WWW.CHEMICALPROCESSING.COM

CHEMICAL PROCESSING

LEADERSHIP | EXPERTISE | INNOVATION

Special Report

SEIZE WATER CONSERVATION OPPORTUNITIES

Start ▶

PutmanMedia®

TABLE OF CONTENTS

AD INDEX

Chemical Processing Plants Save Water

Operating companies step up conservation and re-use efforts

By Seán Ottewell, Editor at Large

AS OUR February cover story "The Tide is Turning," www.chemicalprocessing.com/articles/2013/sustainable-water-management-the-tide-is-turning/, highlighted, chemical makers increasingly are focusing on water-related issues. In particular, concern over availability is spurring leading operating companies to implement a host of novel strategies and technologies to optimize water use.

For instance, as part of its contribution to World Water Day on March 21st, Dow Chemical, Midland, Mich., outlined how it's optimizing water use at two of its major facilities — at Brazosport, Texas, and Terneuzen, the Netherlands.

Brazosport, which covers more than 5,000 acres near the mouth of the Brazos River and which Dow claims is the largest integrated petrochemical facility in the world, is in an area that experienced severe drought conditions in 2011. This prompted the company to launch a number of initiatives aimed at conserving water — including establishing a water strategy director and steering team, a community water symposium and a contest for employees for water-conservation-project ideas.

As a result of all these efforts, Dow identified and implemented:

- *Chlorine once-through cooling-water recycle*. This project recycles the once-through cooling water for the rectifiers at one of the chlorine plants, as well as the once-through cooling water for an air compressor station to the site's clarified water system for general re-use, and represents about 1,300 gpm in savings.
- *Eliminating one-pass fire-water monitor cooling at a power station*. Installation of piping allowed use of seawater for cooling, saving 200 gpm of continuous freshwater use and 200–600 gpm during startups and shutdowns;
- *Demineralization plant resin change*. This project significantly improved the operation of a resin bed, and also included modifications to a reservoir to maintain the gains in efficiency;
- *Supplemental cooling automation at another power plant*. The idea initially was to change from water cooling to air cooling for a section of the power plant that required intermittent cooling. However, space was insufficient to install the required fin-fan exchangers. So, instead, existing equipment was slightly modified and process control was implemented to allow for the automation of the cooling water valve;

DUTCH COMPLEX

Figure 1. Access to fresh water long has been a challenge for Terneuzen facility. *Source: Dow Chemical.*

COOLING SYSTEM CHANGE

Figure 2. Santa Clara, Calif., hydrogen plant now uses recycled water as makeup for cooling system. *Source: Air Products.*

- *Improved cooling-tower chemistry*. Dow worked with its water treatment chemical provider to modify the water treatment chemistry on 25 cooling towers to reduce makeup water by 400 gpm;
- *Soft water recycle*. Installation of piping, valves, flow meters and other instrumentation enabled recycling soft water from a propylene oxide plant to the site river water header when only two trains are running — saving 3,000 gpm;
- *Improved maintenance of many older river water lines*. Identifying and fixing leaks as part of a maintenance strategy reduced water draw by another 1,000 gpm; and
- *Other efforts*. Eliminating slab washing and watering landscaping saved another 3,500 gpm.

In addition to the almost 10,000 gpm saved by these projects, temporary water-conservation measures further reduced consumption by 3,500 gpm.

At Dow's Terneuzen facility, which is another massive chemical complex and the Dutch city's heaviest industrial water user, one of the main challenges has been the plant's location — at a seaport where for decades fresh water has had to be piped in from a distance of over 120 km (Figure 1).

Over the years, Dow has worked with local desalination plant operator Evides to re-engineer its plant with reverse osmosis membranes, low-pressure feed pumps and improved process automation. In 2010, the city's wastewater treatment plant was equipped with a membrane bioreactor (MBR). The MBR serves various objectives — for example, it adds 20% treatment capacity to the municipal plant while dramatically improving the quality of effluent sent to Evides' facility.

As a result, Dow and its partners now are twice reusing the community's treated wastewater through an innovative wastewater recycling program, thereby using every liter of water three times instead of once.

