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US Water Services Newsletter, Winter 2011

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keyword: zero liquid discharge

written by Charlie Kroeger, US Water Services & Rick Vondra, Patriot Renewable Fuels

Water supply issues are emerging as a national concern with the energy sector coming under increasing scrutiny. This is certainly the case with the ethanol industry. State discharge regulations have and are dictating that plant designs incorporate technological solutions to minimizing water use. These designs involve utilizing equipment that allows flexibility in reusing water streams internally such that no water is discharged to the environment thus operating as a zero liquid discharge (ZLD) facility. This brings additional challenges in an ethanol production plant because process water quality must be compatible with biological processes occurring in fermentation and will affect co-product quality as well. The complexity and risks associated with failing to integrate the water system design with the ethanol process can become painfully manifest. The wrong decisions can be disastrous and costly, even leading to plant inoperability and shut down. US Water Services (USWS) has participated in repairing a number of these designs in order to allow plant operators to meet water quality requirements compatible with ethanol production.

While USWS had historically designed traditional water systems for a number of facilities, it embarked on its first ZLD ethanol plant in the United States in California, which began operations in 2006 after a year and a half of careful design and construction. This was the first operational ethanol plant in the US incorporating ZLD that was mandated by the state of California. Since then, USWS has been involved with a number of additional clients that have been required to incorporate ZLD in their designs. Other plants have been designed with equipment and piping options that allow for future ZLD operations should the need or preference to do so arises.

This was the case with Patriot Renewable Fuels in Annawan, IL. From original plant design and inception, Patriot Renewable Fuels included the option to operate as a ZLD facility in the interests of conserving water. As a first and critical step, Patriot CEO Gene Griffith led the effort to strategically locate a site for the plant that would insure both water quality and supply availability to meet the expected use demand consistent with plant production capacity. This led to the purchase of properties that were suitable for plant location and reliable water supply. Twenty nine acres with three wells was purchased and underground pipelines were run under a canal and under interstate highway 80 to connect this supply to the plant.

> *"As regulations become more stringent, many plants are looking to zero liquid discharge as the alternative."*
>
> *-Charlie Kroeger, US Water Services*

The engineering design for the plant that followed included the water treatment equipment that would be required to reprocess typical waste streams such as cooling tower blowdown and reverse osmosis concentrate and operate as a ZLD.

The plant began operations in August 2008 operating as a traditional facility in terms of water use *(continued on page 4).*

can your plant benefit from upgraded steam equipment?

written by Mike Mowbray, US Water Services

Steam quality is a measure of the amount of liquid water contained in steam generated by a boiler. It is often expressed as Percent Dryness. Typical low pressure boilers have a Percent Dryness of around 99%, which means that there is 1% moisture in the steam. That 1% is important, because moisture, in the form of condensate, contains less heat energy than dry steam, and as a result a pound of wet steam does less work than a pound of dry steam. Put another if your boiler is producing wet steam instead of dry steam.

In many boilers, an upgrade of the boiler system can be the solution to improving steam quality. Upgrades might provide improvement if your boiler is more than 10 years old, and the original separators are worn or loose. An upgrade might also improve the performance in a system where the original separators were not well matched to the boilers actual application. The benefits from dry steam are gained in three main areas, which are drier steam, reduced blowdown *(continued on page 5)*

connect with us in person...

February

National Biodiesel Conference
Phoenix, AZ
2/6-2/9

National Ethanol Conference
Phoenix, AZ
2/20-2/22

March

PFMA
Green Bay, WI
3/2-3/3

Green CA Summit
Sacramento, CA
3/1-3/2

Environmental Food & Beverage Conference
Bonita Springs, FL
3/27-3/31

For information regarding any of these events, please contact your US Water Services representative.

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Building A Brighter Tomorrow, Today

bringing clean drinking water to Cite Soleil, Haiti

written by Karen Danielson

After a devastating 7.0 magnitude earthquake shook the small country of Haiti on January 12, 2010, over three million people were left without access to safe drinking water.

There are two main issues surrounding water supply shortages in Haiti: quantity and quality. While in many areas of Haiti, there are adequate sources available to meet water quantity needs, the country's poverty level not only impedes the ability to construct a system that would allow for development and maintenance of these water supplies, but also the ability to purchase a means to cleanse contaminated water. Sewer and wastewater treatment systems are simply non-existent causing biological contamination in many of the surrounding streams and aquifers from both human and industrial waste and agricultural runoff.

