



Municipal Wastewater Treatment Update

No. 7 September 24, 2018

Contents

A visitor to WEFTEC is informed by pre show publicity as well as the presentations and exhibits. His focus may be on certain processes, products, end users, or suppliers. The contents of this analysis are divided by segments reflecting products with the exception of one on struvite which focuses on a problem. Each segment is followed by a key word tabulation reflecting the specific end users, suppliers, consultants or media which are covered in the sub segments.

Overview

Making the best use of WEFTEC and the interconnection among speakers, visitors, exhibitors, and media

Sludge Dewatering

More efficient sludge dewatering with new solutions to address struvite using chemicals

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Exhibitor locations and speaker presentations

Struvite

Insights from exhibitors and speakers on struvite clogging reduction and phosphorous recovery

Pumps and Valves

Exhibitor Analyses

Aerators

Exhibitor Analyses and speech summary plus links to blower articles in magazines and examples from McIlvaine Aeration Blower Decision Guide

Automation

Training Course, presentation summaries, and exhibitor analyses with links to articles in the media

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Listing of magazine exhibitors and links to articles relevant to WEFTEC appearing in the magazines

Way forward

The value of preparation prior to visiting WEFTEC, the supplier use of exhibitions, and media in a coordinated manner to achieve validation of lowest total cost of ownership

Overview

WEFTEC is a huge annual event with many more exhibits and many more papers than can be attended in four days. The mobile app provides an excellent search engine but this is just a starting point. There are 4 knowledge needs (4As): Alerts, Answers, Analysis, and Advancement. How can suppliers and operators utilize WEFTEC to maximize the 4As value?

WEFTEC will efficiently alert you. Just walking through the exhibition hall provides insights you will find valuable but didn't know about in advance. The media has been alerting visitors in advance. A number of magazines have pre show coverage. They are also sending out emails such as the *WaterWorld* sneak previews.

Finding Answers to your questions is more of a challenge. A carefully structured route map through the exhibits and presentations will pay dividends. There is a big potential to make analyses at WEFTEC but these analyses should be nearly finished ahead of time and WEFTEC utilized to resolve the remaining issues. WEFTEC has a number of training courses to provide Advancement.

McIlvaine is helping suppliers forecast the serviceable obtainable market for their products. This market is largely determined by where the supplier has the lowest total cost of ownership (LTCO) offering. McIlvaine along with the suppliers and owners are therefore all seeking the validation of LTCO (LTCOV). The following analysis is a tool in the LTCOV process and it involves the Industrial Internet of Wisdom (IIoW) to connect knowledge with the people who need it by leveraging the efforts of the media and conference organizers.

Sludge Dewatering

A - Sludge Dewatering, WEFTEC, and the Industrial Internet of Wisdom

WEFTEC should be bigger and better than ever this year and maybe even exceed the record attendance in Chicago last year. Here are the details

WEFTEC 2018

91st Annual Technical Exhibition & Conference

Conference: September 29 - October 3

Exhibition: October 1 - 3

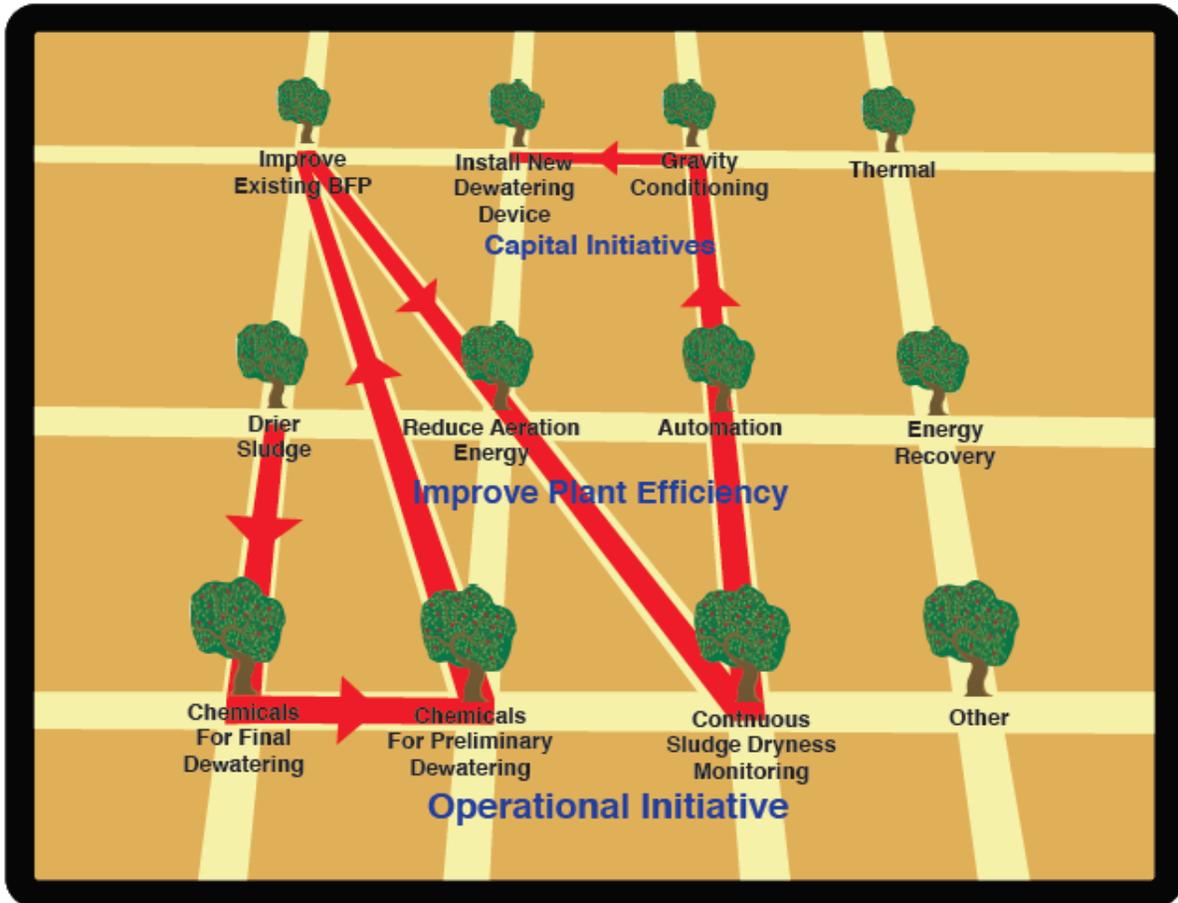
Core Hours: 8:30 am - 5:00 pm daily

New Orleans Morial Convention Center

At the 2013 WEFTEC McIlvaine prepared a Global Decisions Positioning Guide (GDPS) informing visitors of all the WEFTEC resources to better sludge dewatering. Here is that link

www.mcilvainecompany.com/Decision_Tree/subscriber/Tree/DescriptionTextLinks/Municipal%20Wastewater%20Flow%20and%20Treatment%20GdPS%20at%20WEFTEC%202013.htm

This guide provided locations and times of relevant speeches as well as booth location of exhibitors who could impact sludge dewatering. It starts with simple adjustments to dewatering equipment, change in quantity and type of treatment chemicals, as well as monitoring, automation and addition of new dewatering devices.



This GdPS concept is part of the Industrial Internet of Wisdom which is a McIlvaine initiative to connect people and knowledge. One of the included services is [Municipal Wastewater Decisions](#).

McIlvaine has extensively covered WEFTEC over the years including news coverage but also stand audio and video interviews. The more recent ones are displayed at http://www.mcilvaine.com/Decision_Tree/subscriber/Tree/Default_Global.htm And then type in WEFTEC. Video interviews by McIlvaine at WEFTEC date back to the early 1990s when they were tape recorded. There was extensive investigation of belt presses in the 1980s when the McIlvaine *Liquid Filtration Newsletter* editor, Nancy Duetsch was known as the Queen of Sludge. The McIlvaine role over the years has evolved from supplying technical analysis directly e.g. liquid filtration knowledge network to now focusing on market forecasting and determination of lowest total cost of ownership through collaboration with those supplying the technical knowledge such as conference organizers and publishers.

B - Smart Dewatering is Already Improving Centrifuge Operation

The positive benefit of IIoT and Remote Monitoring in conjunction with water treatment chemicals was the subject of a McIlvaine webinar last year. This can be viewed at <https://youtu.be/YD5C93c6ujw>

The webinar included a presentation by Kemira on the merits of controlling treatment chemicals based on multiple parameters. Here is a recent example of the Kemira approach.

The Miami-Dade South District Wastewater Treatment Plant (WWTP) utilizes a conventional activated sludge process, with dewatering of the plant's anaerobically digested sludge via four Sharples centrifuges. The plant wastewater flow averages 100 million gallons per day (MGD) and sludge flows to the dewatering operation average 600 gallons per minute (gpm). The centrate is recirculated to the plant's headworks. For a number of years the dewatering operation has been impeded by heavy struvite formation, resulting in significant investment in weekly system cleanings and the associated downtime. Kemira's solution was real time sludge conditioning with PIX chemistry and Smart dewatering. The results were a significant reduction in dewatering polymer consumption, increase in cake solids, struvite control/elimination, reductions in maintenance costs, improvements in centrate quality and solids capture rates and total overall dewatering cost savings. Other benefits were observed in the treatment process at South District WWTP.

Struvite in the centrifuge bowl and centrate lines was reduced from 2-3 inches thick to none within a week of the KemConnect SD solution. Struvite build up has been under control with no struvite deposits observed during period inspections of centrifuges and centrate lines.



BEFORE



AFTER



With the KemConnect SD solution, cake solids have increased by an average of about 4% TS and the polymer consumption has been reduced by approximately 50%. With recent centrifuge optimization with KemConnect SD cake solids as high as 10% TS have been achieved. Continued trials and data gathering are in progress.

The centrate ortho-phosphorous levels dropped from >200 mg/L (as high as 540 mg/L) to consistently less than 15 mg/L. Solids capture rates have improved from 87-90% to 97-99%, exceeding the plant's target rate of 93%. As a result, centrate quality has improved significantly and less solids are returned to the plant head works. The improved solids capture rates allow dewatering operators room to further reduce polymer usage (cost savings) or lower the pond level for drier cake solids. An average of 0.850 MGD of centrate is returned to the headworks at South District WWTP daily.

With the sludge conditioned with PIX 317, South District has been able to increase the throughput on the centrifuges by 40-50 gpm or approximately 22-28% when needed at the same reduced polymer dosage. Tank levels, alarms, trends, notifications and answers are accessible real-time on the KemConnect dewatering dashboard available on phone, tablet or laptop.

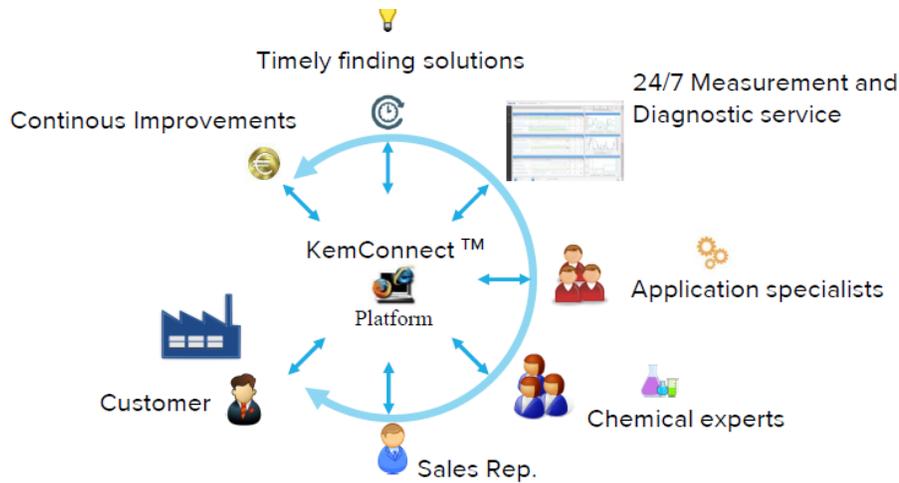
A number of Kemira people will be at WEFTEC. The best contact as a starting point will be Tafadzwa "Tee" Mariga, Sr. Manager – Advanced Water Treatment (AWT) | Industry & Water | NA tafadzwa.mariga@kemira.com, +1.817.875.3665. or Richard Waterous, Sr. Specialist, Advanced Water Treatment (AWT) Sales | Industry & Water | NA richard.waterous@kemira.com, +1 410 935 2032

C - Sludge Dewatering and IIoT

The Sludge Dewatering Guide is included in Municipal Wastewater Decisions. The WEFTEC Sludge Dewatering GDPS is part of the guide initiative. The potential for sludge dewatering improvements through IIoT and Remote O&M are substantial. The Miami-Dade example above shows this potential.

Taking this to the next step includes process management programs and 24-7 monitoring. In the McIlvaine IIoT Water Treatment Chemicals Webinar (see this at

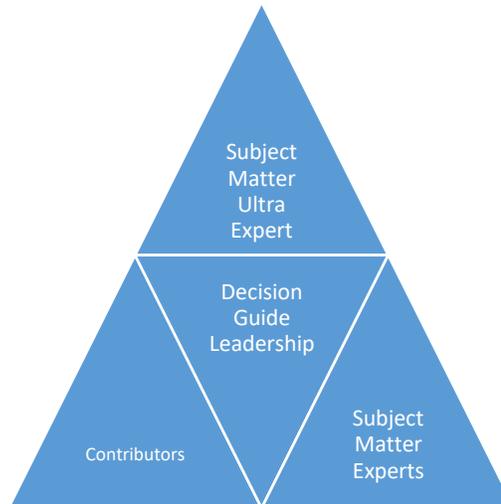
<https://youtu.be/YD5C93c6ujw>) programs already underway for 24-7 monitoring and support by Nalco, Solenis and others are examined. The following Kemira diagram shows the basics.



The experts on the chemicals are personnel at the chemical companies as well as individuals at consulting companies and the municipalities. The experts on applications include people at the dewatering, pump, valve, instrumentation, compressor and other supplier companies.

Andritz supplied the dewatering equipment at Village Wastewater. It also supplies process management and subject matter expertise. It will be exhibiting at stand 1829. Interconnecting the Andritz and Kemira experts and knowledge is highly desirable.

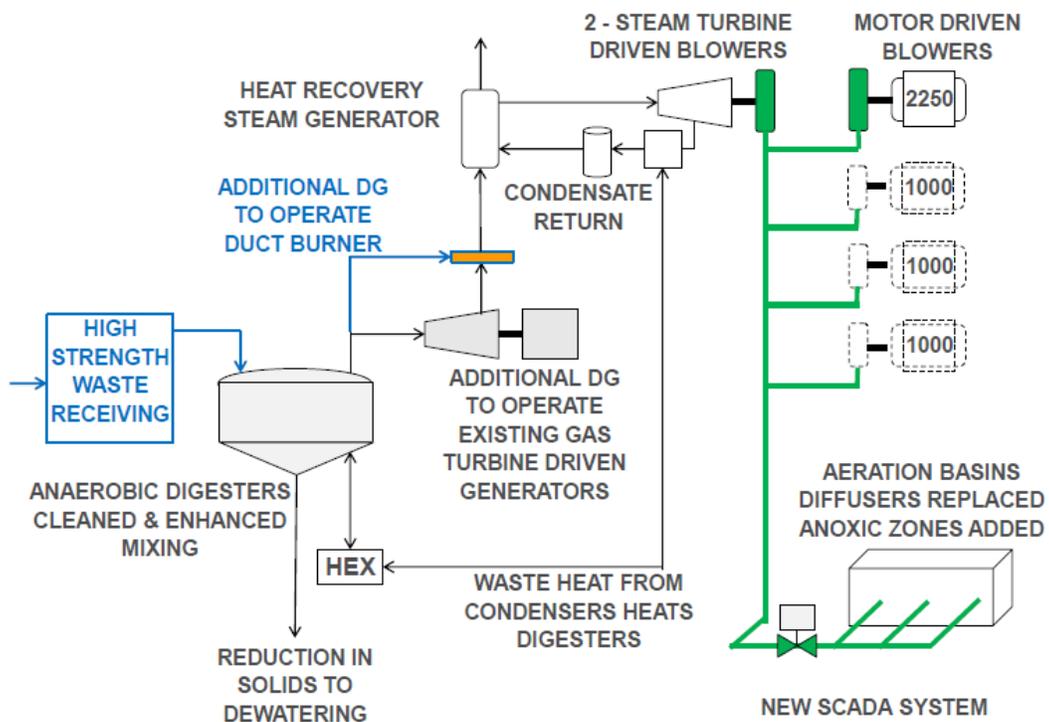
Municipal Wastewater Decisions is a program which facilitates the development and access to this expertise. There should be hundreds of specific Decision Guides as part of the IloW effort. There is an expertise hierarchy. Expertise contributors should include thousands of people who have niches of knowledge in narrow areas.