Today, Evides purifies 10,000 m^3/d of municipal household wastewater for Dow, which uses it to generate steam and feed its manufacturing plants. Steam condensate serves in cooling towers until the water finally evaporates into the atmosphere. Compared with conventional desalination of seawater for the same use, recycling Terneuzen's wastewater cuts energy use by 95% — the equivalent of reducing its carbon dioxide emissions by 60,000 tons each year, says the company.

Not only is membrane separation inherently more energy efficient than desalination but using municipal effluent instead of seawater as the raw water source requires less driving force (pump pressure) to remove salt from the water because it has a lower salt content. In addition, the lower-salt-content effluent pares use and cost of chemical treatment of the membrane systems in half.

FOCUS ON ASSESSMENTS

In January 2011, Air Products & Chemicals, Allentown, Pa., had its water team begin work on water assessments in conjuction with GE Water, Trevose, Pa., its long-time primary provider of water treatment chemicals and services.

"The assessments are very focused on looking at operating procedures and so far we have carried out 25 globally. They are also very much focused on larger water consumers such as air separation and hydrogen conversion production facilities. Opportunities are identified by our operating staff working closely with GE Water," explains Julie O'Brien, Air Products corporate sustainability manager.

Overall, this had led to changes in two main areas. The first is an up-to-four-fold increase in cooling tower cycles — saving between 2 and 10% of water consumption, depending upon the facility. The second is greater use of recycled water, particularly for cooling.

Using this approach at Air Product's Santa Clara, Calif., HyCo hydrogen production plant has helped save 62 million gal/yr of potable water.

"At Santa Clara, we're using water that previously has been used by others and pretreating it prior to use on-site. The main lessons from this site are that there are increasing opportunities for grey and recycled water to be used for cooling, and opportunities for greater water reuse within the facility — for example, using process condensate in the cooling tower makeup water (Figure 2). There have been other opportunities at other plants, but they're very site specific. For example, at one we are upgrading our monitoring systems to better quantify our ongoing water usage," notes O'Brien.

Air Products is sharing the recycling and reuse lessons learned at Santa Clara among its sites. In addition, the company is going beyond individual assessments to look more systemically at other strategies to improve overall water consumption. For example, it's developing technologies to reduce consumption and reuse water in water-constrained geographies. Initiatives such as the use of waste heat for water purification may influence the way it plans, designs and builds plants.

Overall, greater use of recycled water, combined with process improvements, enabled Air Products to decrease water consumption by 1.2 billion gallons between 2011 and 2012. The company already has met its 2015 water reduction goal but continues to focus on eliminating waste, increasing recycle and reuse, and offsetting water withdrawals from primary sources with reclaimed supplies.

O'Brien offers a cautionary note about how water is treated as a business cost: "First there was a push on carbon emissions, which led to questions about energy consumption and this, in turn, has led to questions about water consumption. They are all linked; so over time, more and more companies will likely appreciate that water scarcity and quality are business risks. At the same time, it may be difficult to justify water system improvement projects, such as the installation of pretreatment systems for recycled water, because water is not fully costed in many places, so the project paybacks might not meet hurdle rates. This will change as water rates increase."

SPANISH SITE

Figure 3. Water at Tarragona complex primarily goes into semi-closed circuits such as those for cooling water. *Source: BASF.*

A WATER STEWARDSHIP FIRST

On May 3rd, BASF, Ludwigshafen, Germany, set an industry milestone when its production facility in Tarragona, Spain, (Figure 3) became the first chemical site ever to achieve gold-level certification to the European Water Stewardship (EWS) standard.

The EWS was developed by governments, businesses and nongovernmental organizations under the leadership of the independent European Water Partnership (EWP), Brussels, Belgium, and became effective at the end of 2011.

The award came after an audit by third-party

certification body TÜV Nord Integra, Berchem, Belgium, assessed the entire water-management performance at the site, from extraction of water at its source to its reintroduction in downstream water bodies.

The assessment includes more than 50 indicators. These address the four principles of water stewardship: sustainable water sourcing, ensuring good water quality, protecting vulnerable areas and equitable water governance (which is defined by EWP as making certain of an adequate quantity and quality of water supply for all members of the population including the most disadvantaged). In addition, the assessment checks whether a site has a water recycling strategy and a cohesive crisis management strategy.