John Lapointe, P.E., design engineer for US Water Services Engineering & Equipment, partnered with Kevin McClellan, a self-employed Minneapolis businessman, and brought the dire water quality situation in Haiti to the attention of Allan Bly, owner of US Water Services (USWS) water treatment company. After discussing the best immediate and long term options available, a plan was developed to provide a reverse osmosis (RO) unit to the Lamp for Haiti clinic located near Cite Soleil, a large slum neighborhood situated alongside the ocean on the outskirts of the city of Port-au-Prince.

Lamp for Haiti is a non profit organization founded in 2006. The organization provides a free medical clinic in Cite Soleil which is operated by a full Haitian staff. The hospital treats 75-100 patients daily, more than half of whom are diagnosed with water-borne related illnesses caused by contaminated drinking water. The RO unit will be provided near the Lamp for Haiti clinic in an effort to provide safe drinking water to the Cite Soleil residents, especially those seeking medical care at the clinic.

The groundwater in the vicinity of Cite Soleil is severely contaminated not only by human and agricultural waste, but also salt from seawater intrusion due to its close proximity to the ocean. A RO unit is optimal for these types of conditions as it can be used to remove salt from water. Clean water passes through the system while the RO concentrate containing the removed salt is discharged to a canal, eventually feeding back into the ocean. The discharge from this RO unit could be used as flushing water in a future sanitation system.

The Global Ethanol plant in Riga, MI, which on October 22, 2010 became a part of Green Plains Renewable Energy Inc, donated an existing RO to the project worth $132,000. The USWS team took charge of the project upon the units arrival at the corporation's St. Michael equipment production facility in early September, providing all parts and labor required to refurbish the unit.

The RO initially had a total production capacity of 100 GPM of water. With assistance from Wes Byrne, US Water Services' reverse osmosis specialist, the company was able to re-design the unit to run around 50 GPM, which will help keep the cost of operations and materials to a minimum. This will still provide an average of 6,000 gallons of safe drinking water to the community for every two hours of operation. In addition to the system re-design, USWS also provided training of the RO's operation and maintenance to Kevin McClellan, who would be the sole person responsible for transporting and installing the Cite Soleil unit. McClellan will also be responsible for training the Lamp for Haiti staff of the proper care required to maintain this unit with the intent of transferring complete responsibility to the clinic's Haitian staff on-site.

Throughout the three month duration of the project, other contributors stepped in to provide additional support. Dow Chemical provided a supply of RO membranes necessary to run the unit; and Bongards Cremery donated a large food grade stainless steel tank that will serve as a water storage facility once on-site.

"This is a humbling project to be part of", Lapointe stated, "many things we take for granted as Americans are basic necessities the people of Haiti are deprived of everyday. I'm thankful that we were able to take this step to help the residents of Cite Soleil, but the challenges are far from over." Once the RO arrives in Haiti, an adequate water supply to operate the unit will still have to be located, as well as construction of a filter and water storage tanks to supplement the RO equipment.

The RO unit shipped out of Lake Charles, LA on route to Port-au-Prince, Haiti at the end of December 2010 with a shipping container full of donated food, arriving successfully in early January 2011. With the help of John Lapointe, P.E. and Wes Byrne, US Water Services will continue to support the project providing design and system start-up assistance from Minnesota.

reducing water use

in ethanol production *(continued from page 1)*

Cooling tower blowdown and RO concentrate were discharged to the environment as permitted by the State of Illinois and as typically practiced by nearly all industrial plants.

The plant was designed with a nameplate capacity of 100 MMGPY. Typical water use during the first year and a half of operation was about 900,000 GPD. This calculates to approximately 3 gallons of water per gallon of ethanol produced. This may sound like a lot of water until compared with an average of 35 gallons of water per gallon of gasoline produced.

At the request of Patriot, US Water Services (USWS) team members reviewed the status of plant operations in early January to determine feasibility of the transition to ZLD. This review of operations validated that current plant operations were consistent with water use predictions that USWS had investigated and modeled at the time of the original design. The initial engineering review led to the original plant design which included the necessary piping to capture waste streams for recycle. Periodic well sampling also confirmed that the well water supply quality was stable and the decision was made to implement recycling strategies.