Subject matter experts (SMEs) are proactively developing the areas of niche expertise . Subject matter ultra-experts (SMUEs) are individuals who are actively participating and leading analysis of a niche area in the Municipal Wastewater Decisions.

The WEFTEC Sludge Dewatering GDPS will provide stops at automation and software companies as well as consulting company stands which would be a source of niche expertise and 24/7 support programs. The WEFTEC conference and exhibition is an opportunity to provide interconnection of the knowledge and people relative to dewatering decisions. Decisive classification of options is one outcome. More broadly it is the leveraging of the Industrial Internet of Wisdom which will empower IIoT.

One of the knowledge interconnections is a paper at Michigan WEA "Steam Powered Energy Conservation at Fort Worth's Village Creek WRF. The authors are Peter Caganaro of Johnson Controls, Andrew Cronberg of City of Fort Worth and Alan Bush of AECOM. The paper describes the project to utilize biogas to generate electricity but also other improvements to reduce the solids needing dewatering. A process management system with a holistic approach not only achieves better sludge but reduces the amount of sludge.



#	Suppliers	Consultants	Operators	Struvite
A				
B	Kemira		Miami Dade	x
C	Nalco, Solenis, Kemira		Fort Worth	

Centrifuges

A - Exhibitors

A number of companies are listed as centrifuge suppliers but only eight are actual manufacturers. Some of those listed offer systems which may include purchased centrifuges and one, Viscotherm, supplies auxiliary equipment.

Company	Stand
Alfa Laval	2717
Andritz	1829
Centrisys	4921

Flottweg	6439
GEA	537
Hiller	1813
Phoenix	5239
Pieralisi	131

B - Alfa Laval provides process management software for centrifuges. Struvite problems are a recurring challenge which we are highlighting as an example of decisive classification and decision making in this pre show analysis. To control the process effectively, Alfa Laval Octopus Plus needs accurate, reliable measurements of the suspended solids content in both the feed and the centrate. To achieve such accuracy, Alfa Laval uses Solitax® sensors manufactured by Hach Lange. The Solitax® sensors measure the turbidity and the suspended solids by scattering infrared light into the target stream and measuring the reflected light via two light sensors. One of these measures turbidity, while for color independent measurement of solids content, both detectors are used. To keep the lens surface as clean as possible, the system periodically doses diluted acid onto the lens surface to ensure that there is no build-up of struvite, which would distort the sensor's measurement. <http://softcomprest.ro/wp-content/uploads/2016/08/Alfa-Laval-Octopus-Plus-Autopilot-for-decanter-centrifuges-in-sludge-dewatering.pdf>.

Relating this article to the NYC article above, the question arises if the Alfa Laval system were using the new Kemira polymer would this eliminate the need for the acid dosing? Hach Lange is part of Danaher who also owns Chemtreat. Does Chemtreat have an alternative solution? The Alfa Laval stand is 2717.

C- Centrisys has publicized its stand, along with its recent successes but also the following presentation.

How to Save \$1M Per Year in Operational Costs: Efficiencies in Sludge Dewatering

Session [617 Expectations Exceeded? Promises Met?](#)
Location Room 344
Date Wednesday, Oct 3 4:00 PM
Duration 30 minutes

Author John Nicholas Rogers, CDM Smith
Co-Author Tom Nangle, Brown and Caldwell

Sludge dewatering and disposal costs constitute a large percentage of a typical wastewater treatment plant's (WWTP) operating costs. Utilities can; therefore, realize significant savings by increasing sludge dewatering operational efficiencies. The New York City Department of Environmental Protection (NYCDEP) just completed a dewatering upgrades project at the Wards Island (WI) WWTP dewatering building. Upgrades included replacement of 13 aged centrifuges with 16 new centrifuges, and

upgrades to ancillary processes to improve overall performance. The upgrade has resulted in savings of \$1.1 million per year in power, polymer and biosolids disposal costs by improving dewatering operational efficiencies at the WI WWTP. In addition, the upgrade increased the dewatering capacity at WI WWTP by 70%, which allows NYCDEP to decommission a dewatering facility at one of its other WWTPs.

The NYCDEP owns and operates 14 WWTPs with a combined permitted capacity of over 1,800 mgd. The Wards Island WWTP (275 mgd capacity) has recently been converted to a step feed biological nutrient removal (BNR) process. Sludge generated at Wards Island is anaerobically digested, stored on site and dewatered by centrifuge. Offsite digested liquid sludge is barged in from three other NYCDEP WWTPs and stored prior to dewatering by centrifuge. The offsite sludges are generally kept separate from WI sludge, but the sludges can be blended prior to dewatering. The Wards Island's dewatering building had 13 Humboldt centrifuges operating reliably but were approaching the end of their useful life. In preparation for replacement of the aging centrifuges, New York Power Authority (NYPA) evaluated newer, more energy efficient centrifuge technologies. NYPA's Energy Services Program (ESP) provides energy-efficiency improvements to reduce energy costs generated by the Authority's public customers, including the NYCDEP.

The study evaluated the lifecycle cost of replacement options, which included current centrifuge technologies from four leading suppliers (Alfa Laval, Andritz, Centrisys and GEA Westfalia), as well as retrofitting the existing centrifuges. The study predicted that replacing the existing centrifuges with current technology equipment, coupled with other improvements, would reduce power cost by more than 50%. Although a pilot program was not implemented, the study predicted a 1% increase in cake dryness could be achieved. Additional ancillary system improvements were predicted to reduce the polymer consumption by more than 10%. Also, the reliable throughput of each centrifuge was expected to be higher than the existing units, increasing the facility dewatering capacity by 70% with three additional centrifuges.

The centrifuges were pre-purchased through a competitive performance bid, with stringent performance guarantees and liquidated damages applied for excess power consumption. Centrisys CS won the bid and the design commenced from 2012-2013, with the first centrifuges coming on line in 2015. The current operating data confirms the predictions made in the 2012 study, with power consumption reduced by 60%, polymer consumption reduced by 19% and the dewatered cake increased by 1%. These results are even more impressive because between the study and startup of the dewatering upgrades at Wards Island, several of NYCDEP's WWTPs switched to BNR processes, which tend to increase sludge volume and decrease dewaterability of sludge.

This manuscript will identify the specific improvements made to the dewatering system to achieve \$1.1M per year in operational savings, as well as identify the improvements for maintainability of the system. The manuscript will also present detailed troubleshooting activities and lessons learned during the startup process.

The operational savings are a result of evolved centrifuge technology and improved design of centrifuge support systems. The new centrifuges have design features that enhance dewaterability and energy efficiency, with feed zone and scroll improvements and revised bowl geometry. Materials improvements have allowed a longer span between bearing housings, increasing the length to diameter ratio which decreases the bowl diameter for a given G-volume. Reducing the bowl diameter reduces the mass moment of inertia, which decreases the force required to spin the bowl – resulting in less energy consumption – and less force exerted on the centrifuge bearings. Discharging the cake and centrate closer to the rotating axis also reduces the power consumption. Other improvements that enhance the operational efficiencies and maintainability of the centrifuges will be discussed, along with challenges and lessons learned during construction and startup.

Improvements to the centrifuge ancillary systems were key to improving operational efficiencies and increasing the capacity and reliability of the dewatering system. The improvements include:

- Introducing four polymer activation units upstream of the polymer aging tanks. These units precisely meter the polymer and water ratio and provide a high shear environment to increase emulsion polymer activation, which helped reduce polymer consumption. This system has performed well; however, operations and troubleshooting information will be provided for others considering similar systems.
- Re-designing the centrate system for increased capacity, to encourage conveyance of solids, discourage blockage of the odor control system and improve access for maintenance. An acid cleaning system was also included to assist in struvite management. Troubleshooting and lessons learned during construction and commissioning will be discussed for this system.
- Introducing total solids analyzers to automatically pace the polymer dosing from the solids throughput of the machines. Implementation, troubleshooting and operations recommendations will be discussed.

In summary, improving sludge dewatering operational efficiencies can offer significant annual savings in operational costs. This manuscript will offer other municipalities insight into the challenges and lessons learned in designing, constructing, commissioning and on-going operations of the centrifuge dewatering system. Other utilities will be able to reap benefits from NYCDEP's dewatering upgrades at the WI WWTP, by adopting what worked and being aware of the challenges that were faced during construction and operation of the new system.

This promotion by Centrisys of the speech along with its stand can be effective. The attendee can plan to attend the speech and to visit the stand. The more interconnections which the exhibitor can create the more effective the exhibition. If system exhibitors are incorporating the product or if a consultant exhibitor has positively evaluated the product then those links can also be worthwhile. If the consultants giving

the NYC speech do not have a stand then the exhibitors can ask to supply their mobile number to visitors who may want to talk to them at the show.

There can also be a complimentary promotion. In the case of the NYC centrifuge process there can be coordination with the consultants but also the pump, process management, analyzers, valve and treatment chemical suppliers to tout the success of the installation and the role each plays.

WEFTEC is a hugely valuable experience but it is very challenging for a visitor to take maximum advantage of what is available. The GdPS and other tools can be used by exhibitors to lessen the challenge.

D - Flottweg The formula is simple. Dryer waste solids equal less solids. Less solids equals lower disposal costs. Other important goals are to keep polymer and energy consumption to a minimum. The results of numerous tests of the Xellektor system are decisive. Depending on biosolids quality, the centrifuge can save about 20% on energy while providing significantly better performance. Not only that, it also increases your throughput by up to 15 %, reduces the volume of waste solids by as much as 10%, and saves up to 20% in energy and polymer consumption. The secret is in the unique design of the rotor, especially the scroll.

Dewatering decanter centrifuges have reached their physical limits of performance. In the past, bowl diameter was the measure for a machines throughput performance. With [Xellektor](#) this no longer holds true. The radically new design of [Xellektor](#) allows Flottweg decanters to reach higher performance values with a smaller machine. This allows for dryer cake which reduces transport costs. The new design also reduces the sheer rate of the Polymer being used as a separation aid, hence reducing the amount of Polymer that is needed.

Most recently, a [Solvay chemical waste treatment plant](#) in West Virginia has installed the new design and is already seeing improvements. The Rosenheim sewage treatment plant in Germany was able to achieve a 2% increase in dryness vs a conventional high-performance series.

Consider a sewage treatment plant in a large city such as Hamburg, Cologne, or Munich, with 500,000 m³/year at 3% dryness. Conventional Machines will produce 59,100 tons/year of dewatered sludge at 25% (solids content). Xellektor will produce 54,700 tons/year of dewatered sludge at 27% (solids content), which is 4,400 tons/year

Sewage treatment plants must therefore, according to this example, dispose of about 4,400 fewer tons of sludge. At disposal costs of about 80 dollars per ton, that means a savings of \$352,000 a year! “

#	Suppliers	Consultants	Operators	Struvite
A	8 companies			
B	Alfa Laval, Hach			x

C	Centrisys	CDM, Brown & Caldwell	NYC Wards Island	
D	Flottweg		Hamburg, Cologne, Munich	

Struvite

A - Here is a Hazen and Sawyer discussion of this option

<https://www.acsawater.com/sites/default/files/websitefiles/SVWWTPN/Dec%202013%20-%20Hazen%20and%20Sawyer%20-%20Part%20of%202.pdf>

B - Suez has a struvite phosphorous recovery process

<https://www.suezwaterhandbook.com/degremont-R-technologies/sludge-treatment/recovery/recycle-phosphorus-from-effluent-to-produce-a-valuable-fertilizer-Phosphogreen>

Suez will be exhibiting at stand 4017 and will be featuring a high rate media filter. The FiltraFast extreme-rate compressible media filter from SUEZ is designed to achieve a very high hydraulic loading rate. It is customizable to meet specific requirements for industrial water filtration and tertiary wastewater treatment. Its backwash sequence enables maximum recovery of water, extends media life and limits energy consumption. This process reduces the footprint, maintenance and replacement costs.

C - Veolia is extracting phosphorous from struvite.

Their stand # is 3117

https://www.veoliawatertechnologies.com/sites/g/files/dvc471/f/assets/documents/2017/10/170324_VWT_NA_WAVE_Sludge_web_1_0.pdf

Veolia will also be presenting papers on a number of different subjects but there are valuable interconnections from one to another.

Monday: 11 AM - Mainstream Deammonification Update with the ANITA Mox Process (*Brad Mrdjnovich*)

2 PM - Advanced Wastewater Treatment Solutions for Food & Beverage Facilities (*Graig Rosenberger*)

3 PM - Hydrotech - A Smart Approach for Primary Treatment (*Mark Stewart*)

Tuesday 10 AM - Water Reuse - The Future Source for Raw Water Make-up to the Power Industry (*Michael Pudvay*)

11 AM - Aquavista™ Smart Water Management (*Veronique Bourgier*)

2 PM - High Efficiency Dewatering & Partial Drying: Paving the Road for Netzero Waste Resource Recovery Facility (*Sudhakar Viswanathan*)

4:15 - QuenchFlow™ Enables Ethane Cracker Quench Water Reuse (*Albert Low*)

Wednesday 10 AM - Vacuum Evaporators for Industrial Wastewater (*Gianluigi Bianco*)

D - Electrochemical Precipitation of Phosphorus for Struvite Recovery. Industrial Scale Application of ePhos®

Location Room 350
Date Wednesday, Oct 3 11:00 AM
Duration 30 minute

Author Iosif Mariakakis
Fraunhofer IGB

Co-Author Siegfried Egner
Fraunhofer IGB

This is the first study of the industrial scale application for phosphorus recovery in the form of struvite by the innovative ePhos technology. Phosphorus was recovered from centrate-water of a German wastewater treatment plants (WWTPs) performing enhanced biological phosphorus removal (EBPR). The ePhos technology: The patented ePhos technology is an electrochemical phosphorus-precipitation process. It takes place in an electrolytic cell consisting of an inert cathode and a sacrificial anode made of magnesium (Mg). By the cathodic reduction water splitting takes place: OH⁻ ions are formed that raise the pH while hydrogen gas (H₂) is evolved. At the anode, the oxidation of metallic Mg takes place: Magnesium ions dissolve and react with the phosphate and ammonium contained in the water to form struvite. The pilot-plant: The pilot plant consisted of two cells with a total hydraulic capacity of 12 m³/h. For the separation of struvite sedimentation tank with a total surface of 20 m² was employed.

The cell geometry was flat and each cell had a reaction surface of 0.3 m². Magnesium sacrifice electrodes with a total mass of 210 kg were arranged as flat sheets parallel to each other. The pilot plants treated the phosphorus-rich centrate-water of the dewatered digested sludge. Different feed volume flow rates at a set current of 30 A between 0.4 m³/h and 1.5 m³/h per cell were tested for the derivation of the optimum conditions in terms of maximization of the phosphorus recovery and specific elimination kinetics, as well as minimization of the energy consumption and magnesium dosing. The influences

of the frequency of polarity reversal and the galvanic operation with no current application were also investigated. Part of the effluent of the sedimentation tank was recirculated back to the cells at a rate of 4 m³/(h and cell).

The Wastewater Treatment Plant (WWTP): The plant was integrated and operated at a Wastewater Treatment Plant performing EBPR. It receives an annual load of 130 t/ P/a and a hydraulic load of 68,000 m³/d. The centrate of the digested sludge after the sludge dewatering has a varying concentration between 40 mg/L PO₄³⁻-P and 80 mg/L PO₄³⁻-P. Operation: The pilot testing for phosphorus recovery was successful. The pilot plant had been incorporated into the operation of the WWTPs and was operated continuously for 5 months in a side-stream configuration.

The major results are listed at Table 1. The best phosphorus removal efficiency was achieved for a volume flow of 400 L/h and polarity reversal every 15 minutes. With increasing flow rates the phosphorus elimination efficiency decreased and reached 73.7 % for the maximum tested flow of 1500 L/h and cell. The energy demand of the process also decreased with increasing volume flow from 0.93 kWh/m³ at 400 L/h down to 0.25 kWh/m³ for 1500 L/h due to the higher centrate quantities that were treated while keeping the energy input, i.e. the current constant. The Magnesium to Phosphorus stoichiometry did not exhibit a clear trend and varied between 1.7 and 2.9. The specific phosphorus elimination kinetics in terms of unit surface and time increased with increasing volume flow rates from 0.027 kg P/(m² h) for 400 L/h to 0.121 kg P/(m² h) for 1500 L/h. This can be attributed to the higher phosphorus load treated.