The Tarragona site relies upon the nearby Ebro River (for industrial and drinking water), groundwater (for industrial duties) and sea water (for production of demineralized water). It's just starting to tap treated municipal wastewater for industrial duties.

The plant uses water between two and seven times in cooling towers (semi-closed circuits) and nine times in steam production (via condensate return).

Tarragona is in a water-stressed area (Figure 4), i.e., one in which more than 60% of the naturally available water sources are already exploited. In total, around 20% of all BASF sites are located in such water-stressed areas. Last year, the company sourced around 7% of its worldwide water supply from these areas.

"By the year 2020, we want to introduce water management to the EWS standard at all sites where water is scarce," says Ulrich von Deessen, head of BASF's competence center, environment, health and safety.

Chemical makers in other water-stressed areas also are taking action. For instance, Sabic, Riyadh, Saudi Arabia, aims to significantly reduce its consumption of fresh water from the current level of 124 million m^3/yr. The goal is to cut by 2025 fresh-water use intensity (m^3 water used/metric ton of product sales) from the 2010 level of 3. It's implementing a number of water conservation and reduction projects in plants located in water-scarce regions such as Saudi Arabia, Brazil and Spain.

SEVERE WATER-STRESSED AREAS

Figure 4. Water supplies in many regions around the globe already are heavily exploited. *Source: BASF.*

For example, at the Al-Jubail and Yanbu complexes in Saudi Arabia, the company has developed a seawater cooling system to minimize use of desalinated water. This is Sabic's only seawater cooling system and has been purposely designed not only to save desalinated water but also to minimize damage to plant equipment and prevent any possible toxic chemical leaks to the seawater environment.

The company has reduced water usage at its Campinas, Brazil, facility by 20% while increasing production by 16%. This was achieved by improving the integrity of underground water supply pipelines and reusing treated industrial wastewater.

At its Cartagena, Spain, plastics plant, Sabic uses micro-filtration to clean and reuse process wastewater from multiple sources within the complex. In the last six years, this has saved more than 850,000 m^3 of raw potable water and over $1.2 million in associated costs.

Since 2010, DSM has been working to optimize water use at its engineering plastics compounding site in Pune, India. The company says that the Pune facility is one of the first in the group to have completely eliminated release of waste water. A treatment and checking regime allows the waste water to serve for gardening purposes. This year the facility, through a combination of increased process water recycling and strict monitoring of potential leakages, has slashed by two-thirds the amount of water used in the manufacture of thermoplastic polyester and polyamide compounds.

Optimize Tank Cleaning

A more-effective method can offer significant benefits

By Andrew Delaney, Alfa Laval Tank Equipment Inc.

CHEMICAL PROCESSORS often view cleaning of tanks and totes as a necessary but costly and headache-ridden burden. Tank cleaning requires a significant amount of resources to ensure a quality, uncontaminated next batch. In addition, inefficient tank cleaning when your clean-in-place (CIP) device isn't working properly, cleaning well enough, or is out for maintenance or repair can cause production to come to a halt. Yet, despite the adverse effect on the bottom line, many manufacturers continue to rely on outdated procedures for cleaning, missing the opportunity for substantial cost reductions and revenue recovery through CIP optimization.

Understanding how to optimize a cleaning process requires a grasp of the basics of cleaning. Herbert Sinner, a former chemical engineer for Henkel, first summarized the basic principles of cleaning in 1959. His summary, now referred to as the "Sinner's Circle," describes the four factors that can be manipulated in any cleaning scenario: temperature, chemical action, time and mechanical force.

Increasing the effectiveness of any factor will result in a decrease of one or more other factors. Dishwashing provides a good example of how the four factors interact. Hot water (temperature) will remove stuck-on food better than cold water. Adding soap (chemical action) makes the process even easier, and you either can soak a dish overnight (time) or scrub it clean (mechanical force).

It's imperative to examine the effectiveness and efficiency of your procedure — and then to apply the Sinner's Circle to compare CIP options. The most-common cleaning practices are: "boiling out" or "fill and drain," manual cleaning, wetting (static spray balls), rotary wetting (rotary spray balls) and rotary impingement cleaning.

