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Special Topic: Solids and Slurries

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COVER STORY

Schneider Electric: Paving the Way for Smart Pumping Technology

Schneider Electric has been a leading innovator of connected technologies and solutions since the late 20th century. Through a series of strategic acquisitions and technological advances, the company has established a unique technology portfolio in software, critical power and smart grid applications. With connectivity and intelligence as the foundation for its safe, reliable and efficient systems, Schneider Electric has excelled in its industry business and helped shape smart pumping technology.

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END USER INTERVIEWS

16  Designing Basic & Detailed Processes for Mega Methanol Plants: An Interview with George Gabriel, Engineering Manager at South Louisiana Methanol

Pump Engineer had the pleasure of speaking with George Gabriel about the various roles and responsibilities he took on while designing the basic and detailed processes of mega methanol plants. As a senior process engineer, Gabriel provided interesting insight into the various pumps that are used in methanol plants and highlighted the importance of working on a project from its inception to its completion.

20  Tips for Maintaining Brewery Equipment: An Interview with Justin Farmer, Maintenance Manager at Rhinegeist Brewery Facilities

Justin Farmer has worked in food and beverage processing for more than half of his life. As a teenager, he learned from his father, who was a master electrician, an industrial maintenance manager and engineer. He started at the bottom but quickly earned the experience and knowledge to work his way into a leadership role at Rhinegeist Brewery in Cincinnati, Ohio, where he is transforming the maintenance and reliability programs of the historic brewery.

SPECIAL TOPIC

13  Progressive Cavity Pumps Reduce Costs for Digesting Residual Sludge: Lower energy and maintenance costs while simultaneously reducing downtime

Operators looking for the most reliable, low-maintenance and efficient solution for discharging digested residual sludge at a sewage plant in Germany recently began a comparison of an inclined conveyor versus fourstage progressive cavity pumps. The results show that use of the progressive cavity pumps helped the plant save significant amounts of energy and lower maintenance costs, while simultaneously reducing downtime compared to an inclined conveyor.

COLUMN: Q&A SOLIDS AND SLURRIES

30  Q&A Sealing Solids and Slurries

Pump Engineer is proud to present Q&A: Solids and Slurries. This article will address common questions and challenges faced with slurry applications. Readers are encouraged to ask questions for consideration in future editions.

TECHNICAL ARTICLES

20  Revisiting Structured Failure Analysis to Solve Pump Problems: Part 2

The reoccurrence of pump failures is (usually) an indication that the root cause of a problem was not found. Alternatively, if the cause of the problem is known, then someone must have decided not to attempt to resolve the problem. Pursuing a structured failure analysis approach is necessary to solve problems. Guessing or “going by feel” will never do.

34  API 610 Pumps for Boiler Feed Water Service: Options and Design Features

Specifying the correct features and options on API 610 centrifugal pumps going into boiler feed systems is the first step in optimal reliability. Boiler Feed Water applications are one of the most difficult process fluids that centrifugal pumps can encounter. There are a number of primary areas to focus on, when considering boiler feed water pumps, in order to achieve a state of optimal reliability.

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Dear readers,

As we head into the New Year, I cannot help but be excited for the opportunity to venture further into the technical, innovative and adventurous industrial pump world. The chance to expand on my ever growing knowledge of pumps and pump applications stares me in the face as I look forward to the dynamic compilation of articles we have for 2019. In this year’s first issue of Pump Engineer, our attention on the solids and slurries, which is this month’s special topic, allows us to take a closer look at industry sectors, like mining, dredging, sand and gravel extraction. Here we get the chance to see how these sectors use slurry pumps as a cost effective solution for transporting solids.

In this latest edition of the magazine, we look at the pump industry from the manufacturer, distributor and end user point-of-view. Our cover story on Schneider Electric explores the company’s use of connectivity and intelligence as the foundation for its safe, reliable and efficient systems. Schneider Electric has excelled in its industry business and helped shape smart pumping technology, which is growing ever more prevalent in our IOT society. We explore the vital role smart pumping has on enhancing pump efficiency, and the company’s endeavour to aid the pump industry transition from a reactive to a proactive approach to managing equipment failures, in the full article on page 8.