IMPLEMENTATION

The first step in implementing ZLD operations at Patriot was reviewing and modifying the distributed control system (DCS) to eliminate a cold lime softening (CLS) recycle loop that was integrated into the water management software. The intended purpose of this recycle loop was to maintain steady flow through the CLS unit during periods of lower water use. Recycle of CLS effluent is one way to stabilize CLS hydraulics as large flow rate changes can result in performance upsets. However, this results in treated process water being (re-treated) which increases chemical usage. In a ZLD environment, minimizing any chemical addition is critical to managing ion balance. Elimination of the CLS recycle loop was key to reduced chemical usage. In order to manage and stabilize CLS hydraulic flow, the plant now allows the finished water tank level to rise and fall between a comfortable range to meet plant demand while maintaining adequate reserve storage.

The next step was to replace sulfuric acid with plant generated CO_2 for recarbonation (pH adjustment) of CLS effluent. This replacement is critical to managing the water system ion balance; specifically, sulfate loading that impacts co-product quality and value. Notably, this also becomes a sink for carbon dioxide that would otherwise be vented to the atmosphere.

These modifications were followed by introducing the waste streams in two phases: The first stream to be recovered and recycled was cooling tower blowdown water. This was easily accomplished by the pre-engineered piping and valve manifolds designed to divert blow down water to the well water tank. This tank is the supply tank for the CLS and includes a blend of well water, gravity filter backwash water, and in transitioning to ZLD,

> *"After ZLD integration, the plant saves enough water each year to supply the entire city of Annawan & a number of surrounding farms."*

now includes the introduction of cooling tower blowdown. Recovery of the first of these streams began in early February 2010.

The next step was to introduce RO concentrate into the well water tank. This had also been engineered into the system piping allowing easy diversion to the well water tank now operating as a "blend" tank of well water, CT blowdown and RO concentrate. With the recovery of this waster stream, the plant ceased discharging any wastewater and achieved ZLD operations.

As a follow up, water treatment equipment performance and water system ion balance continued to be monitored closely by both the plant and USWS personnel. Since water recycle and reuse will increase the concentrations of soluble ions that impact downstream equipment, it is necessary to monitor reverse osmosis units and cooling system heat exchangers to assure that all affected equipment is operated in safe ranges to avoid scaling conditions or increased corrosion.

Subsequent water testing indicates that the plant is able to operate reliably in a ZLD environment and meet water specifications for all downstream uses, i.e. cooling tower makeup, boiler water makeup, and importantly, process water used in ethanol production.

In the interests of maintaining long-term operations and guaranteeing a good water supply, the plant can draw from three different wells. The three wells can be operated individually or together as controlled blends. These potential blends are also being observed to determine the optimal treatability. Initial well water use during the transition to ZLD incorporated using the well with the most difficult to treat characteristics to validate operability under worst-case conditions.

Water usage was at approximately 2.9 gallons of water per gallon of ethanol produced prior to implementing ZLD. During the transition, water usage has been reduced to about 2.0 gallons per gallon of ethanol, nearly a one third reduction. For an annual perspective, this amounts to a savings of 100 million gallons of water per year. This is enough water to supply the needs of the entire city of Annawan and additionally a number of farms surrounding the plant in Henry County.

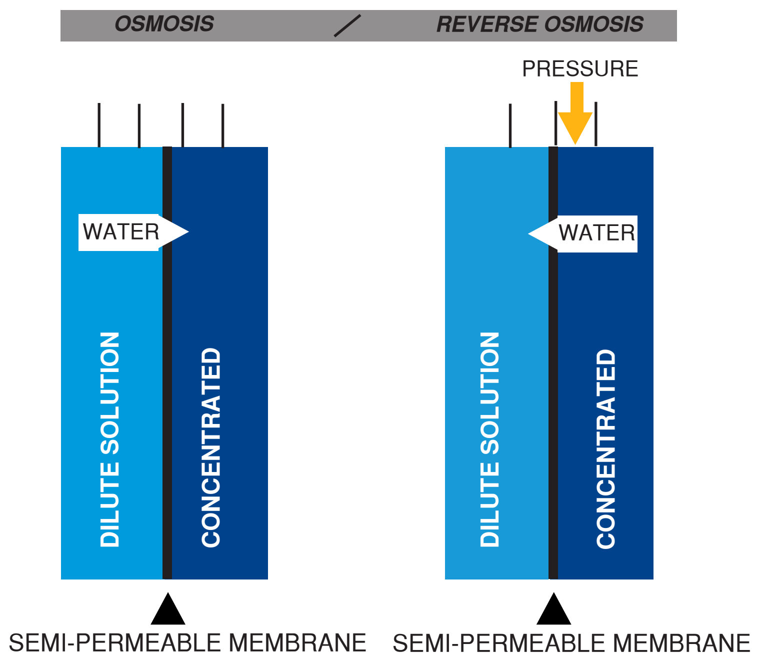
The plant has achieved the goal of operating as a ZLD facility. Importantly, this was done voluntarily by Patriot (the first voluntary ZLD ethanol conversion in the US) in keeping with their corporate philosophy: providing good jobs in the community and a market for locally grown grain, and contributing to international trade with a significant $35 million dollars in overseas exports. By proactively reducing water usage, they are demonstrating their commitment with actions that prove they are trying to be a good neighbor in the community.

