

Reclaimed Water Reduces Stress on Freshwater Supplies



Courtesy: Veolia Water Technologies

Power generation need not be another source of strain on diminishing freshwater resources. Well-established water reclamation technologies are enabling producers to conserve resources—and money.

Michael Pudvay

Meeting the needs of a planetary population expected to surpass eight billion people by 2025 is requiring more output from fewer resources. In the case of dwindling supplies of freshwater, the strain on the natural resource from economic and population growth, and climate change, can be exacerbated by other demands. One example: producing enough food for the growing population. Agriculture requires large quantities of water for irrigation and now claims close to 70% of all freshwater appropriated for human use.

Power generation is another rising demand drawing heavily on water resources. The energy sector is responsible for 10% of global water withdrawals, second only to agriculture, mainly for power plant operation as well as for production of fossil fuels and biofuels. As new power plants are built to accommodate the growing population's power needs, increasing amounts of water will be needed for power generation and cooling. By 2040, 16% of electricity consumption in the Middle

East will be related to water supply, according to the International Energy Agency.

Interwoven Resources

In addition to water's importance to power production, energy is also vital to providing freshwater needed to power systems that collect, transport, distribute, and treat it. Each resource is thus interdependent on—and vulnerable to—the other. For the power generation sector, constraints on water can challenge the reliability of existing operations as well as the physical, economic, and environmental viability of future projects. Conversely, the use of water for energy production can impact freshwater resources, affecting both their availability (the amount downstream) and quality (their physical and chemical properties).

In recognition of the vulnerability of water, a resource critical to the future of power generation, the industry is increasingly looking to solutions that conserve water through reclamation, recycling, and reuse.

Multiple Solutions

A relatively easy way for the industry to reduce water consumption is to use water more efficiently, such as by increasing the cycles in cooling towers. Another method is identifying nonfreshwater sources for cooling, which accounts for most of the water usage in a power plant. This can involve recycling and reusing plant wastewater and/or using treated sewage or industrial wastewater from an external source. Power unit efficiency can also be improved to produce more megawatts per gallon of water used, which also adds to both sustainability and profitability.

One solution for power plants to reduce freshwater usage that is proving increasingly interesting is using reclaimed water or treated municipal wastewater. Use of sewage effluent for cooling began in the U.S. in the 1970s, and it is proven and safe. Today, more than 70 power sites in the U.S. are using treated, reclaimed water—and not just in arid regions.

Highly available, sewage is a virtually risk-free source. It has consistent quality and

1. Small but effective. The Hydrotech Discfilter is a mechanical, self-cleaning filter that offers a large filter area in a small footprint. *Courtesy: Veolia Water Technologies*



temperature compared to surface waters. Because secondary effluent is relatively consistent in quality, the treatment process, and the design and operation of the water treatment system, become easier. In addition, the cooling tower blowdown may be able to be returned to the municipality, eliminating one of the waste streams requiring treatment at the power plant.

Reclamation Requirements

Several sets of regulatory requirements govern the use of reclaimed water for cooling. Federally, the Clean Water Act requires a permit, issued under the National Pollutant Discharge Elimination System (NPDES) program, authorizing any discharges of pollutants to surface waters. The U.S. Environmental Protection Agency (EPA) implements the NPDES program and has the power to authorize states to issue permits and administer the program.

NPDES permits contain discharge limits determined by the treatment technology that the EPA believes is available and affordable, as well as by the states' water quality standards and available dilution in the receiving water bodies. State rules vary according to factors such as the likely degree of public exposure to reclaimed water. Where exposure is high, reclaimed water must be highly treated. States usually establish limits on fecal or total coliform bacteria and may require that wastewater be filtered before it can be reused as reclaimed water. Turbidity standards are also frequently established.

On the operational side, unique treatment issues posed by utilizing reclaimed water include the need to determine cleanliness levels that must be achieved to satisfy a plant's individual operational requirements. Reclaimed water's chemical elements can cause problems like mineral scaling, corrosion, stress cracking, and biofouling. These

problems can increase in closed-cycle cooling systems when water evaporates and leaves behind higher concentrations of constituents.