Throughout this edition, end users George Gabriel - a senior process engineer, and Justin Farmer- a process chemical engineer, provide valuable insight about the best parts of being an engineer, the challenges they face, the tools that make it possible and how collaboration, coaching and sharing brings out the best in all of their colleagues on pages 16 and 26. This issue also features a number of technical articles ranging in topics from improving balancing processes and revisiting structure failure analysis, to an extensive overview of the options and design features of API 610 Pumps for Boiler Feed Water Service.

I hope you enjoy this issue of Pump Engineer and are looking forward to the upcoming year as eagerly as I am. I encourage you to send me your technical articles, case studies and press releases and I look forward to meeting with new end users. Please feel free to contact me at a.pajkovic@kci-world.com, should you have any questions or would like to be featured in Pump Engineer magazine. Together, we can continue to explore all of the sectors that rely on pumps, and the ways that they enhance each industry’s productivity. Thank you again for your continued support, I wish you a happy 2019!

Yours sincerely,

Angelica Pajkovic
Editor, Pump Engineer
a.pajkovic@kci-world.com

For more industry events, visit: www.pumpengineer.net/calendar
Product developments

The KSB Group has introduced the KSB Delta Solo, a type series of fully automatic, ready-to-connect single-pump systems. Each one is fitted with a multistage Movitec pump and a motor-mounted frequency inverter. The output is adjusted to demand, by increasing or decreasing the speed. The SVP variant is driven by a synchronous reluctance motor (0.55 to 7.5 kW) from the KSB SuPremE type series, designed for three-phase current, 400 volts, in combination with PumpDrive Eco. The MPV variant (0.55 to 1.1 kW) has a three-phase IE3 motor which can be connected to a single-phase 230 V power supply. All systems are supplied ready-to-connect, pre-assembled and factory-tested.

Wanner has introduced a new intelligent pump control for its Hydra-Cell pumps. High pressure coolant pumps are traditionally set to accommodate the tool in the carousel with the largest coolant flow requirement. Hydra-Cell Intelligent Pump control (patent pending) is an open loop system without pressure gauges and complex electrical feedback loops. It delivers just the right flow of coolant to maintain the required system pressure, regardless of tool size. Coolant chillers are also smaller and consume less energy. The Hydra-Cell Intelligent Pump offers ultimate controllability and can be programmed to produce individual pressures for each tool in the carousel if required. This allows it to deliver coolant exactly when it’s needed in the exact quantity, at the exact pressure while eliminating the need for coolant bypass. High pressure coolant is proven to reduce costs and increase machining productivity.

HOMA, the German pump manufacturer, has developed a submersible motor agitator for its HRS series with a new propeller design that prevents clogging. HOMA focused on the ability of the hydraulic system to withstand fibrous elements that do not disintegrate. A new propeller design effectively prevents clogging while the stainless-steel construction is resistant to both corrosion and wear caused by abrasive elements. The propeller was designed with the aid of a computer which allowed the company to conduct trials and detailed analysis of the results. HOMA was therefore able to target, analyse and improve the weak points in the propeller. Once the data had been analysed, HOMA designed its eight- and twelve-pole systems to include investment cast propellers, which allow particularly good flow optimisation of the blades.

Watson-Marlow Fluid Technology Group has extended its Qdos pump range to include a 12-24V DC power option. The new range introduces a pump designed for mobile and remote applications. The Watson-Marlow pump can aid any user who requires a precise, closely-controlled metering pump where main power is not readily available or practical to use. Watson-Marlow describes the Qdos pumps as being able to, “boost productivity and cut chemical wastage via accurate, linear and repeatable metering.” The new 12-24V DC pump will be suitable for both remote static and mobile battery-powered applications. The pump will typically be used for agricultural seed coating and crop irrigation, remoted water treatment/sampling, potable water refining and on-truck pumping operations.

SIDE Industrie has expanded its Direct In-Line Pump (DIP) System with the launch of the new DIP28. DIP Systeme has been in existence for 16 years and is used in around 2,000 installations worldwide. The new DIP28 is an auto-adaptive, more compact mode, with the inlet/Outlet on the same side so it takes up less space. It fits any sanitation network configuration and includes the self-cleaning DIPCut impeller. The DIP28 offers all the features of other DIP models with a larger performance range. It has an immersible IP67 rating with high efficiency motors, is controlled by smart frequency converter, has integrated level sensor protection against rocks and sand and two suction valves for a simplified maintenance.