CIP IN ACTION

Watch this video to see how rotary impingement technology efficiently and effectively cleans vessels of residues and contaminants, saving companies time and money while eliminating confined space entry.
https://www.youtube.com/watch?v=QP0_UIMMyyE

TANK SPRAY PATTERN

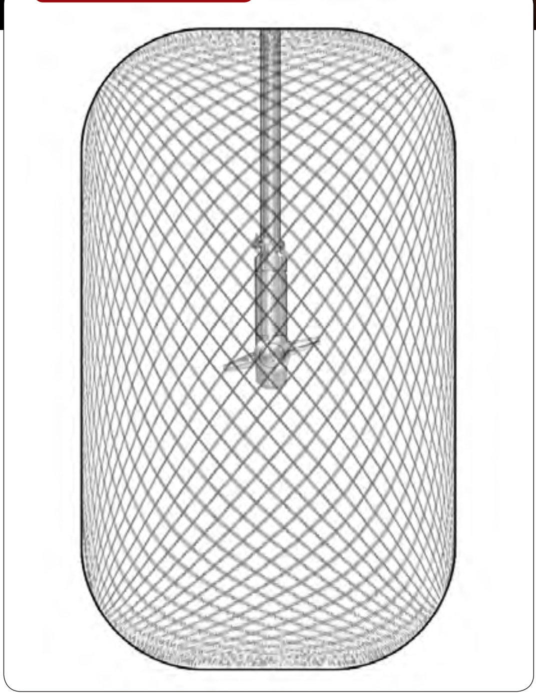

Figure 1. A rotary impingement machine provides precise, repeatable and comprehensive scouring of vessel interior.

Boiling-out or fill-and-drain methods involve filling tanks with hot water and caustic. These procedures are time-consuming and use lots of water and chemicals, which is a large concern due to sustainability goals and the expense of disposal.

In manual cleaning, people remove residue by scrubbing, scraping or other means. Although companies have automated nearly every other process, many still rely on manual cleaning not only to clean but also to validate the cleaning process. However, human error may occur, and manual cleans never are identical. In addition, the procedure may subject employees to toxic fumes or dangerous materials in a vessel and pose risks from confined space entry. Moreover, the potential damage to the tank is high.

Static spray balls and rotary spray heads rely on small orifices or narrow passages to distribute the wash fluid. The water and chemicals typically are split four or more ways, depending upon the manufacturer. These devices can be positioned at any angle inside a tank and can wet a tank quickly. For easy-to-clean residues such as powders or dry materials, spray balls and spray heads can be a suitable option. If quick dispersion is needed to coat a tank rapidly with a chemical or disinfectant, or if water usage isn't an issue, a spray ball may be a good choice. Opt for a rotary spray head if the cascading cleaning effect provides a sufficient clean.

Rotary impingement machines combine pressure and flow to create high-impact cleaning jets. Cleaning occurs at the point the concentrated stream impacts the surface. The impingement force is distributed in a precise, repeatable and reliable 360° pattern (Figure 1); this full-coverage, indexing pattern ensures the entire interior is cleaned every time. The impacts and resulting tangential force radiating from the points blast contaminants from the surface, scouring 100% of the tank interior. This reduces the time and temperature required, and can cut water and chemicals usage by up to 80%.

SUCCESSFUL APPLICATIONS

A major chemical company was using a fill-and-drain method that was taking too long to clean. Moreover, water usage was a major concern

because of drought conditions. The total process consumed 5,800 gallons of water with a caustic concentrate per batch, which amounted to 1.5 million gallons per year.

The company switched to a rotary impingement device to deliver hot water and caustic. It thoroughly cleaned the tank — including shadow areas due to internal obstructions — with only a 12-minute wash time. Not only was the cleaning 94% faster but the company also achieved its goal of reducing water and chemical usage by 95%.

Another chemical manufacturer couldn't meet customer demand because of the downtime incurred for cleaning its tanks with spray balls. The tanks were shut down every day for cleaning. This took a minimum of one hour but often longer because of the frequent clogging of the spray balls and the need for manual cleaning when the spray balls would fail. The company turned to rotary impingement tank cleaners and was able to clean 91% faster, which allowed a 71% increase in production.