To control the water quality, power plant operators have a number of options, including removal of some of the concentrated, recirculating water. Flow volumes and makeup can also be adjusted, and incoming reclaimed water can be treated prior to being added to the recirculating system.

What Is the Best Option?

In determining whether use of reclaimed water makes sense for a power plant, a series of questions need to be asked about the circumstances.

Some questions to ask and items to consider include:

- Does the plant need to meet a specific legal or regulatory performance requirement? It is imperative that plant management understands all legal and regulatory obligations before making modifications. There is no excuse for breaking the law.
- What are the costs? The costs of technologies can vary widely. Investment in disc filtration, for example, even for a very large flow may be as low as \$500,000 to \$1 million. While ultrafiltration costs may be three to four times as expensive, other savings such as from running cleaner water through the system or lowering chemical costs may favorably impact life cycle costs. The costs of freshwater resources also are rising in some places and beginning to reflect the true costs of water.
- What are the benefits? These may include less immediately tangible, but still important, benefits to the power company's image with key stakeholders. For example, decreasing discharges of secondary effluent and reducing pressure on water resources to the benefit of local communities could be a positive example of corporate social responsibility for power companies.
- Are there publicly owned treatment works (POTWs) nearby to keep the costs of transporting wastewater sufficiently low? A study by the University of Pittsburgh found that 97% of power plants proposed in the U.S. could meet their cooling needs by utilizing secondary treated wastewater from POTWs located within 25 miles.
- What is the level of water risk in the local area? As the effects of climate change continue to manifest themselves, it is clear that no place is safe—even in the historically rain-soaked Northwest, the states of Washington and Oregon have been faced with drought emergencies in recent years.

- What technical option is the best approach? Alternatives could include clarifying systems, disc filters, biological processes, submerged microfiltration, or ultrafiltration membranes.
- Are there special issues that need to be addressed? For example, some POTWs have low ammonia levels, while others can be quite high. Chlorine treatment is one option, but breaking down the ammonia requires high levels of chlorine, creating new risks and adding costs. Biological systems may negate some of these concerns although requirements to maintain a minimum flow circulation even during planned power outages can be a drawback.
- Is the power company comfortable operating the water treatment system, especially if it's biological? If not, alternative solutions may be possible, such as having the POTW host and operate it, or outsourcing the operation to the system supplier.

Based on the responses to these and other questions, determining the right combination of primary and secondary systems to provide the appropriate level of water purity at a reasonable cost can be determined with the help of an expert systems solution provider.

Award-Winning Treatment

A pretreatment strategy was the approach applied in the growing city of Mankato, Minn. The city installed a new water reclamation facility (WRF) to treat effluent from its wastewater treatment plant (WWTP), which would supply the cooling tower needs of an electrical generation plant. In addition to providing quality reuse water for the energy center, the WRF needed to meet new state phosphorus removal regulations.

2. Efficient filter media. Solids catch on the inside of Hydrotech Discfilter panels. As solids impede flow, water level increases, triggering disc rotation and a backwash cycle. *Courtesy: Veolia Water Technologies*



A Two-Stage Process

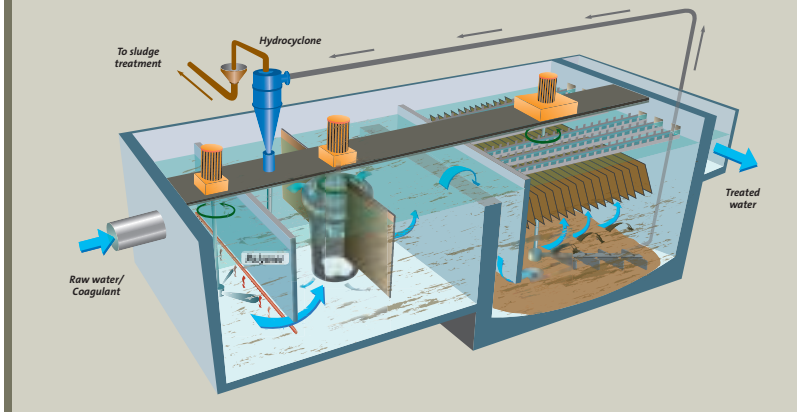
ACTIFLO Turbo technology (Figure 3) uses a patented draft tube design to flocculate incoming solids with a proprietary microsand. The dense microsand acts as a ballast as flocculation occurs, and dramatically increases the settling rate of the solids. This results in excellent solids/metals separation, using a very small footprint. Hydrocyclones separate the sludge from the microsand, and recycle it back into the unit, adding to the sustainable operation of the unit by minimizing sludge volume.