Enerpac has announced the launch of its new ZUTP-S Series electric tensioning pumps for oil and gas, wind power and power plant applications. The tensioning pump provides reliable power and precision for critical bolting joints in the assembly of gas and wind turbines, compressors and power shaft couplings. The ZUTP-S Series features a pendant-operated solenoid valve which is ideal for multiple bolt tensioning applications and allows for single-person operation. The operator can pressurise and retract the tensioner directly from the pendant. The pump generates 21,750 psi (1500 bar) of pressure without the need for an intensifier. This allows for low-maintenance and less cost for the user. The ZUTP-S Series also features a two-stage pump design providing high flow at low pressure for fast system fills and controlled flow at high pressure for accurate operation. An easy access manual override valve quickly releases pressure if power is lost.

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**ACQUISITION**

**Pumpenfabrik Wangen Acquires Cavity Pump Business from Knoll**

Knoll Maschinenbau, based in Bad Saulgau, has developed, produced and sold pumping and filtration systems for roughly 15 years. It is well known for its pumps for machine tools and positive displacement pumps for the processing industry: The MX progressing cavity pump. KNOLL has announced that it has sold this particular business area to Pumpenfabrik Wangen. Pumpenfabrik Wangen, a medium-sized company from the town of the same name in Allgäu, specializes in the manufacture of screw pumps. Managing Director Markus Hofheinz is convinced that “the screw pump from KNOLL will be an excellent addition to our range of pumps, particularly in the hygienic and industrial sector.” This purchase marks the first milestone in the long-term growth strategy that we are implementing together with the new majority shareholder Silverfleet Capital.

The smooth transition of the business has been planned and announced by both parties and will be completed in the first quarter of 2019 – the intention is to continue to provide products and services without interruption.

**PROJECT**

**DP Pumps Supplies Pumps for LNG Project**

DP Pumps Drakos Polemis has provided three vertical mixed flow pumps to the 3rd and largest liquefied natural gas tank at Greece’s Revithoussa terminal.

The Revithoussa project, which received €40 million from EU cohesion policy funds, included three DP Pumps Drakos Polemis vertical mixed flow pumps with the following specifications: Q = 6582 m³/h, H = 55 m, 1350 kW – 740 RPM.

Project construction was carried out in two stages: the first included a power and heat cogeneration unit. The second involved the expansion of the Revithoussa terminal’s storage capacity. The construction of a third tank, the upgrading of marine facilities and the installation of new technological equipment to increase the rate of gasification were all parts of the second stage.

**ACQUISITION**

**Alfa Laval Wins SEK180mn Framo Pump Orders**

Alfa Laval has announced that it has won two orders, worth roughly SEK180 million, to supply Framo pumping systems to an oil facility in the Middle East and to an Floating Production, Storage and Offloading (FPSO) vessel currently under construction in China.

The orders comprises of pumping systems for crude oil in a cavern, for crude oil offloading, slop and ballast pump duties. Deliveries are scheduled for 2019.

“I am pleased to announce these two large orders for our Framo pumping systems. These pumping systems are used in a variety of duties, all with heavy demands on safety and reliability, where they provide an optimized performance,” said Peter Leifland, President of Alfa Laval’s Marine Division.

**PROJECT**

**University of Mali to Receive Landia Pumps**

Designed and manufactured by Landia of Denmark, four pumps are to be installed at a new university campus in Bamako, Mali. The pumps will be housed in a new inlet pump station at a wastewater plant close to completion in the district of Kabala.

The Mali-bound Landia pumps will be supplied by HYDRANET - Atlantique Industrie Groupe of Ancenis near Nantes, France. HYDRANET is the main distributor of Landia equipment in France and also supplies French speaking countries in Sub-Saharan Africa.

Ideal for pumping heavily contaminated fluids, as well as effluent with a high content of solids, the Landia DG-I 80s are equipped with an external knife system at the inlet to the pump, which ensures hassle-free operations under conditions in which many other pumps have problems with clogging.
Schneider Electric: Paving the Way

Schneider Electric has been a leading innovator of connected technologies and solutions since the late 20th century. Through a series of strategic acquisitions and technological advances, the company has established a unique technology portfolio in software, critical power and smart grid applications. In the Industrial Automation sector, Schneider Electric has made connectivity and intelligence the foundation for its safe, reliable and efficient systems. No place is this more evident than in their contribution to helping shape today’s ‘Smart Pumping’ technology.