A third chemical producer was concerned not only about the time and money it spent on manual cleaning but also about validating the cleaning process and employee safety. The manual cleaning procedure took 2 hours per day and included confined space entry, scraping and scrubbing. Moreover, it consumed a significant amount of water — millions of gallons of water per year, which cost the company $16,000. After switching to a rotary impingement device, total cleaning time per tank dropped to only 20 minutes. The automated machine gives this facility a repeatable and reliable cleaning pattern, allows it to meet U.S. Occupational Safety and Health Administration requirements by eliminating confined space entry, and saves $11,000 per year.

BENEFITS TO TANK CLEANING

Watch this video to learn more about Gamajet's line of tank cleaning machines that help optimize tank cleaning procedures, minimize downtime, eliminate manual cleaning and reduce water usage.
https://www.youtube.com/watch?v=oEgiC6tXJmY

TOTE CLEANING

Many plants use totes for storing and transporting materials. Improper or inefficient cleaning of totes directly impacts overall productivity. Traditionally, facilities have outsourced tote cleaning or paid a fee to return dirty totes to suppliers. However, rotary impingement tote cleaners enable cleaning to be done on site in 2–7 minutes, cutting costs and improving productivity, as one chemical company can testify.

That company ships its products in totes; after the products have been delivered, the totes are returned for re-use. It also re-uses many of the totes it gets from suppliers of raw materials.

The director of operations was frustrated by the time, inconsistency and costs of sending dirty totes to a vendor for refurbishing/cleaning. He also had to make sure that re-used totes were 100% clean to avoid the dangers of cross-contamination between product shipments. This often necessitated manual cleaning on site — but the results were less than perfect.

So, he purchased a rotary impingement machine. It reduced the time spent cleaning totes on site and increased the level of cleaning effectiveness. As a result, the company spent 50% less time cleaning while eliminating outsourcing and achieving a consistent clean. The machine paid for itself in one week.

MAKING THE RIGHT CHOICE

Rotary impingement machines aren't the answer for all tank-cleaning applications, though. For example, with relatively easy-to-clean residues such as powders, the devices can be overkill for the job — providing more water-jet impact than necessary to effectively clean — and for the budget. Whereas a spray ball or rotary spray head typically costs under $1,000, rotary impingement machines generally run $3,000–$5,000. Just as with any purchase, conduct a return-on-investment (ROI) analysis to determine the payback of a rotary impingement machine versus a spray ball or rotary spray head. If the payback on a rotary impingement device exceeds 5 years, then opt for a spray ball or rotary spray head. An easier test is to ask yourself a simple question: Is this spray ball getting my tanks clean, quickly and effectively? If the answer is yes, then stick with the spray ball. If not, then it may be time to upgrade to the higher water-jet impact offered by rotary impingement cleaning.

If quick dispersion is needed to coat a tank rapidly with a chemical or disinfectant, don't consider rotary impingement machines. At this time, they don't have the capability for quick dispersion.

Also, at sites where water is abundant and cheap and, thus, where reducing water use isn't a top priority, the savings provided by a rotary impingement machine may not be as compelling as elsewhere.

It's also important to note that some rotary impingement machines can be damaged if operated at a pressure higher than that recommended by the manufacturer.

Tank size, internal obstructions as well as the residue must be considered when selecting and sizing a machine. Also keep in mind that not all rotary cleaners are equally robust. Many "off-the-shelf" devices easily clog, break down and incur high repair costs; the result is inefficient cleaning and massive tank downtime. To make the most out of your CIP, your tank cleaning machine should be durable. Furthermore, maintenance and necessary repairs should be quick, easy and affordable.

Tank and tote cleaning, when done properly, can save massive amounts of time and water. Audit your CIP to see what you can do to make your sustainability goals a reality. The right rotary impingement machine may provide significant benefits that directly impact the bottom line.

ANDREW DELANEY is executive vice president, operations, for Alfa Laval Tank Equipment, Inc., Exton, Pa. E-mail him at andrew.delaney@alfalaval.com.


It's raining dollars on the plant floor
(thanks to Gamajet tank cleaning devices)
Substantial savings come from the most unexpected places.
With Gamajet tank and tote cleaning devices, you will experience:
85% less time spent tank cleaning
80% less water and chemical usage
20% increase in productivity
100% cleaning effectiveness
BEFORE
AFTER
GAMAJET®
part of the Alfa Laval Group
www.gamajet.com