The investigation of the frequency of the polarity reversal showed that slightly better results in terms of specific elimination kinetics can be achieved for longer reversal increments. The galvanic operation exhibited similar elimination kinetics and efficiencies to those observed during the electrolytic operation at 400 L/h and 30 A, but for a volume flow of 150 L/h. The advantage of such operation lies at the fact that no energy is required. During the 4 month operation of the cell no significant problems with the plant were observed. More than 90% of the struvite could be recovered by the sedimentation tank operated at 0.25 m/h surface loading rate.

Profits: By the full-scale implementation, the elimination of the phosphorus in the centrate-water would reduce the phosphorus load of the WWTP by up to 17% and would significantly enhance operation stability of the WWTP.

Conclusion and outlook: The pilot-plant operation of the ePhos technology was successful and the advantages of this technology; like fast start-up, no addition of precipitation chemicals or chemicals for the increase of the pH, low energy demand were confirmed. The operation can be flexible comprising of modules independently operated. Further investigations will be carried out to complete the industrial design in order to demonstrate the technology in first full-scale installations.

E - Full Scale Implementation of AirPrex™ Phosphorus Recovery and the Development of a Mechanistic Process Model

Session 606 Sidestream Impacts From Startup to Implementation
Location Room 354
Date Wednesday, Oct 3 3:30 PM
Duration 30 minutes

Author

Hiroko Yoshida
Centrisys Corporation

Co-Author

Dr Malcolm Fabiyi
Drylet

Background

Struvite harvesting is widely accepted as a viable option to recover phosphorus, a valuable and finite resource, from the Wastewater Resource Recovery Facilities (WRRF). Successful application of struvite harvesting at WRRF require understanding the release and precipitation mechanisms for phosphorus and other inorganics for controlled phosphorus precipitation and avoiding challenges of uncontrolled precipitation of struvite in pipes, equipment and anaerobic digesters. The AirPrex™ phosphorus recovery process is a mature struvite harvesting technology that has been applied at full scale in wastewater treatment facilities. AirPrex is typically installed between the anaerobic digester and dewatering equipment. Struvite is precipitated by supplementing MgCl₂ and adjusting pH by stripping out of CO₂. Implementation of AirPrex can ensure the 90% reduction of both soluble and total phosphorus in the return flow.

The challenge for evaluating AirPrex™ or any struvite harvesting technology is the determination of the impact that the process has on plant wide operations. For instance, the reduction in Ortho P level in the centrate or digestate streams due to struvite harvesting, will cause a significant reduction in the recycled quantities of soluble P back to the head of the plant. This will affect important factors such as the VFA to OP ratio, C: N: P ratio entering the biological process – with implications for processes like Bio-P and ENR, as well as nuisance Struvite formation in the anaerobic digestion process. Understanding the impact on plant wide operations requires dynamic process modeling of the entire wastewater treatment plant.

The purpose of this study was to develop a well calibrated and standardized model that 1) allows evaluation of any WRRF configuration using struvite recovery technologies to understand the plant wide operational effects and 2) enhance communication between equipment providers and end users regarding plant wide benefits of struvite harvesting.

Methodology

The operational data collected from three pilot tests carried out at different full scale WRRFs was used to develop and calibrate the model. These pilot tests were carried out using the same pilot skid, between 2016 and 2017. The pilot unit comes in two standardized ISO 40 ft containers. The AirPrex® reactor is mounted into a 40 ft

container frame. The other containers houses MgCl₂ dosing tank and struvite harvesting and washing equipment. The capacity of the pilot unit is up to 13 gpm.

Comprehensive operational data was collected at the eight successful demonstration sites. The use of the same skid at multiple sites, allowed for the generation of data covering similar parameters, across a broad range of parameters values due to the differences in the wastewater characterization and operational modes at both facilities.

Model development was done using the Mantis2 model in the GPS-X™ simulation platform. Mantis2 is a comprehensive bio-chemical whole plant model which allows users to analyze different wastewater treatment plant configurations for BOD, nitrogen and phosphorous removal, resource recovery (biogas, struvite) and side stream treatment using the de-ammonification process. Key features of the modeling platform include: 1) A single set of state variables for both the liquid (activated sludge) and solid (Anaerobic digestion) processes 2) Two step nitrification and denitrification processes 3) Methylo trophic denitrification on external substrate like Methanol 4) ANAMMOX (Anaerobic ammonium oxidation) process 5) Precipitation of common precipitates of Al, Fe, Ca, Mg and PO₄ in the liquid and sludge streams. 6) pH estimation in both the liquid and solid streams and 7) Elemental mass balance for COD, C, N and P and other inorganic components like Ca, Mg, and K.

The chemical precipitation reactions of precipitation of CaCO₃, MgHPO₄, CaPO₄, AlPO₄, FePO₄ and Struvite are also included. The Mantis2 model was customized to the AirPrex™ process by developing a module that incorporated two distinct and unique features of the AirPrex™ process – the use of air for CO₂ stripping to raise pH, and the addition of MgCl₂ for enhancing Struvite precipitation. CO₂ stripping was modeled using a modified oxygen transfer model. Struvite formation in the AirPrex process was modeled by using kinetic precipitation equations incorporating struvite solubility product (pK_{sp}) and a precipitation rate constant.

Results

Calibration and validation of the model to operational data from the three pilot sites has been undertaken. The model robustly replicates the operational features of the AirPrex™ process. The CO₂ stripping and the pH increase in the sludge was impacted by the aeration efficiency and alpha factor settings. Very low values for alpha*SOTE were obtained, consistent with the expected mass transfer characteristics in a coarse bubble aerated process with high organic and inorganic solids concentrations. The pH, total-Phosphorus, Ammonia-N, Magnesium and Orth-P concentration were well predicted by the model for the datasets from both the pilots. The predicted Calcium concentration was higher than that measured in both the pilots. Further investigations are being made to understand the nature of Calcium precipitation in Airprex reactor.

Significance

The pilot studies and the modeling exercise described in this paper have demonstrated the robustness of the AirPrex™ struvite recovery process, and the practical use of modeling tools for enhancing operations when using innovative technologies for nutrient recovery. The full paper will provide detailed overviews of the pilot studies, and extended details on the model development process. Our findings will make a

significant contribution to the quest for providing developing robust options for struvite harvesting and the development of operational tools that can enable adopters of such processes, understand their plant wide impact and levers for optimization. The availability of plant wide models allows for training, process optimization and troubleshooting to be carried out by operators in a risk free manner.

#	Suppliers	Consultants	Operators	Struvite
A		Hazen & Sawyer		x
B	Suez			x
C	Veolia			x
D		Fraunhofer IGB		x
E	Centrisys, Drylet			x

Pumps and Valves

A - Idex-VanLare installs Pulsafeeder Metering Pumps

Located on the southern shore of Lake Ontario, the Frank E. VanLare Wastewater Treatment Facility, Monroe County, N.Y., has a total treatment capacity of 660 mgd and is currently running around 100 mgd. The plant uses Non-metallic Eclipse pumps to pump 12.5% Sodium Hypochlorite, Chlorine, for disinfection before the final discharge of the wastewater. VanLare runs 24 hours a day, 365 days per year.

VanLare originally installed peristaltic pumps for Sodium Hypochlorite and its Environmental Service team was in search of a better solution. Peristaltic hose life is unpredictable and inconsistent. These pumps are not leak free so worker safety was also a concern because of inhalation and skin contact with the chemicals. To solve the problem they installed Non-metallic Eclipse pumps. Eclipse sealless design ensures zero emissions of hazardous or regulated chemicals. These pumps have superior chemical resistance. Service is quick and piping and electrical stay in place because of the front pull-out design.

In addition to pumping Sodium Hypochlorite, VanLare installed three Non-metallic Eclipse E25 pumps into the Ferric Chloride station. Ferric Chloride is used for phosphorus removal. Pulsafeeder will be a stop in the Sludge Dewatering WEFTEC GDPS at stand 4308.

B - Accudyne will be a stop in the Sludge Dewatering WEFTEC GDPS

Accudyne Industries business units manufacture pumps designed to inject coagulants, disinfectants, softening agents, acids and bases for pH control and de-chlorination chemicals into a plant's water systems:

Milton Roy metering pumps are efficient, cost-effective and reliably designed specifically for wastewater treatment.

Milton Roy mixers are widely utilized for basic treatments, sludge digestion and O2 injection.

Williams pneumatic metering pumps are ideally suited to precisely inject a wide variety of chemicals designed for treating industrial water and wastewater.

LMI chemical metering pumps are used for versatile applications in water and wastewater treatment.

Sunflo high pressure centrifugal pumps are widely utilized for boiler feed water and membrane filtration wash down.

The Milton Roy stand at WEFTEC will be 3739

C - Thames Water Modgen Plant switches to SEEPEX Pumps

Originally built in the 1930s, the Mogden sewage treatment plant has undergone major expansions over the decades to keep up with exploding population growth. Operator Thames Water has now converted the large plant over to using SEEPEX pumps. The customer needed more than just equipment, requesting a sophisticated service package as well to ensure optimal operation.

This was no small challenge given the variety of sludges involved of differing densities and temperatures. SEEPEX had to precisely design every pump – ranging from the small metering pump for liquid polymers to the many transfer pumps for sludge treatment – for specific requirements. Pumps also had to be developed which were capable of moving 180 cubic meters of slurry to the sludge treatment facility 16 km away. Additionally, special measures were required to ensure smooth and efficient pump operation, reducing downtime and costs.

SEEPEX N300-36 transfer pumps were deployed, becoming milestones in technological development by being the biggest progressive cavity pumps in existence at that time in both length and weight.

Since commissioning, SEEPEX has performed full-service monthly inspection and maintenance of the pumps, checking dry running, overpressure, wear, driving power and efficiency. The key is performing preventive maintenance, on site and the same day if necessary, before any breakdowns can occur.

The success is evident, as pump downtimes at the sewage plant have been drastically reduced. SEEPEX UK is now responsible for maintaining a total of 68 progressive cavity pumps and macerators at Thames Water facilities and at the neighboring Iver South sewage treatment plant located in Slough.

Seepex is one of the identified stops in the Sludge Dewatering WEFTEC GDPS at stand 6939.

D - Lift Station Valves furnished by DeZURIK to Phoenix

APCO SRA Surge Relief Angle Valves were installed on a new Lift Station in the city of Phoenix. New freeway construction required the existing lift station to be relocated. The new location is in a hilly part of town with elevation changes, and the Lift Station discharges into a force main system. The 8" SRA-3000A Surge Relief Angle valves are designed to prevent line damage from surges that occur when the lift station pumps cycle on and off. The surge valves were installed and set to relieve system pressure at 135 psig. DeZURIK PEC Eccentric Plug Valves are used as isolation valves on the lines.

The surge relief valve is typically installed downstream of the check or pump control valves on the pump discharge header with the valve inlet connected to the side outlet of a tee and the valve outlet piped to the sump. The normally closed surge relief valve opens quickly when the system pressure rises above its adjustable relief pressure setting allowing fluid to be discharged from the system through the open surge relief valve to atmosphere. While the surge relief valve is open, the system is no longer contained, fluid compression is limited and surge pressure is controlled (green line). The valve will remain open as long as the system pressure exceeds the valve's relief pressure setting. The valve will slowly begin to close at an adjustable rate as the surge pressure subsides and the system pressure falls below the valve's relief pressure setting. DeZurik will be at stand 4929 at WEFTEC

E - NOV Progressing Cavity Pump

The article below appears in the preview of WEFTEC in Industrial Water World, the sister publication of WaterWorld. The magazines provide an important function by educating potential visitors.



The EZstrip™ maintain-in-place progressing cavity pump from NOV is designed with new features to make maintenance more user friendly. It has quick and safe removal of the full drive train including rotor, stator, shaft, rod and seal. With its patented Positive Torque Split Coupling Rod, maintenance and assembly times are reduced. The tie-bar-free design allows the EZstator clamps to lock the stator securely in place, further reducing stator removal time by over 50% and improving safety of

common maintenance operations. Available in cast iron or stainless steel with a choice of rotor and stator materials, it suits multiple applications.

National Oilwell Varco (NOV)
www.nov.com
Booth 1313

F - Netzsch Booth 1319

On display will be the N.Mac Twin Shaft Grinder; FSIP (full service-in-place) version of the industry-leading NEMO progressing cavity pump, including the new xLC unit; the revolutionary TORNADO T2 rotary lobe pump, and the iFD-Stator 2.0.

Also to be highlighted is the maintenance-friendly FSIP NEMO progressing cavity pump and its new xLC unit. Providing full access to all of the pump's rotating parts, the FSIP pump allows users to conveniently open the pump cavity on-site and dismantle all rotating parts and simply install them again without having to remove the pump or disconnect the piping. This significantly reduces installation complexity and maintenance time. The new addition to the NEMO's portfolio, the xLC unit, triples the service life of the pump, particularly when conveying difficult, abrasive media.

When wear occurs in the rotor-stator system, the new xLC unit allows the performance of the pump to be re-established by adjusting the preload between the conveyor elements <https://www.wateronline.com/doc/netzsch-to-showcase-range-of-innovative-pump-technology-weftec-0001>

At the town of St Marys in Canada changes resulted in increasing the viscosity of the thickened biosolids significantly, and also increased the percentage of solids from 3% to a range of 8% to 14%. The centrifugal type pump previously used, could not handle the highly viscous biosolids. The Netzsch P.C replacement solved the problem

<https://www.waterworld.com/articles/2018/06/canadian-wwtp-reduces-loading-times-with-netzsch-vertical-pump-install.html>

The N.Mac™ Twin Shaft Grinder from NETZSCH is designed to fragment a variety of materials and is ideal for wastewater treatment and industrial applications. Available in both channel and inline (flanged) housing construction, the N.Mac can be installed into effluent channels or upstream from a pump. The cartridge design features a leak-free combination of mechanical seal and bearing cartridges, enabling quick and simple replacement and servicing. <https://www.waterworld.com/articles/print/volume-33/issue-10/products/products-services-wastewater-treatment.html>

G - KSB: Pumps and Mixers will be on display at booth # 4641 and will feature

Virtual experience of the new generation Amarex KRT submersible pump with the F-Max impeller

- New generation Sewatec horizontal dry well pump with F-Max impeller
- New Additions to our hydraulic lineup (K-Max and E-Max)
- Most reliable submersible motor pump with axial propeller
- Complete line of our efficient vertical tubular casing pumps for your water applications
- KSB System Analysis – System Efficiency Services
- Watch the Operations Challenge teams practice with the NEW KSB Maintenance Event

In a 2018 WaterWorld interview KSB explains its "Cycle of Solutions" concept, addressing how integrated technology is now needed for water intake to disposal <https://waterworld.brightcovegallery.com/detail/video/3580038825001/ksb>

KSB now (as of 2012) offers the Sewatec dry-installed volute casing pump. Used for wastewater transport and treatment, sludge handling, and stormwater applications, the pump features a flexible hydraulic design to meet a multitude of conditions. The Sewatec dry pump line is a derivative of the KRT line of submersible pumps (also available from KSB). Because Sewatec's impellers, bearings, mechanical seals, O-rings and discharge covers are interchangeable with the KRT line, inventory streamlining is easy for customers that also use KRT wet well pumps.

<https://www.waterworld.com/articles/iww/print/products/2012/07/wastewater-pump-ksb-inc.html>

H - BJM Pumps Booth 1901

BJM Pumps® provides fluid handling solutions for industrial and municipal services. BJM Pumps has grown quickly by supplying world class pumps and accessories, priced competitively, through its global network of stocking distributors in the United States, Canada and South America.



BJM Pumps has announced the new XP-KZN heavy-duty, submersible, explosion-proof pumps that are designed for tough conditions where explosion-proof, FM, C/US approval is needed. The XP-KZN features a top discharge, slim-line design with an agitator to suspend heavy slurries containing abrasive materials, as well as to allow for

an easy fit into tight, thin spaces. It features robust construction and unmatched design, making it able to outperform and outlast standard wastewater predecessors in harsh environments. The agitator helps keep solids suspended in liquid and helps prevent the pump from clogging, reducing capital and operating costs.