RO Best Practices & Standards *edited by Wes Byrne*

Reverse Osmosis (RO) is a proven technology with new applications for various industries. US Water Services representatives pride themselves on having an extensive knowledge of RO unit installation, operations, troubleshooting, and cleaning procedures. Let's review the standards and best practices for RO units by first reviewing the process of osmosis.

OSMOSIS: A NATURAL OCCURRENCE

Osmosis is a natural process that causes water to flow through a semi-permeable membrane from a dilute solution to a more concentrated solution, thus diluting the concentrated solution. The rate of water movement is driven by the difference in salt concentration, called the osmotic pressure. This movement will cause the height of the concentrated solution to rise until an equilibrium is reached when the difference in solution heights equals the difference in osmotic pressures.



REVERSE OSMOSIS (RO):

Reverse Osmosis technology involves the application of pressure to the water stream in order to overcome osmotic pressure. When the pressure is increased and applied to the concentrated solution the flow of water is reversed.

RO CLEANER SELECTION GUIDE

	ROC 20 Liquid	ROC 20 Plus Liquid	ROC 20 KBT Liquid	ROC 50 Liquid	ROC 50 Plus Liquid	ROC 50 KBT Liquid	Iron "Cleaner"
Inorganic Salts (i.e. $CaCO_3$)	POOR	POOR	POOR	EXCELLENT	EXCELLENT	EXCELLENT	GOOD
Metal Oxides (i.e. Fe, Mn)	POOR	POOR	POOR	FAIR	GOOD	EXCELLENT	EXCELLENT
Inorganic Colloids (i.e. Clay, Silt)	FAIR	GOOD	EXCELLENT	POOR	POOR	POOR	POOR
Biofilms	FAIR	GOOD	EXCELLENT	POOR	POOR	FAIR	GOOD
Organics	FAIR	GOOD	EXCELLENT	POOR	POOR	POOR	POOR

A portion of the concentrated solution is forced through a very fine membrane to emerge as purified product water leaving impurities to large to pass behind.

WATER TREATMENT TECHNOLOGY: RO UNITS

RO units are quickly becoming a standard constituent for the reduction of contaminants within water systems. Water is able to permeate an RO membrane much better than dissolved salts and particles so that most of those contaminants remain in the concentrated solution. Common applications of a RO unit include, but not limited to; ethanol, industrial, boiler feedwater preparation, wastewater treatment and food processing.

PRETREATMENT: VITAL FOR OPTIMAL PERFORMANCE

Proper pretreatment of the feedwater to a RO unit is critical for maintaining optimum performance and maximizing membrane lifetime. Excessive concentrations of suspended solids or biological activity will foul a RO membrane system. High hardness levels or other dissolved salts will scale up a RO if not controlled with the right US Water scale inhibitor. The goals of RO pretreatment are to eliminate scale formation and minimize fouling by suspended solids and bacteria.

PROPER MAINTENANCE:

The removal effectiveness of a RO unit depends on how well it is maintained. The largest operational problem with RO units is fouling such as iron, inorganic colloids like silt and suspended solids. When properly maintained, an RO unit will:

1. Dramatically improve water quality
2. Reject 95-97% of incoming solids
3. Greatly aid in the prevention of scale in a boiler program
4. Reduce blowdown and chemical use by allowing increased cycles of concentration in boilers and cooling towers

Excessive membrane fouling can partially negate these accomplishments resulting in:

1. Decreased productivity
2. Increased operational costs
3. Reduced membrane life
4. Reduced product water quality

HOW OFTEN SHOULD RO MEMBRANES BE CLEANED?