The Hydrotech Discfilter process offers

the following benefits:

- Low cost gravity filtration
- Low power consumption
- Small footprint
- Continuous filtration
- High water recovery
- Low backwash rate (no large pumps or sumps required)
- Automatic backwash and flat panel design are easy to keep clean
- Low installed cost (can use existing basins for frame design or flat pad for tank designs)

3. State-of-the-art clarification. ACTIFLO is a high-rate, compact water clarification process in which raw water is flocculated with microsand and polymer in a Turbo-mix draft tube reactor. *Courtesy: Veolia Water Technologies*



The city turned to Veolia Water Technologies, a global expert in optimizing water use and wastewater treatment. Veolia provided a two-stage treatment process using a combination of its ACTIFLO and Hydrotech Discfilter (Figures 1 and 2) processes (see sidebar). The first stage ACTIFLO process is a compact, extremely high-rate clarification system that utilizes the combination of coagulation, flocculation, and sedimentation, using microsand as a seed for floc formation. The microsand provides surface area that enhances flocculation and acts as a ballast or weight. This first stage was designed to provide phosphorus removal for all of the WWTP's current and future needs. The second stage provides additional filtration to meet the California Title 22 water reuse requirements, which focus on suspended solids and effluent turbidity reduction.

The system enabled the city to avoid supplying water from its local surface and groundwater supplies to the power facility in order to accommodate the plant's needs. Annual savings for the city from the process

changes were estimated to be about 680 million gallons of water and \$1.5 million in potable water costs. In saving its natural water supply and monetary expenses, the city was able to turn waste into a resource.

The effluent water characteristics produced by the Mankato treatment facility are:

- Total phosphorus <0.4 milligrams/liter (mg/L)
- Total suspended solids <5 mg/L
- Turbidity <0.6 nephelometric turbidity unit
- Biochemical oxygen demand <2 mg/L

The water reuse project was the first of its kind in the state of Minnesota and one of the first in the nation. The Minnesota chapter of the American Public Works Association gave the Mankato facility its Project of the Year award following the treatment process upgrade, and it was also honored with a Minnesota Government Reaching Environmental Achievements Together (MnGREAT) award (see opening photo).

4. BIOSTYR. The BIOSTYR biological aerated filter system removes ammonia and a majority of solids from municipal wastewater. *Courtesy: Veolia Water Technologies*



Replicated Success

Veolia has also helped clients in custom-designing biological processes to resolve other specific treated effluent challenges, such as ammonia. In New Jersey, Veolia furnished West Deptford Energy with a BIOSTYR biological aerated filter and Hydrotech Discfilter system, allowing effluent from a municipal wastewater plant to be reused in the operation of their new environmentally friendly energy station.

The BIOSTYR process (Figure 4) combines biological treatment and filtration into one compact system, removing ammonia and a majority of wastewater solids. The BIOSTYR effluent is then gravity fed into the Discfilters, which provide an ideal filtration system for solids removal above 10 micron, thus producing much cleaner water needed for use in plant operations. The use of recycled water has proven to be a win for the environment and for West Deptford Energy in saving significant chemical oxidant costs while making their power station a model of highly efficient and sustainable energy generation.

After the power plant was operating, West Deptford Energy decided to add ultrafiltration (UF) to further treat the effluent from the Discfilters. The UF treated water was a suitable source for their existing boiler feedwater system, which further reduced their reliance on city water and the cost associated with it.

As the strain on freshwater resources intensifies and energy demand grows, the power industry is increasingly turning to reclaimed water as a highly valuable resource. Reclaimed water offers a win-win solution that ensures the continued ability to respond to rising global demand by an inseparable pair. ■

—**Michael Pudvay** (*michael.pudvay@veolia.com*) is an industrial projects business development manager at Veolia Water Technologies.