<https://www.waterworld.com/articles/print/products/2015/march/submersible-pumps.html>

I - Boerger, LLC Booth 5927

Headquartered in Germany with subsidiaries around the world, Börger develops, manufactures and sells rotary lobe pumps, macerating technology and feeding technology for the conveyance of low to high viscous and abrasive materials. Börger's core product, the Blueline Rotary Lobe Pump, is a self-priming, valveless, positive displacement pump available in 21 models within six series delivering flow rates up to 7,500 gpm. All Börger equipment is constructed using MIP (Maintenance in Place) design. This allows for an almost limitless operational lifetime. Through the Quick-Release Cover all wetted parts can be maintained or replaced without the removal of pipe or drive systems.

Rotary lobe pump interview with McIlvaine at WEFTEC 2010

http://www.mcilvainecompany.com/WEFTEC_2008/WEFTEC2008BorgerRotaryLobePumps.htm

J - Flygt, A Xylem Brand Booth 5939

Xylem's Flygt manufacturers submersible pumps, mixers and mechanical aeration equipment for use in markets ranging from water and wastewater treatment, raw water supply, abrasive or contaminated industrial processes, mining and irrigation.

Operators of a municipal wastewater pumping station in the rural town of Lomma on Sweden's south-western coast agreed to install and trial a revolutionary new wastewater pumping system in an effort to solve clogging issues at the pump station.

As well as delivering clog-free pumping, Xylem's Flygt Concertor, a state-of-the-art pumping system with integrated intelligence, significantly reduced energy consumption at the wastewater pumping station. The operators were so impressed that they decided to purchase and permanently install the new system at the facility.

<https://utilitymagazine.com.au/flygt-concertor-trial-a-success-for-swedish-municipality/>

Rene Prins discusses Flygt's new Exporior wastewater pumping system, which combines the best in hydraulics, motors and intelligent controls to deliver a user-friendly, energy efficient wastewater pumping solution. Water World Weekly video interview <http://site-438305.bcvportal.com/detail/video/1277219628001/flygt-a-xylem-brand>

With the development of the centrifugal N-pump and introduction of the PC-pump in the Flygt assortment ITT Flygt in 2008 was able to offer a complete assortment of pumps for sludge applications. McIlvaine Company Interview

http://www.mcilvainecompany.com/WEFTEC_2008/WEFTEC2008ITTFlygtCorporation.htm

K - Gorman-Rupp Pumps Booth 3429

Gorman-Rupp Pumps is a manufacturer of pumps and pumping systems for the municipal, water, wastewater, sewage, industrial, construction, and original equipment manufacturing markets. Solids handling self-priming and submersible sewage pumps offer maximum dependability and ease of service. Established in 1933, Gorman-Rupp provides a quality, competitively priced product backed by customer service.

Gorman-Rupp supplies sewage pumping systems including pumps, motors and controls (complete sewage lift stations). The solids handling self-priming and submersible sewage pumps offer dependability and ease of service.

Struvite Choking Problems Solved: SE Water decided to go with Gorman-Rupp Super T Series self-priming pumps with an internal coating to attempt to slow the struvite growth. These pumps can be installed above the liquid (high and dry) to enable operators to easily access and monitor at ground level <https://www.pumpindustry.com.au/stps-struvite-pump-choking-problems-solved/>

L - LobePro Rotary Lobe Pumps Booth 4241

LobePro Rotary Pumps manufactures 3 lines of positive displacement, rotary lobe pumps: S-Series: Sludge, Mud, and Slurries and General Use applications; C-Series: Corrosives & Chemicals; and D-Series: Duplex Pumps for Abrasives & Corrosives. Each line is also available in an API-Series: API 676 Compliant version. Our rotary lobe pumps are typically used to pump sludge to and from thickeners, separators (such as belt presses, centrifuges, and rotary presses), digesters, clarifiers. They are suitable for pumping any wastewater sludge which has had the hard solids over 1/8" and most grit removed for flows up to 2000 GPM and pressures up to 150 PSI. the company can specify an in-line grinder, filter or knock-out tank should hard solids larger than 1/8" be present.

According to Bill Blodgett, president, the recent rate of innovation in production from Biosolids has been amazing. However, one consistent requirement is the need for low shear, pulseless pumping of viscous material (often containing 2% or greater solids). Just as important is pumping at a measured flow rate and pressure. LobePro rotary lobe pumps excel in this. LobePro pumps are available in capacities up to 2000 gpm and pressure capability up to 150 PSI. The pumps are happy to run clockwise or counter clockwise. This allows one pump to both load and unload or back flush. (for other properties see [Properties of Rotary Lobe Pumps](#)).

M - Putzmeister America, Inc. Booth 2857

Putzmeister is well known for its complete systems approach, especially for handling the most difficult applications, including the transport and storage of coarse sludges and slurries. From the mud of the Assuan Dam and the sewage waters of Paris, to land

reclamation, coal and ash in power stations, and gold slimes in mining – Putzmeister is the first choice for municipal and industrial project applications. Organic applications: biomass, sewage treatment, co-incineration, coal slurry, cement industry, special waste, paper industry, chemical industry. Inorganic applications: mining, fly- and bottom-ash, surface water sludge removal, tunnel construction, oil industry/offshore. Putzmeister technology has opened up new applications for difficult material, making it possible to efficiently convey sludges and slurries that seemed impossible before.

N - Shanghai Techase Environment Protection Co., Ltd Booth 4651

TECHASE, which was invested in by Tongji University, is a worldwide leading company in solid-liquid separation of industrial and municipal wastewater. Our head office and factories are located in Shanghai. TECHASE intends to provide customers with professional consulting services, the best cost-effective solutions and products of top quality, high performance, and for customization.

O - Schwing Bioset, Inc. Schwing Booth 2914

Schwing Bioset, Inc. has supplied complete biosolids treatment and handling systems for over thirty years. Growing from a biosolids handling supplier, it now offer process systems as well, including MBR systems, phosphorus management, screw press dewatering, piston pumps, screw conveyors, Class A alkaline stabilization and drying technologies, sliding frames, live bottoms, and more.

At wastewater plants utilizing anaerobic digestion, Struvite commonly forms and creates issues with pipes clogging and equipment being damaged as a result of scaling. Additionally, tanks can accumulate Struvite, which requires periodic removal and creates an additional expense to plant operations. Schwing Bioset's Nutrient recovery system recovers Ortho Phosphate and Ammonia Nitrogen from wastewater while offering great benefits to the treatment plant, not only by significantly reducing phosphorus in the waste stream, but also preventing unwanted scaling and accumulations, and creating a valuable end product. The phosphorus forms a stable Struvite crystal that can be marketed and sold for beneficial reuse, thus keeping excess phosphorus out of the local waterways and helping close the phosphorus recycling loop.

White paper: Although the advantages of anaerobic treatment are obvious, subsequent nutrient removal still remains an important issue. Readily biodegradable organic matter needs to be bypassed towards aerobic post-treatment in order to achieve the final nutrient effluent standards, thus reducing the potential biogas yield and increasing the waste sludge production. Nutrient removal by struvite ($MgNH_4PO_4 \cdot 6H_2O$) or magnesium ammonium phosphate (MAP) precipitation is an interesting alternative approach to address phosphorus removal (von Munch and Barr, 2001; Gonzalez and De Sa, 2007).

To read the entire white paper, please submit the download form.

<http://www.schwingbioset.com/white-paper-phosphate-removal>

P - SRS Crisafulli, Inc. (also known as Crisafulli Pump Company) Booth 7230

Full line of dredges for managing settled wastes, biosolids, sediment, lime and alum sludges, and high-volume pumps for dewatering, stormwater management, lift stations and pumps.

The SRS Crisafulli remote control FLUMP dredge is designed to remove settled wastes and other by-products from settling ponds or lagoons. It is equipped with discharge pumps in sizes 3", 4", 6", and 8". The integrated system is comprised of major standard and optional components – i.e., flotation system, primary and secondary motors, hydraulic and electrical systems, cutterhead, pump, ladder, manual or programmable computerized controls, cabled traverse system, and Crisafulli Integral Floating Discharge System. Four models are offered with standard dredging depths to 12 feet. Custom depths to 30 feet. <https://www.waterworld.com/articles/print/volume-26/issue-6/products/products--services.html>

O - Yamada America Booth 645

Yamada Corporation is a global producer of air operated double diaphragm pumps with over 100 years of experience. It pursues an ever-increasing number of pump applications involving corrosives, slurries, viscous and shear sensitive liquids. Pumps range from ¼" through 3" in a wide array of materials of construction. Specialty pumps include solids handling, powder, and high-pressure pumps.

U - Weir Booth 5739

Weir designs and manufactures highly engineered pumps and related equipment for the global water and wastewater industries. Engineers work closely with customers to understand their operational challenges and help improve productivity and lower total operating costs.

At Stand 5739, Weir will be displaying its full product portfolio for the water and wastewater markets including products from Weir Floway and Weir Specialty Pumps (WEMCO and WSP brands).

Weir Floway has been manufacturing vertical turbines for more than 80 years. We are recognized by customers around the world for industry leading quality and performance. We have evolved into an engineered-to-order company that can solve the most complex and demanding of applications. From special materials and custom designs, Weir Floway is dedicated to providing superior quality, top hydraulic performance, and long service life.

Weir Specialty Pumps (WSP) are experts when it comes to wastewater pumping and grit removal applications. WSP brings more than 60 years of experience in providing equipment to the municipal wastewater market with our WEMCO Torque-Flow recessed

impeller grit pumps, WEMCO Screw-Flow screw centrifugal solids handling pumps, and the WEMCO Hydrogritter for grit removal and dewatering applications. In addition, WSP also manufactures the WSP Chop-Flow chopper pumps, WSP Self-Primer, and WSP Non-Clog pumps. WSP is able to provide pumps in a multitude of arrangements including horizontal, vertical, and submersible.

V - Egger Booth 1543

Egger's Iris valve provides Stable, Linear, Accurate, Repeatable and Reliable control of aeration basins.

In the past, WWTP's have upgraded their processes with Fine bubble diffusers, High-speed Turbo Blowers, Hyperboloid mixers but never dealt with the most critical & final piece of the puzzle; a good process control system including a unique valve design. The laminar flow characteristics can reduce blower energy consumption 20% through better control.

W – Asahi/America Booth 1145

Asahi/America, Inc., a manufacturer and distributor of corrosion resistant thermoplastic fluid flow solutions including valves, actuators and piping systems, will be exhibiting in booth 1145 at WEFTEC. Asahi will be featuring two of their newest solutions at the show, the latest innovation in butterfly valves: the Type-57P; and the compact and powerful Series 17 electric actuator.

The Type-57P butterfly valve is the next generation of Type-57 butterfly valves. The redesigned valve is available in an ANSI wafer-style connection and shares the same face-to-face dimensions as all like-size Asahi/America Type-57 butterfly valves.



New Design Features

- Molded tag holes for valve identification and labeling
- Redesigned indicator plate for lever handle models 0° closed to 90° open legend with 10° intervals
- Improved design of seat and disc bushing for increased internal sealing performance
- Newly designed disc and seat for added valve life

The Type-57P's body and disc are injection molded for durability, and the 316 stainless steel stem is non-wetted. For high cycle life and smooth torque, the seat and disc bushings have been fitted with dual O-ring seals.

Asahi/America's Type-57P butterfly valve is available in sizes 1-1/2" through 8" with a lever, and in 1-1/2" through 14" with our Plasgear™ operator. Available body and disc materials include PVC, CPVC, PP and PVDF. The Type-57P top flange features an ISO 5211 F07 – F14 bolt circle, and all sizes can be electrically or pneumatically actuated.

Asahi/America's Type-57P is assembled to customer specification and tested in their Lawrence, MA facility.

In addition, Asahi will be featuring their new Series 17 actuator at WEFTEC.

The compact, lightweight and powerful Series 17 electric actuator features a reversing motor with multi-voltage capabilities, an internal heater, auxiliary switches, and two LED position indicators.



Internally, the Series 17 includes a permanently lubricated steel gear train and declutchable manual override.

The Series 17 also features a combination NEMA 4X and 6 enclosure, which is finished with a thermally bonded powder coat to protect against corrosion, an ISO bolt circle and flying leads.

#	Suppliers	Consultants/ Media	Operators	Struvite
A	Pulsafeeder			
B	Accudyne			
C	Seepex		Thames Water	
D	DeZurik		Phoenix	
E	NOV	WaterWorld		
F	Netzsch	WaterWorld	St Mary's, Canada	
G	KSB	WaterWorld		
H	BJM	WaterWorld		
I	Boerger	Mcllvaine		
J	Flygt	Utility Magazine Water World	Lomma, Sweden	
K	Gorman Rupp	Pump Industry	S.E. Water	x
L	Lobepro			
M	Putzmeister			
N	Shanghai Tecase			
O	Schwing Bioset			x

P	SRS Crisafulli			
R	Yamada			
S	Watson Marlow	TBD		
T	Wilo	TBD		
U	Weir			
V	Egger			
W	Asahi/America			

Aerators

A - Aerator Blower GDPS at WEFTEC

Municipal Wastewater Decisions includes a very detailed analysis of aerator blower types and the benefits and limitations of each relevant to specific conditions and processes encountered in municipal wastewater plants.

http://www.mcilvainecompany.com/MWT_Decisions/Subscriber/Aeration%20Blower%20Purchasing%20Decisions.pdf

One of the main theses of the Decision Guide is the replacement of large blowers with smaller ones. The reason is that with fluctuating flows it is cost efficient to run smaller blowers as needed. In the 'Village Wastewater' case the decision was made to convert to large unused blowers to operate with steam powered drivers. So this paper will also be linked in the blower purchasing decision guide.

Here are the aerator blower exhibitors

Atlas Copco	4837
Aerzen	817
APG Neuros	3407
Gardner Denver	7039
Howden	1117
Pillaerator	4107
Sulzer	2515

B - Atlas Copco: This year Atlas Copco will have blower equipment for most of product lines on display – rotary lobe, rotary screw, multistage, and high speed with magnetic bearings.

1. Atlas Copco is launching a rotary lobe blower line for the first time at WEFTEC. This is the ZL product line, and we will have a new ZL unit with integrated blower controls and an integrated VFD in a new, compact package. Atlas Copco had this product line available for other markets, but the new ZL2 on display is a new package design that will also be launched in North America.

2. The new ZS rotary screw blower product line will also be on display. The ZS4 covers motor sizes from 40 to 125HP and is equipped with a new, more efficient blower element in every package. The company is also displaying a premium version with an integrated VFD and permanent magnet motor for increased energy savings. This blower is claimed to be the most efficient screw blower in this power range on the market.
3. The high speed centrifugal blower, the ZB, will also be on display in a new design with a smaller footprint. In addition, the company will be expanding the range of this equipment further with new variants.

All of these machines are new designs and this will be the first time they are on display at a trade show. Contact: Travis McGarrah, product manager
travis.mcgarrah@us.atlascopco.com mobile (281) 840-0468

C - Howden

At last year's WEFTEC, Howden announced the acquisition of Siemens Turbomachinery Equipment businesses in Europe and China, along with a Siemens Energy business in America. This expanded Howden environmental industry product portfolio to include Turblex® in the US, HV-TURBO® and Kuhnle, Kopp & Kausch® in Europe, to its existing Roots® and Exvel® brands.

At WEFTEC 2018, in addition to displaying the reliable Roots positive displacement blowers and the highly efficient Turblex single-stage geared compressors, Howden will introduce the EasyAir™ Turbo blower. The EasyAir™ Turbo blower is an integrated blower package with leading aerodynamic technology, magnetic bearings and permanent magnetic motor single stage blower for the wastewater treatment industry.

Also on display is Howden's internet of things (IoT) solution Uptime®. Uptime® is a unique digital solution that enables data capture from rotating equipment with instant access to asset documentation for predictive maintenance and efficient equipment operation. Visitors will be able to experience the Uptime® digital twin technology via the immersive Augmented Reality (AR) displayed on mobile devices or smart eyewear. Stand 1117 Contact: Amber Roberts (Howden Americas Sales), amber.roberts@howden.com, mobile (573) 808-3497.