Even with proper treatment, periodic cleanings are usually needed to maintain equipment integrity and efficiency over an extended period of time. Cleanings need to be customized to the fouling solids. The cleaners themselves are usually low pH (acidic) solutions or high pH (alkaline) solutions. Generally the high pH cleaners lend themselves to better removal of clay/silt, biological and organic contaminations. Low pH cleaners are better suited for inorganic scales and metal oxides. It is common for both to be applied during a cleaning process. If the fouling or formation has been allowed to progress for an extended period of time, the fouling solids will stabilize. Flow channels may become blocked. The time required to completely clean the system will increase, possibly to the point that it is impractical to clean the RO on-site.

US Water Services recommends that a RO system be cleaned prior to a 15% increase in feed-to-concentrate pressure drop or decrease in permeate flow, both parameters are normalized for changes in other variables. US Water Services can assist in this RO system performance analysis.

Determining if an Extended Warranty Is Right for You? *written by Karen Danielson, US Water Services*

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Are extended warranties worth the cost?

If you're like most consumers, myself included, you decline extended product warranties without thinking twice; convinced that it's just another sales technique to get more money. Personally, I used to assume that when investing in a large piece of equipment any defects with the machine would show up within a year and be covered by the manufacturer's warranty. Well, like I said, that what I used to think.

A while back, I purchased a new name brand washer for my home. When prompted to purchase an extended warranty, I did what I always do, checked the "No Thank You" box as it already came with a one year manufacturer warranty. I figured I was covered. One year passed with no issues or problems. After a while (the time frame of which my extended warranty would have been in effect), the machine started shaking and bouncing around the floor. I called in a technician only to find out that the motor, through no fault of the manufacturer, was going bad. Motors burn out, it happens. After browsing the internet to research parts and find the best price, I finally found a motor for my machine for the "bargain" price of $320.00. $320!! My extended equipment warranty would have only cost me $83.00. Why didn't I just purchase the extended warranty?!? Seriously, what's another $83 when you're already spending hundreds of dollars? Hindsight is always 20/20.

Now the intent of this article is not to say that everyone should always purchase an extended equipment warranty; but rather how to avoid the same 20/20 hindsight I experienced by determining if an extended equipment warranty is right for you ***before*** you need it. Determining the answers to these questions and what they mean for your organization can help you decide if an extended equipment warranty makes sense for you. Typically, the more important the product is to your operation, the more important the warranty becomes.

1) What is the lifespan of your current equipment?

2) What's the likelihood something will burn out/need replacing during this lifespan?

3) What will the cost of repairs be if parts on this machine break (don't forget to include the time you invested)?

4) How important is this piece of equipment to your overall operation?

5) How much would lost production cost if this machine were down for repairs?

Contact our customer service department to discuss extended equipment warranty options on USWS purchased equipment.

can your plant benefit from upgraded steam equipment?

continued from page 1

reduced blowdown and improved purity. To get an idea of the economic impact to each of these areas, let's take the example of a 125 psig boiler, generating 100,000 pounds per hour of steam at 99% dryness. It uses natural gas at $6.00/MSCF, and operates with 75% condensate return.

Drier Steam

At 125 psig, steam contains 1109 Btu/lb, while condensate has only 324 Btu/lb. Since this boiler generates steam at 99% Dryness, the 1% that is condensate reduces the work load that can be done by the steam by 0.7%. This doesn't sound like much, but over the course of a year, it can increase fuel costs by over $150,000 in this example.

Steam Purity

The water that is entrained in the steam is not pure. It will contain any contaminants that have made it through the pretreatment system as well as boiler treatment chemicals. These dissolved solids will eventually evaporate out on equipment contacted by the steam, and can form solid masses of deposits. They might start out small, but over time, the deposits could become large enough to restrict steam flow in pipes, through valves or across heat exchangers. In a worst case scenario, these deposits can, and have, caused unexpected plant shutdowns, which can cost a company tens of thousands of dollars per hour.

Reduced Blowdown

By reducing carryover of dissolved solids in the steam, the return condensate quality, and as a result, the boiler feedwater quality, will be improved. This will be directly measurable in terms of lower feedwater conductivity.

For this example, our reduced feedwater conductivity allows for an increase in boiler cycles of concentration, resulting in reduced blowdown of heated boiler water. This has a direct impact on fuel usage, which in this case would mean a reduction to the annual gas bill $31,000.

There are several companies that sell aftermarket steam separators, and there are many designs. A typical installed cost for a water tube boiler like the one in our example would be between $45,000 - $60,000. So, could your plant benefit from an upgraded steam separator? In many cases the answer is a definite yes.

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