Figure 5 shows the variation in filtered water total flow from membrane tank cleaning operations, and corresponding decreases in high service pump flows. As shown in Figure 6, modified sequencing designed to stagger non-production cleaning intervals of the membrane trains results in more stable flow allowing the pumps to operate at a stable rate of 12 mgd.

Conclusion

The Hemet Water Filtration Plant project demonstrates that a partnering approach between owner, engineer, and supplier allows the owner to take full advantage of a membrane filtration process without negatively impacting the interests of the supplier. This is a win-win situation that could certainly apply to many future membrane projects.

About the Authors:

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