Howden Intelliview controls are controlling aeration at Bird Island
https://www.howden.com/Brochures/BirdIsland_wastewater_casestudy_May2017.pdf

There was good coverage of the WEFTEC 2017 displays in
<https://blowervacuumbestpractices.com/technology/aeration-blowers/show-report-2017-weftec-aeration-blower-technology>

The McIlvaine free site has many relevant articles and presentations
http://www.mcilvainecompany.com/Decision_Tree/subscriber/Tree/Default_Global.htm

On the McIlvaine protected site there is an extensive ongoing aerator analysis in
[Municipal Wastewater Decisions](#)

There is an evaluation of the blower options by Carollo
<http://www.cwea.org/sarbs/pdfs/Blower%20Technologies%20Loera%20061712.pdf>

D - Achieving Process Optimization and 30 Percent Energy Efficiency Through the Purchase of an Expensive Turbo Blower

Session NOCC-259 308 In Pursuit of Energy Neutrality: Development and Implementation of Energy Optimization Programs and Strategies at WRRFs
Location Room 347
Date Tuesday, Oct 2 11:30 AM
Duration 30 minutes

Author John Koch
HDR

- **Co-Author** Gary Duranceau
City of Mount Vernon

Background

The City of Mount Vernon is striving to reduce costs and become carbon neutral. As part of a city-wide energy optimization effort, they recognized there were opportunities for energy grants and opportunities to purchase new technology with shorter paybacks. At their plant, they had already replaced old coarse bubble diffusers with new membrane fine bubble disk diffusers and made process changes and reconfigurations to more efficiently operate their activated sludge system, resulting in a significant reduction of air demand.

Existing old multistage centrifugal blowers did not have a very wide range of turndown, and automated butterfly valves that control dissolved oxygen (DO) to the individual aerobic zones were not providing stable air flow control. These valves were a carryover from the coarse bubble diffusers and conventional plug flow reactors. It is important to note that sizing control valves is an exact science and bigger is not always better. An upgrade to a new turbo blower was an excellent opportunity for the City, given facility evaluation information and the potential to increase operability and save energy cost.

Problem

At the City's plant, air requirements during the diurnal periods and dry weather low flow periods had gotten too low for their old centrifugal blowers. As a result, air had to be wasted to an old selector cell, which was not only hard to control it was a costly process. In addition, oversized butterfly valves also made it difficult to control basin DO. A small percentage change in the butterfly opening caused a substantial change in the air flow to each basin. As aeration basin valves opened, the air header pressure dropped and the aeration blower inlet valve opened, increasing the blower airflow and pressure. For plant staff, this hunt and seek process control takes several hours to stabilize, while the basin DO either increased or decreased, leading to the process instability. Due to this control fluctuation, power usage in the plant fluctuated.

Methodology

The team worked with plant staff to analyze air demand historical records; yearly, monthly, and daily minimum and maximum air flow requirements were determined. As important, operator observations, as well as a Biowin model, were used to determine the minimum and maximum values. For proper sizing of a control valve, the desired response of the valves is to have a 1 percent change in valve position, which provides a corresponding 1 percent change in the flow. Having a Cv curve of existing valves will provide the necessary data to select appropriately sized replacements. For a typical butterfly valve, for good control and response the Cv should be in the 30 to 80 percent open range.

For the City, once the desired Cv ranges were calculated, minimum to maximum, the manufacturer's published Cv table was entered to select an appropriate size. Table 1 is an example of butterfly valve Cv table.

Table 2 shows calculations of the air flow control valve for aeration basin cell number 4 (AB #4) with an appropriately sized valve in the recommended opening range of 30 to 80 percent.

Results

Proper valve sizing and an energy study helped the City determine that they could realize a payback of just over 4 years with the purchase of an energy efficient blower, illustrated in Table 3.

A high-speed turbine blower was purchased through an evaluated competitive procurement process. Table 4 illustrates the completed bid form from the successful low bidder.

After the contract was signed, plant staff changed the oversized butterfly valves to smaller units and they installed the blower. At blower start-up issues immediately arose,

including the inability to turndown to the low diurnal flows necessary for the evening operation without going into a shutdown condition. In the evaluation phase, minimum and maximum daily values were analyzed, not the daily diurnal flows. These unforeseen issues manifested in unstable blower operation and unstable DO in the activated sludge system. Figure 2 illustrates the wide variation in power and blower shut downs after the new blower was installed.

Working with plant staff, the City's instrumentation/programming firm, and the blower manufacturer, a means was developed to achieve the project goals. Because the blower manufacturer could not achieve the low flow requirements and actual nighttime low air demand was substantially less than previously assumed, an alternative fix was the installation of an automated waste air valve in an unused flocculation basin. During several days and nights of observation of blower operation and aeration basin system pressures, it was determined that a modified, mostly open valve control system would provide the benefit of the lowest energy consumption as well as stable blower operation. As needed, the waste air valve would only open if the blower was at a minimum flow and if the aeration basin valves were at a minimum open position.

The DO set point has a dead band of ± 0.25 mg/l so the DO essentially remained flat lined. Stable blower operation, flat line DO control, and 30 percent energy savings were achieved with the new turbo blower.

Conclusion

Daily minimum and maximum air flow data is necessary for determining overall air flow demands, but a complete diurnal trend and historical data should be reviewed to determine lowest air flow usage, reducing the potential of a blower that cannot be turned down enough. The City has deemed the new turbo blower a success, with modification, and 30 percent energy savings has been achieved.

E - Aeration Blower Articles in *WaterWorld*

CASE STUDY: Severn Trent installs ZS blowers to upgrade RGF processes

Severn Trent Water has installed ZS oil-free rotary screw blowers from Atlas Copco as part of an upgrade to six of its water treatment plants in the UK.

Turbo Blower

Xylem Inc.'s Sanitaire TurboMAX blower is a high-speed turbo blower line offering high-efficiency, low-maintenance blower technology to reduce energy consumption and operating costs.

Blower Package

The Qube™ blower package by Tuthill, featuring the new Qx™ blower, is a quick-delivery solution for wastewater aeration and more.

Turbo Blowers

GE Energy offers new Roots™ turbo blowers, which offer an innovative air-foil bearing design and efficient high speed motor technology, proven in a power range of 600kW (800 hp) down to 22.5kW (30 hp).

Wastewater Aeration: Low-pressure Screw Blowers Vs. Traditional Lobe Technology

Air supply is a critical component for aeration processes within wastewater treatment. Although traditional lobe blowers are common, advances in screw blowers are showing how energy savings can be made for utilities. End User - Anglian Water, Supplier - Atlas Copco

High Speed Blowers

Gardner Denver offers a new line of high speed centrifugal blowers using break-through technologies.

A Turbo for the Base Load, Blower for the Peak Load

Aeration and the production of air continues to account for the majority of electricity costs at wastewater facilities. Previously, air for the aeration basin was generated by means of positive displacement blowers at Bremervörde, Germany. These old units were replaced by two Aerzen blowers series Delta Blower.

Energy efficiency at German sewage treatment plant improved with screw blowers

In an effort to supply energy-efficient compressed air to process sewage at a treatment plant in the town of Versmold, Germany, two Atlas Copco ZS 55+ oil-free screw blowers with variable speed drive have been installed.

F - *Water and Waste Digest Aeration Blower Articles*

Screw Blowers

This article in the August 3018 magazine covers Kaeser compressor. The CBS rotary screw blower brings all the advantages of screw blower technology to lower-flow-rate applications. For wastewater treatment plants.

For wastewater treatment plants requiring differential pressures up to 15 psig, this screw blower is a suitable solution, with flow rates from 190 to 448 cu ft per minute. These integrated packages are up to 35% more efficient than conventional blowers and come complete with blower, advanced integrated controls and a full complement of sensors to ensure a reliable operation.

G - McIlvaine Aerator Blower Decision Guide and Intelligence System. McIlvaine has a decision guide and intelligence system with organized arrangement of articles which can be used by others to construct a more robust decision system

[Neuros blower performance evaluated by CDM at Franklin, N.H.](#)

The advantages of high speed turbos compared to PD blowers were analyzed bases on a demonstration by Neuros. 32 % higher efficiency was demonstrated by the direct drive unit and close to 50% higher efficiency achieved with D.O monitoring and control.

Revision Date: 12/29/2017

Tags: 221320 - Sewage Treatment Facilities * , Camp Dresser & McKee, Blower, Aeration

Multi stage centrifugals replaced at City of Altamonte Springs, FL

The City of Altamonte Springs Regional Water Reclamation Facility (RWRF) has a permitted design capacity of 12.5 million gallons per day (MGD) on an average annual daily flow (AADF) basis. The current AADF is approximately half of the permitted value and the facility maintains consistent compliance with regulatory agency permit requirements related to effluent quality. • takeaways • Older multistage centrifugals replaced with more efficient selections • Either turbo or rotary blowers recommended for the process • Concerns about complexity of turning down volume with multi stage centrifugal • Install centralized aeration control system • Rotary blower with VFD recommended for aeration in sludge holding tank where load fluctuations offer potential for energy savings

Revision Date: 12/15/2017

Tags: 221320 - Sewage Treatment Facilities * , Tetra Tech, Aeration Blower, Blower, Aeration

High speed blowers for Garland Texas wastewater

High speed blowers were installed at Garland Texas and reduced energy consumption compared to the previous multi-stage blowers. The control system has been optimized to utilize several blowers in the most efficient manner. The high speed blowers had a higher initial cost but a 2 year payback on energy savings.

Municipal Wastewater Decisions

H - APG-Neuros

APG-Neuros is a privately-owned company with headquarters located in Quebec, Canada and production facility in Plattsburgh, NY. The company has been a leader in developing high-speed turbo blower technology in the wastewater treatment market. The following case studies can be viewed on the website.

<http://apg-neuros.com/case-study-killingly-wwtp-danielson-ct/>

<http://apg-neuros.com/case-study-haliotis-wastewater-treatment-complex-nice-france/>

<http://apg-neuros.com/case-study-city-of-watsonville-ca-wwtp/>

<http://apg-neuros.com/case-study-city-of-orange-cove-wwtp-california/>

<http://apg-neuros.com/case-study-king-county-wtd-south-treatment-plant/>

<http://apg-neuros.com/case-study-city-of-gig-harbor-gig-harbor-wastewater-treatment-plant/>

#	Suppliers	Consultants Media	Operators	Struvite
A	Seven companies			
B	Atlas Copco			
C	Howden	Carollo, Best Practices, Mcilvaine		
D		HDR	City of Mt. Vernon	
E	Kaeser	Water & Wastes Digest		
F	Aerzen, Atlas Copco, Gardner Denver, Howden, Xylem	WaterWorld	Anglican Water, Bremervorde, Severn Trent, Versmold	
G	Many	Mcilvaine	Many	
H	APG-Neuros		Killingly, Haliotis, Watsonville, Orange Cove, King County, Gig-harbor	

Automation

A - inCTRL Solutions Course – Introduction to Advanced Data Analytics

When: Friday, September 28th, 2018 (just before WEFTEC.18), 9am – 5pm.

Where: Hampton Inn and Suites Convention Center, 1201 Convention Center Blvd., New Orleans.

Audience: Wastewater engineers with interest in advanced data analytics. Knowledge of basic statistics is of advantage. *Note that the space is limited to 20 people.*

The concept of **Big-Data** is receiving increased attention due to its promise of improved information extraction.

The one-day Introduction to Advanced Data Analytics course will combine **lectures**, **break-out discussions**, and **hands-on examinations of data sets** to give participants an overview of the most useful Big Data methods for wastewater applications. The workshop will focus not only on the theory of how multivariate methods work but also in their use and interpretation via real-world examples.

Participants will build their understanding of how information can be extracted from many measured and sampled quantities simultaneously by avoiding the pitfalls of typical one-variable-at-a-time analysis. Topics such as **data cleaning**, **missing/bad-value**

replacement will be discussed as will the generation of **predictive soft-sensors** and **fault detection and isolation methods**.

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Leiv Rieger, CEO (rieger@inCTRL.ca)

B - SCADA is Dead: Rethink Your Approach to Automation

Author

Dean Ford, CAP, PE

Westin Technology Solutions, LLC

Session 409 Automation and SCADA: Where Have We Been and Where Are We Going?
Location Room 245
Date Tuesday, Oct 2 2:00 PM
Duration 30 minutes

Three major trends are currently converging that is cause for a rethink in our approach to SCADA.

1. The SCADA/Automation workforce is aging, retiring and is not being replaced at a rate to keep pace with demand.
2. SCADA/Automation Technology (Operational Technology) is aligning more and more with Information Technology.
3. Operating budgets continue to see downward pressure at a time when physical assets require more and more capital and expense dollars to maintain. (The Aging Infrastructure)

Some questions to stimulate this discussion:

- In today's resource constrained environment we are operating in, are we taking full advantage of the systems our rate payers have invested heavily in?
- Are our IT and OT groups utilizing each other's strengths to deliver their mission?

To draw some parallels to our brethren in private industry, automation is implemented when there is a clear return on investment. Occasionally automation is used to address a quality or safety issue but even those are expressed in financial terms. Private industry drives tremendous value from the automation systems they have installed.

In the regulatory environment, we too often get locked into thinking that says we need to collect and store data. After all, that is what SCADA is for, Supervisory Control and Data Acquisition, right? We can't let SCADA make decisions for us or in place of our operators who are responsible for systems and plant operation. However, private industry has been doing this for decades, driving every dollar of value out of their systems and providing safer, more reliable and more effective operations.

But we can't do that with SCADA, right? Other industries have installed Automation or Process Control Systems, right? That's not SCADA.

Here is the secret. There are zero differences between the components that run a manufacturing plant and those that are used in the traditional water industries used of SCADA. Every component is identical except one industry has unleashed the power of automation and one keeps it constrained. Why?

Unprecedented convergences of technologies exist today that affords utilities to take advantage of resources across the engineering and IT departments. No longer do these two groups need to be adversarial and have similar resources. The network switches, servers, and workstations that make up the systems in the Operational Technology platform are identical to the Information Technology platform. Operating systems are identical, Databases are identical, and the list goes on. Why do we have separate groups and separate people maintaining identical systems thereby increasing our costs? Why aren't they working together more in partnership? Perhaps it's because they feel their missions are different.

Additionally, with the impending skills shortage of automation professionals while at the same time, the technology is becoming more complex; the same level of resource that can maintain our SCADA system today is not going to be able to maintain it tomorrow. How are utilities going to compete with industries that are paying top dollar and can respond to market conditions quickly to hire and retain top talent. Will you turn into a training ground? How are you going to find, hire and retain the talent required to simply maintain your systems, much less keep them current?

Another way to look at these issues is that of Automation Maturity Model. The industry is moving towards a highly optimized operation through necessity. One can arrive at that destination one of two ways. Being dragged there by technology and vendors and losing out on the opportunity costs during the journey. Or, one could drive there and take advantage of the costs savings and provide a longer and larger return on the investment.

Four major pitfalls exist that must be addressed.

1. Anyone can program for normal. It is the abnormal that puts you on the 5 o'clock news.
2. To automate a manual process is an opportunity lost. You must develop an automatic process and implement the parts and pieces to make that work.
3. At the time of upgrade, you must implement the most current technology and practices. The vendors are investing piles of money to stay current with other technologies. Neuroscience is teaching us so much more about situational awareness and how humans interact with machines and user interfaces that to prevent operator fatigue and accidents, you must stay current.
4. You will never be able to defend against cyber-attacks. Your systems must be built to detect and alert.

We must throw away the notion of SCADA and the mental blocks it conveys. These systems are Automation and should be exploited to drive every possible cost out of our operation. Identifying a Return on Investment should be a common goal. By maximizing our use of the capabilities of automation the following benefits will be obtained:

- we will drive costs out of our operation
- we will keep our automation staff excited about the technology they are working on.

The next generation of worker wants to be challenged and have a social impact. Money is not the top priority unless the job is boring.

- We will deliver the best possible product to our rate payers, the most efficient way possible.

Automation is the future. Are you going to be dragged into it or are you going to take advantage of it?

C - McIlvaine Comments on Dean's paper

In order to facilitate questions to be asked to Dean and to provide continuing discussion of this important subject we will be adding additional comments up to and even after the show. The major question we pose is - What is the role of The Industrial Internet of Wisdom to empower IIoT and how can consultants such as Westin supply not just subject matter expertise but subject matter ultra-expertise. We define a Subject Matter Ultra Expert as someone utilizing decision systems and the latest wisdom to best advise clients whether it is instantaneously as part of a whole cloud based program or whether it is in specific determinations of lowest total cost of ownership. Will this dictate better interconnection within the consulting organizations and the use of experts regardless of location in pursuing assignments?

Dean gave a speech in August at the 2018 ISA Water/Wastewater and Auto Controls symposium in Washington D.C

<http://isawwsymposium.com/program/program-schedule/> . (the next meeting will be August 2019 in Orlando)

In addition to Dean's paper there are other papers and authors who will be contacted.

D - Subject Matter Ultra Expertise.

One source of the ultra-expertise is the dewatering equipment suppliers. Companies such as Andritz have process management software which can serve the edge function and feed the process management system. Suez already has 24-7 remote monitoring. This is covered in our IIoT& Remote O&M webinar on water/wastewater

Recorded 53 Minute webinar on March 28, 2018

View YouTube Recording: https://youtu.be/YI_AGdDWbr0

As noted above treatment chemicals companies such as Kemira can serve the edge function and back it up with subject matter ultra-experts (SMUEs).

E - Field Evaluation of ISE-ammonium Sensors and Their Influencing Factors in WRRFs.

Session 423 Are You Getting the Most Value From Your Sensors: Sensor Performance Evaluation Strategies
Location Room 245
Date Tuesday, Oct 2 3:30 PM
Duration 30 minutes

Author Francesca Cecconi University of California, Irvine

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HORIBA Advanced Techno,Co.,Ltd.

Co-Author Margil Jimenez
Orange County Sanitation District

Co-Author Reza Sobhani
Orange County Sanitation District

1. Introduction In recent years a particular attention has been given to Ion-Selective-Electrode sensors (ISE) for online measurements of water quality (Winkler et al 2004, Bonastre et al 2005, Kaelin et al 2008). One of the most promising applications of these probes has been for the online quantification of ammonium in the aeration units of WWTPs (Ingildsen et al 2002). A main concern with online monitoring resides in the reliability of the signals that they can provide, as they can be subject to various issues such as noise, bias, drift, outliers, etc. (Thomann et al 2002). Previous studies have approached the topic surrounding the measurement uncertainty of generic online (Rieger et al 2005, Thomann et al 2008) and ISE probes more specifically (Rieger et al 2002). However further investigation on the influencing factors of the ISE-NH₄⁺ sensor's response is needed, and is therefore here addressed with a year-long study. The herein proposed research originates from the collaboration of three parties: Horiba Advanced Techno, Co., Ltd. for the ISE-ammonium sensors, Orange County Sanitation District -where the probes have been installed-, and the University of California, Irvine.

2. Materials and Methods The Ammonia Nitrogen Meter HC-200NH from Horiba was installed in the aeration tank of Orange County Sanitation District (OCSD). The probe is supplied with a potassium ion chip, which allows interference compensation from the potassium in the wastewater. Grab samples were collected once a week and analysed with the Salicylate method (AmVer TNT, Hach) for the ammonium measurement and with ion chromatography (940 Professional IC Vario, Metrohm USA) for the cation

content. A standard of procedure to compare the probe measurement with the grab sample analysis was developed to minimize the variability in the aeration tank. A sample of process water was collected from the tank and maintained in mixing conditions through a stirrer. The probe was immersed in the mixed liquor, the measured value was recorded and simultaneously a grab sample was taken for lab analysis.

3. Results and Discussion The various factors influencing the sensor's uncertainty were investigated and are reported below. Fouling: The probe signal was evaluated under different degrees of fouling that have developed depending on the cleaning frequency adopted (Figure 1). It was observed that the gradual increase in fouling on the selective membrane leads to a corresponding underestimation of the ammonium measurement. The response time plots in Figure 2 and Figure 3 show that the fouled signal reaches a lower value compared to the cleaned probe and the difference intensifies with the fouling time. Furthermore the fouling extends the measurement response time, leading to a possible limitation to follow the signal dynamics. This behavior may be explained with an increased diffusional limitation coupled with potential biofilm formation with biological ammonium uptake. Interfering ions: Prior to the deployment of the instrument, a 2-point calibration is required with standard solutions. This step is followed by a sample adjustment with process water, during which the calibration curve is corrected by comparing the sensor measurement against an accurate reference. This procedure is conducted to remove the background signal provided by other ionic species, such as sodium. Due to the variations in ionic composition at a daily, weekly and seasonal timescale this research further investigated their dynamic effect on the measurement uncertainty. The potassium ion chip reliability was tested by comparing the probe measurement against the ion chromatography analysis of the grab samples. The interference of potassium on the ammonium measurement is approximately 0.08 ± 0.04 mg NH_4^+/L , comparable to the precision of the sensor itself (0.2 mg/L of N- NH_4^+). To estimate the influence of sodium on ammonium measurement, different experiments were performed on the field and in the lab. The response of the sensor was evaluated at different sodium content and showed no evident difference within a sodium variation of $\pm 50\%$ from the typical wastewater composition. Figure 4 reports the trend of sodium and potassium in time. The weekly fluctuation of the interfering cations is relatively restrained and therefore a renewal sample adjustment is not required. Maintenance and Human Error: Diverse maintenance operations were addressed to study their influence in the sensor's signal. Ammonium analysis on grab samples was performed before and after the cleaning occurrence to compare it with the probe signal. Figure 5 reports the error between the signal's meter and the reference analysis in time, with notifications on different maintenance episodes. Cleaning procedures do not always result into minor error since other factors can also influence the signal, for example, calibration and sample adjustment. In detail a lower error trend can be noticed since a new reference method was adopted (orange line). The procedure is described in Materials and Methods. This phenomenon highlights the importance to follow an accurate procedure when performing a grab sample analysis comparison. Furthermore specific attention was regarded to the membrane resistance of the reference electrode of the probe (R_R), whose value can be easily displayed. The increase of the R_R parameter in time reflects the fouling and integrity conditions of the membrane: the higher the value, the

more uncertainty towards the ammonium measurement. Figure 6 shows the R_R parameter variation in time and specifies maintenance occurrences. When the junction cap of the reference's electrode was replaced (purple dot) the variation range of the R_R parameter decreased and therefore better ammonium measurements were performed. Finally monitoring the R_R parameter can give additional information about the accuracy of the measurement together with the grab sample analysis comparison. Sample adjustment is a critical maintenance operation due to its potential to create signal disruption. Figure 7 shows that the incorrect sample adjustment led to a drift of the signal, an enhancement of the peaks and therefore a general overestimation of the ammonium content. Consequently, it is important to follow a precise procedure when performing a sample adjustment (explained in Materials and Methods) and also not to misuse of it. 4. Future studies An auto-sampler will be implemented to collect grab samples with a few hours frequency to monitor the daily fluctuation of the interfering cations and to obtain a more frequent comparison with the ammonium signal for a better validation of the technology. In December 2017 a second probe will be installed next to the operative one as a parallel sensor for a direct comparison on the effects of fouling. In addition a low working-range ISE-NH₄⁺ probe will be installed at the end of the aeration process. By summer 2018 the low range meter will be studied with the methodology previously described to validate the technology and assess its reliability and accuracy for final effluent monitoring applications.

F - Keeping Track of pH Sensors in Biological Wastewater Treatment Systems

Session 423 Are You Getting the Most Value From Your Sensors:
Sensor Performance Evaluation Strategies
Location Room 245
Date Tuesday, Oct 2 4:00 PM
Duration 30 minutes

Speakers

Author Kito Ohmura
Toshiba Infrastructure Systems & Solutions Corporation

Co-Author
Marco Kipf
Eawa

Introduction and Motivation

By several accounts, sensors constitute the most sensitive component in advanced control systems for wastewater resource recovery facilities (WRRFs). For this reason, characterizing typical sources of measurement errors and other source of uncertainty has been identified as an important and challenging endeavor. To answer this need, a wealth of fault detection, fault isolation, and fault diagnosis methods have been developed to facilitate the identification and possibly reconcile erroneous data.

Most of these methods are based on the following two assumptions:

- Gross errors, i.e. systematic deviations, never appear simultaneously in multiple sensors at once.
- Upon first-time use, a given sensor will function without any gross error for a while.

These assumptions are indeed very useful. For example, by placing 3 or more redundant sensors in a single location, one can identify the most likely sensor exhibiting a gross error as long as only one sensor becomes faulty at a single point in time. In addition, one can tune fault detection algorithms finely by using normal data, i.e. data that is free of gross errors. In the simplest methods, normal data is used to define statistical control limits (e.g., a 99%-confidence interval).

In order to benchmark processing monitoring and control methods, the Benchmark Simulation Model (BSM) series was developed. These models include sensor fault models to test fault detection and identification methods. Importantly, the incorporated sensor models adhere to the above assumptions, i.e. all simulated sensor faults start independently and only after some time. Consequently, any fault detection and identification method selected or tuned based on this benchmark simulation platform is likely to depend on the validity of the above assumptions.

We study to which extent the above assumptions are valid. We focus on pH sensors as they are the simplest and most widely used ion-selective electrodes on the market. The Demon process is one example of a process requiring precise pH measurement for control. In our case, the pH sensors are used for control of a biological urine nitrification process. This process is developed for the decentralized production of a fertilizer from anthropogenic wastewater and enables (i) reducing wastewater loads to existing WRRFs, (ii) avoiding the use of the energy-intensive Haber-Bosch process for nitrogen fertilizer production, and (iii) avoiding nitrogen pollution of natural water bodies.

Materials and Methods

A set of 10 sensors by Endress+Hauser consisting of 5 pairs of the same exact type (T1 – T5) is used for testing. Each of these is an ion-selective electrode (ISE) pH sensor newly bought. The first 3 pairs of sensors (T1 – T3) are in continuous since the start of the measurement campaign. The 4th pair (T4) was used during the first 180 days of the campaign and replaced after 180 days with the 5th pair of sensors (T5).

The pH sensors are exposed continuously to the medium of a urine nitrification reactor. This medium consists of nitrified urine with total nitrogen concentrations around 5000 g.N/m³ which is present as ammonia and nitrate in roughly equal proportions. The treated urine exhibits a high salt concentration and conductivity (e.g., 16 mS cm⁻¹ [9]). At regular intervals, the sensors are taken out of the reactor medium for testing. In each

test, the sensors are mechanically cleaned with a sponge and then exposed to 5 media in 5-minute phases: (1) tap water, (2) calibration medium A (pH 4), (3) calibration medium B (pH 7), (4) calibration medium A (pH 4), and (5) tap water. During these tests, the raw voltage signal of the electrode is recorded at 1s intervals. The offset is computed as the averaged voltage signal in the last minute of the 3rd phase, at which point a steady-state signal is expected. The sensitivity is computed by computing the difference between the averaged voltage signal in the last minute of the 3rd phase and the 4th phase and dividing by 3. Under standard conditions, an ideal pH sensor is expected to deliver 0mV for the offset and 59mV per pH unit for the sensitivity.

Materials and Methods

We first discuss the results of the monitored offset. In Figure 1, one can see the recorded offset values as a function of experimentation for all studied sensors. It is quite easy to see that the offset changes over time for every sensor. Moreover, the drifts appear largely unidirectional in the sense that the offset becomes more negative over time. For the 2nd, 3rd, and 4th pair the offset amounts to about -59mV in a year or less. This means that after a year – and without any calibration – one can expect to measure a pH of 6 or lower when the true pH is 7. Important with respect to the above assumptions are the next observations. First, all sensors produce a non-zero offset immediately or shortly after their initial exposure. This is most dramatic for 4th pair of sensors. Consequently, it is difficult to find a period of time within which the produced data are free of gross errors. In addition, one can see that the offset and its rate of change is non-zero for all sensors at any given time. This means that placing redundant sensors as a way to find a single, faulty sensor is unlikely to work well in any given situation.

Figure 2 shows the computed sensitivities with scales matching the scales of Figure 1. This means that a given change of the sensitivity in Figure 2 has a similar effect to the same change in Figure 1 when the true pH equals 6. The first observation is therefore that the observed changes in sensitivity have a marginal effect on the pH sensor signal compared to the changes of the offset. The highest (lowest) recorded sensitivity is 61 (54) mV/pH, which corresponds to measuring a pH of 5.97 (6.08) when the true pH is 6 (and the offset zero).

Conclusions and Perspectives

With this work, we have studied the real-world behavior of pH sensors in a biological decentralized process for recovery of fertilizer from human urine. The produced data indicate that the main cause of systematic measurement errors in pH sensors can be attributed to changes in the reference electrode's electrolyte solution. While such changes can be compensated by sensor calibration, this is practically infeasible for decentralized systems such as the urine treatment system. Our results also have

important consequences for the application and study of fault detection and identification methods. Since one cannot record drift-free reference data set and all sensors drift simultaneously, it follows that the practices for application, study, and fine-tuning of fault detection and identification methods need to be updated to match the observed reality.

G - Control Implementation Matters: Discovery of Poorly Implemented DO Control Leads to Greater Process Stability and Less Risk

Session 506 Innovative Process Control Studies and Strategies
Location Room 336
Date Wednesday, Oct 3 8:30 AM
Duration 30 minutes

Author Edison Ruswa
Severn Trent Water

Co-Author Dr John Copp
Primodal Inc

Brockhampton STW is currently being re-permitted to a tighter ammonia limit of 1.2mgN/L. Complicating the design process was the fact that the works was experiencing mysterious daily ammonia spikes that were risking compliance and increasing OPEX requirements. To diagnose the issue and investigate future options, Severn-Trent Process Design Engineering commissioned Primodal to develop a process model. Primodal discovered that the measured effluent ammonia data was well represented by the model if a significant delay was included in the aeration system sub-model. This discovery was confirmed when the Brockhampton (8.2 MLD) aeration control code was found to contain a hard-coded 30-minute dampening delay. The modelling work predicted that eliminating the delay would eliminate the ammonia spikes. The delay was removed on-site and the full-scale daily spikes were eliminated. The model has subsequently been used to risk assess future scenarios and this has negated the requirement for extensive civil works in the current capital scheme. In addition the unaerated volume of the ASP basin was optimised to minimise aeration costs and reduce the risk of poor suspended solids performance due to denitrification in the final settlement tanks.

Brockhampton STW consists of an inlet pumping station, primary treatment followed by a 6 pocket ASP, and four final clarifiers. The influent to the works is complicated by the famous Cheltenham Horse Racecourse which has a dedicated sewer and discharges directly into two storage tanks at the works. Flow from the racecourse is intermittent, but most significant during the Cheltenham Gold Cup meeting in March. This 4-day festival typically sends 3021m³ of waste to the storage tanks. This equates to approximately 33 000 PE worth of load, double the works daily treatment capacity. As such, this is returned to the works from the storage tanks over approximately 30 days. Additionally, a nearby tip is permitted to discharge leachate to the works through a dedicated sewer.

Measured tip leachate loads make up approximately 25% of the total ammonia load to the plant.

Although seemingly large enough, there was a history of mysterious daily ammonia spikes in the final effluent which have significantly increased operator visits to the site.

The model developed as part of this work was based on an earlier model developed by Primodal in 2008 to assess the risk associated with an upgrade at that time. Following that modelling work in 2008, two additional ASP pockets were constructed and the aeration system was upgraded at the site. The plant design was revisited in 2014, in part, because contrary to the 2008 modelling results even with the additional ASP capacity, the plant was unable to adequately treat the incoming ammonia load on a daily basis. As a result, a new modelling project was initiated to investigate the current state of the plant and new upgrades options for the plant. The main objectives of the modelling work were:

- to calibrate a model of the present works,
- to investigate possible causes for observed effluent ammonia spikes,
- to investigate process control/optimisation options to address the effluent ammonia issue.

The modelling work done as part of this project highlighted several aspects including: a) well-calibrated models need very little maintenance over time and can be used years later with minimal additional effort; b) daily spikes in effluent ammonia does not necessarily mean that the tank and/or aeration capacity is limiting the ammonia treatment; c) poorly implemented control logic can have a profound impact on the process and that rectifying control issues can negate the need for costly capital expenditures in plants that have already sufficient capacity; and, d) planned and/or implemented control logic should be modelled by an experienced professional so that problems and inefficiencies can be minimised so that more robust and cheaper treatment can be realized.

The model clearly suggested that the aeration system control was contributing to the effluent ammonia issue. Data from the plant showed large swings in the measured DO and an inability to track the DO setpoint. The model correctly identified that poorly implemented control logic was the cause of the problem and the model was used to correct that control logic. Subsequent changes to the logic on site resulted in the elimination of the effluent ammonia spikes.

Using the calibrated model to help design the future plant for Brockhampton STW has not only allowed the project team the option to risk assess the proposed design, but it has reduced the size of the future plant by approximately 15%. The winter and wet weather performance dictated final size of the ASP as all the modelled scenarios suggested excellent summertime dry weather flow performance.

The correction of the delay in the aeration control logic has significantly reduced emergency operator call outs to the site over the past 2 years and the improved site performance has underpinned the design of the plant to meet the future ammonia

permit.

The planned modification to the anoxic volume will reduce the future power consumption of the plant and provide the added benefit of minimising nitrate levels in the final settlement tanks which will minimise the risks associated with denitrification in those tanks.

It is important to conclude that reliance on the Brockhampton process model was only possible because the model was well-calibrated. Although significant effort was put into the model calibration through an external consultant, data accumulation, process understanding and data reconciliation, the benefit to Severn Trent Water from using the model to assess the risks has more than off-set that effort and those costs.

H - Process Optimization and O&M Savings Using Plant Wide Real-Time Solids Monitoring and Control

Session 506 Innovative Process Control Studies and Strategies
Location Room 336
Date Wednesday, Oct 3 9:00 AM
Duration 30 minutes

Author Alexandre Miot
San Francisco Public Utilities Commission

Co-Author Marta Mendoza
EPC Consultants

Solids management is an essential part of wastewater treatment. Settleable solids are often removed by gravity in a primary sedimentation process. Colloidal and soluble solids are assimilated by microorganisms in a secondary biological process where new biomass is generated. Microorganisms, which are added, produced and removed during treatment are characterized using solids measurements. Therefore, solids concentrations are one of the key parameters used to assess and adjust process performance.

At the San Francisco Oceanside Pollution Control Plant (OSP), the concentration of the solids present in the different solids process lines was previously tested by the plant laboratory once a day. The samples used for the measurement was either a grab sample or a composite sample. Since plant solids loading rates and treatment response change throughout the day, the sample may not have always been representative of the different process condition existing throughout the day. Therefore, the process control decisions made based on the lab results may not have always been optimal despite continuously meeting treated water discharge permit requirements. This lack of optimization could have led to additional labor, chemical, energy and equipment needs or non-optimal bacterial selection, affecting the overall performance and efficiency of the plant. Additionally, lack of optimization led to the need for operating the processes with a certain level of conservatism.

The Oceanside Water Pollution Control Plant (OSP) was originally designed to handle up to 80,000 m³/day (21 mgd) of dry weather flow and up to 246,000 m³/day (65 mgd) of wet weather flow collected in San Francisco's combined sewer system. Currently, the plant only receives approximately 53,000 m³/day (14 mgd).

In an attempt to improve process monitoring and controls and optimize processes performance, total solids (TS) analyzers were installed in all OSP solids streams in 2016. The primary sludge lines, the mixed liquor channel, the waste activated sludge (WAS) lines, thickening and dewatering feed lines were all equipped with analyzers.

Real time monitoring provides OSP operators and engineers with a wealth of new information that allows better understanding of the processes. This is also valuable tool to identify process upsets more rapidly and respond to it more effectively. The Supervisory Control and Data Acquisition (SCADA) system can also be programmed to identify process anomalies automatically and inform the operator, making the process even more effective.

Developing real time data validation tools

Now, this system relies heavily on instrumentation. As much as instruments output can be useful, it can be detrimental if erroneous. Over the past decades, instrument manufacturers have continuously improved the accuracy of the instruments, but wastewater is a complex and dirty medium, which continues to challenge accuracy measurement. Instruments are subject to harsh conditions, certain locations are prone to ragging, fouling, buildup of any sort that can negatively affect the measurement. It is therefore important to develop a method to continuously check the accuracy of the instrument.

Being aware of these challenges, the OSP staff has developed complementary tools to monitor instruments accuracy in real time or in an instantaneous basis and validate output data. When possible, the value being measured is also calculated using outputs from other instruments and both values are continuously compared. In some locations, two identical instruments have also been installed side by side and both readings are continuously compared. In addition, the instrument data is compared with the laboratory data on a daily basis. This sampling frequency will decrease in 2018. Operators are not required to maintain the instrument on a periodic basis; instead, they attend to the instrument when the monitoring system senses a discrepancy.

With a robust data validation system in place, the data generated by the instrument can now be used to automatically control processes. Mixed liquor and WAS TS analyzers are used for automated sludge retention time (SRT) control. The system uses the SRT Master software (Ekster & Associates, CA), which analyzes instruments output data every 15 minutes and computes the WAS pumping rate required to maintain the SRT at the set point. The set point is set by the Chief operator based on long-term plant performance. The SRT Master software, which is directly connected to the SCADA system, adjusts the WAS flow set point automatically every 15 minutes.

The optimized control of the SRT leads to more effective bacterial selection and has

been an effective tool to further control filamentous growth. It has also allowed for more stable operation.

The thickening and dewatering process polymer dosage is automatically controlled. The system monitors the mass of polymer and the mass of solids fed to the processes in real time. The polymer pump speed is adjusted automatically to maintain the polymer dosage at the set point. This set point is expressed in pounds of active polymer per tons of total solids fed to the system and is set by the operator based on process performance.

The optimized thickening and dewatering process polymer dosage has led to more stable operations despite of the different operators' skill set. It has also decreased the labor requirement time. It is expected that it is going to be a valuable tool to optimize polymer dosage and reduce chemical spending.

The advanced monitoring and control systems (not all discussed in this paper) have provided OSP staff with a higher level of knowledge and confidence to push the limit of the different processes. In April 2017, OSP staff took a third of the primary and secondary process capacity offline. This equates to tens of thousands of dollars in O&M cost saving each year. More importantly, it has created capacity and redundancy, which represent a far greater capital cost saving if plant loading were to increase.

Plant wide real time TS monitoring along with other key instruments can be used as an effective way to optimize processes, reduce O&M cost and avoid or delay large capital expenditure. OSP staff has been able to reduce its primary and secondary system capacity by a third. However, it is important to acknowledge that instrumentation needs to be maintained and data output needs to be validated before using it for process control. The full manuscript will describe the different tools developed to validate data and it will discuss the implementation of a robust monitoring and control system into more details

I - A Novel, Optical, On-Line Method for Automated Polymer Dosage Control in Continuous Belt Dewatering Units

Session 506 Innovative Process Control Studies and Strategies
Location Room 336
Date Wednesday, Oct 3 11:00 AM
Duration 30 minutes

Author Todd Andrew Schwingle
Veolia

Co-Author Jose Ramirez
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Co-Author Prof. J. Rudi Strickler Optik Technik

Continuous Belt Machines are widely employed in higher throughput municipal and industrial thickening and dewatering operations. The machines are able to achieve substantial reductions in water content continuously, at relatively modest capital and operating cost, reduced energy consumption and relying on simple mechanical systems that are easy to maintain (WEF, 2008; 2012). The main drawback for continuous belt machines however, has been that dewatering rates (and thus exit-cake dryness) are very sensitive to incoming feed conditions. In order to address this problem, the majority of operators manually adjust dosage of a flocculating polymer administered upstream to the unit. Manual samples of the cake exiting the machine are taken periodically and evaluated with an off-line laboratory method.

It has been widely reported that manual control of polymer dosage results in under- or most likely, over-dosage. Over-dosage results not only in increased polymer costs, but also in decrease dewaterability and cake dryness. Furthermore, this increases costs in downstream operations (heat drying, sludge hauling for example) and unnecessarily augments the plants overall carbon footprint (Lopes et al., 2014).

There have been several attempts at automating the polymer dosing process in response to differing measured process variables. Streaming current detection, torque rheology, centrate viscosity, suspension monitoring with CCD cameras, infrared-based suspended solids meters, UV absorbance on filtrate to name a few; however none have really found widespread application due to complexity in implementation and lack of robustness in the plant environment (Ratnaweera and Fetig, 2015). There is thus a need for a simple, robust method to automatically adjust polymer dosages in continuous belt machines as incoming feed conditions change.

In this paper, we describe a novel method to indirectly monitor cake dryness on the moving belt, non-invasively and in real time. The measurements are then compared to a desired cake dryness set-point and polymer dosage is adjusted in a simple feedback control scheme. The method is based on the observation that experienced operators can immediately tell if there is too much moisture on the cake by simple observation of the sludge on the moving belt.

We hypothesized that the roughness of the profile of the sludge blanket would provide an indication of its water content. A cake with high water content has a smoother profile than a drier cake. A simple means of gauging the sludge profile is through the light sectioning technique invented by Schmaltz in 1934 for microscopy (Hauser et al., 1934). The technique is based on illuminating the target surface with a thin band of light at an angle and positioning a photo-detector at an opposite angle to capture the delineated profile. Typically the clearest profiles result when both angles are 45 Degrees with respect to the horizontal target surface. The surface roughness is characterized by a single mathematical parameter, for example, the variability of the light profile around a mean value (e.g. the root mean square value, RMS) or the fractal dimension of the surface profile.

As can be seen from Figures 1a,1b; the nature of the light-sectioned sludge profile depends dramatically on the moisture content. A very dry profile exhibits a highly uneven, fractal profile (Fig 1a.) while a wet sludge is considerably more uniform (Fig 1b). The same is observed in a dynamic state, where the variations of the profile around a "mean" profile (RMS) have a wide amplitude and high frequency the lesser the moisture content of the sludge. These optical characterizations were correlated to the actual moisture content as measured from conventional quantitative offline methods to create a calibration curve for the sensor. In some cases, where the sensitivity of the RMS variability is not sufficient for control purposes, a more accurate parameter, the fractal dimension (Mandelbrot, 1977) of the profile can be utilized.

The light sectioning technique was evaluated both under static conditions in the laboratory and dynamic conditions in the plant. Samples of waste activated sludge from the gravity belt press dewatering units at the Milwaukee Metropolitan Sewer District Jones Island (Milwaukee, WI) municipal wastewater treatment facility were utilized. The Thickening facility has four, 3-meter Ashbrook gravity belt thickeners (GBT) for waste activated sludge (WAS) thickening. Each GBT can handle up to 1,400 gpm of WAS flow; however, the units are operated at WAS flow rates of between 600 - 700 GPM. The incoming total suspended solids are between 0.5-1.5 % w/w while 4-6% is the target on exit. A cationic polymer for feed conditioning is introduced upstream of the units at dosages close to 90 lbs/ton of solids. Cake is sampled manually every four hours and solids concentrations measured in the laboratory with a commercial microwave solids analyzer. Polymer dosage is adjusted accordingly, typically 1 out of every 6 times.

The optical setup evaluated is described in the attached schematic of Figure 2. The sensor mounted on one of the GBT machines at Jones Island used for our pilot is shown in Figure 3. A calibration curve relating sludge profile variability vs. moisture content was generated with the actual unit by varying the polymer dosage to the unit, manually sampling the sludge and measuring moisture with a microwave laboratory instrument. The methodology was demonstrated to be feasible in predicting moisture content in the cake under static conditions.

The sensor described here can successfully determine, in real time and in non-invasive fashion, the moisture content of the sludge at any particular spot on the belt. Once a calibration curve has been obtained for the particular sludge - a very simple process that can be run in a period of several hours - the curve can be easily programmed into the sensor to obtain moisture readouts that can be used for automatic control or to trigger an alarm. Unlike with other methods (including a new-to-the market optical method recently commercialized), our technique allows the operator to monitor differences in dewatering efficiencies within the belt, say for example due to a misaligned belt, faulty or wrongly-positioned guiding vanes or uneven header distribution of incoming sludge to the belt due to debris, blockage or misalignment. Continuous, automated control of sludge moisture on the belt will lead to substantial savings in polymer, down-stream drying energy requirements and lower solids disposals costs. Quantification of these benefits in the Jones Island plant is ongoing and will be the subject of a future paper.

J - Instrumentation and Automation Exhibitors

The large number of exhibitors offering instrumentation, controls, and software is further proof of the need for specialized GdPS route maps which further segment the exhibitor offerings. The listing of 23 chlorine instrumentation exhibitors below is not fully useful since most of the listed companies are not actual suppliers. Furthermore when you stop at the ThermoFisher stand where many products are offered how do you find the right person to answer a high level question. The typical approach is for the exhibitor to ask for the visitor contact information and arrange for a contact sometime in the future.

But the logical question is how is this approach better than for the visitor to just call the office instead of coming to the stand. One answer is that he is alerted to new products at the stand that he may not have previously considered. So the stand serves the Alert function which is part of the 4As: Alerts, Answers, Analysis and Advancement. But exhibitors may want to consider ways to also provide the Answers in a way that justifies a stand visit. One way is to schedule company niche experts to be on hand at certain publicized times and to publicize the schedule in advance.

Another approach is to have the experts remotely located but able to communicate in a web conference format with the visitor and the stand personnel. In general exhibitions will need to be innovative to maintain their importance in the digital world. The creation of GdPS routes for visitors is a low cost and valuable undertaking for exhibitors.

- Alarms (29)
- Bacteria Cultures & Supplies (5)
- Bioaugmentation (2)
- Biomonitoring Services (2)
- BOD Monitors, Instruments & Test Equipment (11)
- Chlorine Instrumentation (23)
- Chromatography (2)
- COD Monitors, Instruments & Test Equipment (13)
- Data Acquisition & Datalogging Equipment (33)
- Dissolved Oxygen Monitors & Instruments (27)
- Dyes/Tracing (2)
- Emissions Monitors (5)
- Flow Meters & Instrumentation (44)
- Gas Monitors & Detectors (20)
- Geographic Information Systems (GIS) (4)
- Hose Clamps (5)
- Hose: Rubber (5)
- Hydrocarbon Detectors (8)
- Laboratory Information Management Systems (LIMS) (2)
- Laboratory Equipment & Supplies (21)
- Laboratory Services (8)

- Liquid Level Meters & Controllers (24)
- Motors & Motor Controls (14)
- Nitrogen Analyzers (13)
- Oxygen Analyzers (16)
- Ozone Instrumentation (7)
- pH Analyzers & Instrumentation (34)
- Process Control Instrumentation (49)
- Pump Controls (31)
- Pumps: Metering (24)
- Recorders (5)
- Respirometers (1)
- Samplers (9)
- SCADA (32)
- Sludge Blanket Level Detectors & Controllers (5)
- Software: Operations & Maintenance (26)
- Software: Process Control (26)
- Software: Regulatory (7)
- Suspended Solids Analyzers (14)
- Telemetry (21)
- Test Kits (12)
- TOC Detectors (9)
- Turbidimeters (18)
- Turbidity Monitoring Devices (22)
- Valve Operators & Controls (20)
- VOC Monitors (4)
- Water Monitoring & Sampling Systems (48)
- Weighing Equipment (5)

K - Emerson is offering a range of products at stand 8121. The promotion starts with a broad coverage of process solutions and then a specific product – a new actuator. Designed for extended submergence under “dirty water”, Aquanaught is claimed to be the right choice for gate or valve isolation applications. Thoroughly tested, IP68 Certified design is guaranteed to work through the most harsh water conditions even if the cover is left open. Modular electrical enclosure package and the cable entries makes the maintenance and service process easy to manage. Aquanaught incorporates waterproof enclosures with hermetically sealed connections ensuring continued plant operations during flood and high flow events.

The promotion gives the option of contacting Emerson experts or making arrangements to meet at the stand. There is a simple registration form. If potential visitors fill this out in advance then the exhibition experience can be quite efficient. The potential for high level conversations between a knowledgeable purchaser and an Emerson expert are increased. This is an alternative to arrangements of this sort made by the sales representatives who can arrange meetings at the stand, dinners and other interactions with important prospects.

Many of the exhibitors have incorporated Emerson products. Many of the installations discussed in the speeches also incorporate Emerson products. Emerson would be able to create a GdPS with stops at stands and presentations which could be quite extensive. McIlvaine helped the Siemens VFD group do this at the 2013 Power-Gen show [Power-Gen 2013 Will Aid in Your Drive Selection Decisions](#)

L - Danhafer has two stands Hach: 3617 and McCrometer 6521.

Also see N for the Hach process management webinar coverage. Claros™, the Water Intelligence System is a breakthrough suite of software and connected instruments that turns data into powerful operational insights. It combines connected lab and process instruments with a new generation of process-aware software.

With Wims Process data is automatically (or manually) stored into a central, secure database for easy monitoring, analysis, reporting and predictive modeling. Data can be accessed locally or via a secured web interface, ensuring audit trails and historical records are safe and available for easy viewing.



St Louis operates seven wastewater plants and was successfully utilizing the WIMS system as reported in a *WaterWorld* article in 2009.

<https://www.waterworld.com/articles/print/volume-25/issue-5/products/product-focus/software-suite-helps-utilities-manage-water-system-data.html>

Louisville recommended a WIMS purchase of \$157,000 in 2017. This included instrumentation for a new Howard Berry wastewater plant. It is interesting that the initial order for Hach was over \$100K but the annual service contract was \$25K. So service will be a much bigger revenue producer.

<http://www.louisvilleco.gov/Home/ShowDocument?id=13919>. The municipal contracts are publicly available. So this is a valuable resource for decision systems.

At the 2013 WEFTEC *WaterWorld* included the following preview



Flow Meters

With the recent addition of two new ultrasonic sensors, the Hach US9001 In-Pipe and Hach US9003 Down-Looking, the Hach FL900 system offers level-only alarming and redundant-level functionality. In addition to the ultrasonic level sensor technology, the radar, electromagnetic and acoustic Doppler velocity technologies are also available. The plug-and-play design of the Hach FL900 system allows for up to four sensor connections with auto-detection of sensor type, allowing users maximum flexibility for their Hach flow meter inventories.

At the 2015 WEFTEC In a Water Online Radio interview. Randy Fuller, industrial applications development manager with Hach Company, discussed optimisation of wastewater treatment plants to avoid over-treating and ultimately to save costs.

<https://www.wateronline.com/doc/are-you-over-treating-your-water-discover-optimization-0001>

Also at the 2015 WEFTEC Dave Brown who had been a member of the WEF Collection Systems Committee (CSC) for a number of years recommended this group to others. He pointed out the large number of papers in collection tracks. The knowledge contained in the WEFTEC committees is substantial. They will be a valuable resource for decision systems such as “Monitoring flow in collection systems”.

A wide range of flowmeters will be displayed at the McCrometer Stand 6521 The SPI Mag reliably measures flow in water and wastewater as well as any type of industrial flow processes involving conductive fluids such as potable water, slurries, sludge, cooling water, and pulp stock

Pall has been a WEFTEC exhibitor. *WaterWorld* in 2008 reported - Aria MBR systems use the same hollow-fiber membranes as the company's water treatment systems in a new submersible design. The result is a reliable membrane bioreactor at a remarkably low cost. By combining aerobic biological treatment with an immersed membrane system, the MBR system significantly reduces the footprint of a wastewater treatment plant while improving effluent quality. Customized systems are

available. <https://www.waterworld.com/articles/print/volume-24/issue-9/weftec-exhibitors/chicago-to-host-weftec08.html>

McIlvaine conducted an audio interview with Pall at WEFTEC 2008 relative to membrane bioreactors and provided specific product links

http://www.mcilvainecompany.com/WEFTEC_2008/WEFTEC2008PallWaterProcessing.htm

(McIlvaine interviews with many exhibitors at WEFTEC 2008 are displayed at http://www.mcilvainecompany.com/WEFTEC_2008/WEFTEC2008TOFCwithinterviews.htm)

Danaher has the technical knowledge regarding the range of wastewater treatment and reuse applications. As a group Danaher can draw on the microfiltration and RO membrane knowledge of Pall, the treatment chemicals knowledge of Chemtreat and the broad measurement experience of Hach and McCrometer. As described in the Village Water article above wastewater plants are now generating steam from biogas. This provides additional reasons to tap the expertise of Chemtreat, Pall, and Hach as well as McCrometer.

Regarding polymer dosing, struvite and measurement as discussed in the other articles in this analysis the Hach approach to measurement has been adopted for process management systems. Alfa Laval uses Solitax® sensors manufactured by Hach Lange. Various different process management paper abstracts have been presented in this analysis. Where is the Hach measurement employed in these systems?

What about the synergy of the various divisions? Where do McCrometer and Hach overlap in terms of flow control measurement? Chemtreat can weigh in the struvite control. There a number of membrane presentations this year at WEFTEC. What insights would Pall have to these. One Veolia paper is on municipal water reuse for power plants. Pall and Chemtreat have products for this application. What synergies do the various Danaher divisions have to improve the economics of water reuse for power plant cooling or even ultrapure water?

M - Suez TOC Analyzer *The following article appears in the pre-show coverage from WaterWorld and demonstrates the valuable service that magazines perform by educating prospective visitors.*



From industrial process water and wastewater to concentrated brine streams, the Sievers® InnovOx Total Organic Carbon (TOC) Analyzer is designed to measure organic carbon in a broad range of water samples. Offering a dynamic operating range of 50 ppb to 50,000 ppm, this analyzer ensures superior TOC recovery and accuracy with its patented Supercritical Water Oxidation technique. This technique makes the analyzer far more robust and offers greater uptime in harsh sample matrices. Add TOC monitoring to your industrial water applications to protect equipment, avoid regulatory fines and detect process changes.

Suez

www.suez.com

Booth 4017

N - Hach Webinar recorded by WaterWorld. *This webinar shows how the Littleton/Englewood WWTP gained \$122,000 a year in energy savings and \$176,000 a year in methanol savings after implementing Hach's WIMS™ system. It is included to show that publications such as WaterWorld have webinar resources to support the printed information relative to combust, flow, and treat LTCOV.*

How 21st century technology is transforming wastewater treatment

Recorded: 6 March 2018

Now available for on demand viewing.

CEC: A certificate of attendance will be offered.

Duration: Approximately one hour. Free to attend.

Presented by: Sean Graebner, Senior Manager Global Software Sales Engineering, Hach Company Sam Utley, Applications Development Manager, Hach Company Pam Moss, Application Development Manager , Hach Company

<https://www.waterworld.com/webcasts/2018/march/how-21st-century-technology-is-transforming-wastewater-treatment.html>

WaterWorld covers WEFTEC with video interviews. Here is an Interview with Dave Baker which highlights Hach's data delivery service program. This allows customers to get unedited data over the Internet without having to own their own flowmeters.

<http://waterworld.brightcovegallery.com/detail/video/643112150001/weftec.10:-hach-flow>

O – Xylem - YSI

YSI, a Xylem brand, recently introduced the P 700 IQ orthophosphate analyzer—to be used as a stand-alone analyzer or in conjunction with other sensors in an IQ SensorNet 2020 XT continuous monitoring and control system—to address the needs of the wastewater treatment industry. It measures the amount of orthophosphate throughout the wastewater treatment process and can help determine whether or not it has been eliminated.

<https://www.wwdmag.com/how/step-step-reduction-total-phosphorus>

Instructions for Achieving Low Effluent Total Phosphorus ... or with the YSI IQ SensorNet 2020XT controller. Cascade control of aeration based on measurement of DO and ammonium and implemented through a PID controller offers the greatest potential for energy efficiency and process performance. Implementation of PID control at a wastewater facility will require outside technical expertise and investment in instrumentation and control systems,

<https://www.ysi.com/.../W19-How-to-Control-Activated-Sludge-with-Online-Sensors....>

#	Suppliers	Consultants /Media	Operators	Struvite
A	InCTRL			
B		Westin		
C	InCTRL			
D	Suez, Andritz			
E	Horiba		Orange County	
F	Toshiba, E+H			

G	Severn Trent	Primodal	Brockhampton	
H	Ekster	EPC	San Francisco	
I	Veolia, Optik Technik		Milwaukee	
J	Supplier tabulation			
K	Emerson, Siemens			
L	Hach McCrometer, Pall, Chemtreat	Water-on-line WaterWorld Mcilvaine		
M	Suez	WaterWorld		
N	Hach	WaterWorld	Littleton/Englewood Co	
O	YSI	Water/Wastes Digest		

Media

A - Magazines and Interconnection of People and Knowledge

The Industrial Internet of Wisdom interconnects people and knowledge through publications, conferences, and webinars. These provide the support information for the decision systems and Lowest Total Cost of Ownership Validation (LTCOV). Transfer of knowledge from one industry to another is also important. Municipal and industrial wastewater innovations need to be shared. There also needs to be interconnection between the systems designers and the suppliers of components and consumables. Various publishers exhibiting at WEFTEC make the interconnection between industry e.g. industrial wastewater and municipal wastewater or between products and industries e.g. pumps. Suppliers and purchasers can pursue IloW with their assistance.

Magazine	Stand
Chemical Engineering	809
Chemical Processing	542
Endeavor Business Media	4051
Empowering Pumps	4751
Environmental Science and Engineering	2246

Global Water Intelligence	6659
Modern Pumping Today	5150
Pumps & Systems	2852
Stormwater	1652
WaterWorld	3911
Water & Waste Digest	4028

B - Endeavor Business Media is offering industry and product interconnection. The Process Flow Network covers innovative solutions for the process industries. Together, the three brands that make up the network — Processing, Flow Control and Water Technology — serve a diverse audience of engineers, corporate managers, plant operators and other process industry professionals. You can learn more about the Process Flow Network at WEFTEC Booth #4051.

C - Science & Engineering has struvite data. In November 2015, two *HydroFLOW* 160i units were installed on the sludge pipe feeding the GEA Westfalia Separator model CB 505-00-32 centrifuge at Somersworth N.H. One unit was placed before the centrifuge, just after the thickened waste activated sludge pump, and the other was placed before the feed tube just before the centrifuge. Both units were installed without process down-time as they are fitted around existing piping and do not require plumbing modifications.

The units use 120V AC and draw less than 1 Amp, which is similar to the power consumed by a 60-watt light bulb.

Success for this facility meant reducing polymer usage and producing dryer cake, while not adversely impacting the centrate quality. The centrate quality in Somersworth typically averages about 500 mg TSS/L, but rarely exceeds 1,000 mg TSS/L. Surpassing the 1,000 mg TSS/L threshold could affect the plant treatment capacity. <https://esemaq.com/wastewater/new-device-reduces-polymer-use-and-controls-struvite-during-sludge-dewatering/>

D - Modern Pumping Today. One of the recent feature articles covers struvite removal <https://modernpumpingtoday.com/removing-struvite-from-wastewater-systems/>

The article above on struvite removal at NYC with a special polymer was contrasted to an approach which would have made centrifuge pond adjustments. This article presents a third option.

A wastewater treatment company in Canada uses a number of dewatering centrifuges to remove water from sewage sludge. After the sludge has been removed the water is purified and then discharged. Purification occurs in the sludge dewatering centrifuge where the centrifuge's force separates the sludge from the water.

Struvite formed inside the sludge dewatering centrifuge necessitating the need for the centrifuge to be stopped and cleaned every 800 hours of operation (approximately two months) which took workmen a day to clear with chemicals, hammers and chisels.

A Scalewatcher electronic descaling system was installed at the centrifuge with an induction cable around the 6-inch supply mains. When, after four months, the treated centrifuge was opened during the first inspection, it appeared that the wall was only covered with a minimal deposit of softened struvite. Two months later the centrifuge was opened and inspected again whereupon it was found to be even cleaner. To confirm the results, the Scalewatcher was switched off. Shortly afterwards, the operators noticed that the deposits had returned. When the Scalewatcher was switched on again the Struvite disappeared. The magazine covers municipal and other pumping applications and includes in depth analyses which can aid decision making. Vince Marino vince@modernpumpingtoday.com will be at the stand 5150

E - WaterWorld Stand 3091 has an easily used search engine. A search under struvite shows a 2018 article - Howard County Department of Public Works engaged HDR to provide engineering design services for upgrades to the biosolids facilities at the Little Patuxent Water Reclamation Facility in Savage, Maryland. The Little Patuxent facility used dewatered cake lime stabilization for biosolids treatment. The changes to the biosolids processing included eliminating the lime system and replacing it with anaerobic digesters, centrate demmonification and associated solids screening, thickening, odor control and digester gas handling improvements.

After an extensive evaluation of phosphorous removal technologies, the design was based on Centrisys AirPrex because of its demonstrated ability to prevent struvite precipitation in downstream processes, including piping and the solids dewatering equipment. The Little Patuxent facility uses decanter centrifuges for biosolids dewatering <https://www.waterworld.com/articles/2018/06/little-patuxent-water-reclamation-facility-upgrades-system-with-airprex-for-sludge-optimization-and.html>

In a 2017 article in WaterWorld - CNP™ Technology Water and Biosolids Corp. recently announced AirPrex®, a sludge optimization and phosphorus recovery process, has been selected for the Liverpool Wastewater Treatment Plant (WWTP) by the Medina County Sanitary Engineers in Ohio.

<https://www.waterworld.com/articles/2017/04/liverpool-wwtp-selects-airprex-for-sludge-optimization-and-phosphorus-recovery.html>

A comprehensive article on nutrient recovery in a 2016 issue is provided at <https://www.waterworld.com/articles/wwi/print/volume-31/issue-6/featured-articles/nutrient-recovery-2-0.html> This article is from the sister publication, Water & Wastewater International by Dr. Christian Kabbe from the Berlin Centre of Competence for Water, Germany.

For more information, email: Christian.kabbe@kompetenz.wasser.de. The struvite problem and the interest in nutrient recovery is world-wide. The quest for the LTCO should also be world wide

Note Also view the automation N-Hach web recording which is by WaterWorld and the automation-N Suez TOC analyzer article which appeared in WaterWorld pre show coverage as well as the pumps and valves E-NOV progressing cavity pump

F - Water & Waste Digest Stand 4028 has a search engine with multiple articles on struvite. Here is one from 2017 - Struvia prevents uncontrolled struvite precipitation during wastewater treatment. This Veolia process uses a patented mixing system, TurboMix, to produce and separate struvite crystals within a single reactor. This compact, resource-efficient, low-energy process saves on operating costs by reducing struvite-related maintenance and reducing the amount of coagulant used for chemical P removal, all while producing a valuable granular end product consisting of magnesium ammonium phosphate crystals that are rich in recycled nutrients.
<https://www.wwdmag.com/treatment/struvite-removal>

G - Chemical Engineering

The September issue will be distributed at WEFTEC. There is a special advertising section on water treatment but the feature articles are on boiler feedwater treatment. Advertisements for some WEFTEC exhibitors appear in the main section but there are advertorials for each in the special water treatment section. Each of these is the equivalent of 0.5 pages of advertising. So for GEMU, Flottweg and about half of the listed advertisers there is the bonus coverage.

Chemical Engineering September 2018 CFT Advertising		
Company	Pages	Subject
Cleaver Brooks	1	Boilers, water systems, controls
Emerson	1	Engineering and project management-automation
Endress +Hauser	1	Flow meters, transmitters, pH
Badger Meter	1	Flow meters
Flottweg	0.5	Centrifuges
Ross	0.5	Mixers
Load Controls	0.5	Viscosity measurement

Gemu	0.5	Valves, water treatment
Swagelok	1	Valves
NOV	1	Progressing Cavity Pumps, screens, mixers
Krohne	0.5	Level transmitters
Ekato	0.3	Mixing
A-T controls	0.2	PFA lined ball valves
Material Transfer	0.5	Bulk bag discharger
Paul O. Abbe	0.2	Mixing, size reduction
Proco	0.2	Check valve
Seepex	0.5	Pumps , metering system
Bionomic	0.5	Modular scrubbers
Ametek	0.3	Viscosity analyzer
Finder Pompe	0.3	Centrifugal and plunger pumps
Myron L	0.5	Liquid measurement
Arkema	0.5	Kynar

This format of advertising in the main section and advertorials in the special section could be used to provide lowest total cost of ownership validation.

#	Magazines	Suppliers/ Consultants	Operators	Struvite
A	Eleven companies			
B	Endeavor			
C	ES&E	GEA	Somersworth NH	x
D	Modern Pumping Today	Scalewatcher	Plant in Canada	x
E	WaterWorld	HDR, Centrisys, Berlin Centre	Howard Cty. M.D Medina Cty, Ohio	x
F	Water & Wastes Digest	Veolia		x
G	Chemical Engineering	Many		

Way Forward

We will continue to build on this analysis after WEFTEC and look forward to input from the industry. The McIlvaine Municipal Wastewater Decisions initiative will be a template rather than the end product. There are Decision Guides on aerators, sludge incineration, air pollution control and other subjects. However, rather than expand them McIlvaine is offering them as a foundation for others who can do justice to the potential. It is logical that the suppliers should be taking the initiative to help create these systems. These systems can be focused on processes and products Some should be focused on

problems.

One Decision System could be created on struvite. It would include alternatives such as side stream treatment and phosphorous recovery. It should involve the consultants and major suppliers as well as media and associations as sponsors. The organizer could be one of these organizations or a group. The Decision System would be populated with papers and media articles in addition to original analyses. The many links to free data on struvite demonstrated in this WEFTEC initiative show the potential.