Pump Engineer had the pleasure of speaking with Jack Creamer, Pumping Segment Manager at Schneider Electric concerning the company’s commitment to enhancing pumping efficiency and the benefits of Schneider Electric’s EcoStruxure for the pump market.

By Angelica Pajkovic

The mission of Schneider Electric is to serve customers by developing innovative products and solutions that simplify the lives of those who use them. As the global specialist in energy management and automation, the company is committed to worldwide improvement in connectivity, sustainability, efficiency, and reliability and safety.

Pump and Compression are key segments for the Schneider Electric Industrial Automation group.

In the Industrial Automation sector, the company’s expertise and solutions drive new possibilities for efficiency and savings across markets, including the Pump and Compressor segments. Here, the focus is on bringing the promise of the Internet of Things, or IIoT, to both the end user and original equipment manufacturing (OEM) markets.

For years, the pump industry was a basic functioning industry with little priority placed on intelligent control systems. There has recently, however, been an increasing transition from a reactive to a proactive approach to managing Pump System operational efficiency and pump life cycle management caused by detectable issues. Smart pumping is a concept that describes the various systems used to operate and monitor a functioning pump and is being used to accelerate this process. Fundamentally, smart pumping consists of the use of intelligent, connected products, embedded with pump specific functions and measures to optimize pump system performance.

“Smart pumping is not a new idea,” explained Creamer, “it is an evolution. When I began my role in the pump and compressor segments, nearly 10 years ago, very few individuals had ever heard of smart pumping. What started out as a relatively unknown field, has grown significantly in the past few years.”

Variable speed drives (VFDs) with embedded software enhance efficiency and make pumping systems ‘smarter’.

Water crises, heightened concern for improving water and energy efficiency and advancements in technology have driven Schneider Electric to develop effective and reliable systems that will quicken this transition. Using a series of connected products and sensors sharing operational data, Schneider Electric’s smart pumping...
solutions offers early detection and real-time diagnostic processes to troubleshoot and reduce equipment failures and unusual operating conditions. These smart solutions range from variable speed drives that connect via the internet or cloud, to embedded programs that provide warnings based on reading locally collected data against established baselines.

“There is a benefit to being able to monitor the effectiveness and actions of a pump,” stated Creamer. “Smart pumping often resides in remotely located pump systems, a common situation in pumping sectors such as Oil & Gas, Mining, WW, and Commercial Buildings where there is minimal to no monitoring personnel. The application of these systems therefore often leads to preventative maintenance because the technician can actually see what is going on, even from miles away.”

Innovative Technologies

The advancements Schneider Electric have made with smart pumping technology have had a direct impact on both the end user and OEM pump markets. “While the company continues to produce a number of mechanical products, which are vital to building effective solutions – push buttons, relays, circuit breakers, etc. – its the intelligent, connected products, such as Altivar VFDs, Modicon programmable logic controllers (PLCs) and Magelis Human Machine Interfaces (HMIs) that are our primary focus. These are the applications that employ intelligence and connectivity,” stated Creamer.

The company’s endeavour to ensure that it is continually progressing towards more efficient systems is seen through the implementation of intelligent applications in pumping applications. A series of new products, such as the EcoStruxure Augmented Operator Advisor and Machine Advisor, provide technicians with the ability to assess a pump’s performance at any given time.

“While the company continues to produce a number of mechanical products, which are vital to building effective solutions, it is the intelligent, connected products that are our primary focus. These are the applications that employ intelligence and connectivity.”

Pump and Compression are key segments for the Schneider Electric Industrial Automation group.
“The use of these new systems gives the users the opportunity to walk up to a pumping system and view data that provides feedback on its vibration levels, temperature and run-time hours, etc., in real time. It can also provide me with the option of accessing this data from my desk and monitoring what is going on with that machine from miles away,” highlighted Creamer.

Augmented Reality: EcoStruxure Augmented Operator Advisor combines contextual and local data putting actionable, real-time information at your fingertips.

While the practicality of these products, for pumps in remote locations, speaks for itself, there is a significant advantage to having immediate access to the data for pump sites; reliable data is key for making effective and informed decisions.

“Having immediate insight into the state of a pump is great,” reflected Creamer, “but having access to its data over time can be extremely useful for both end users and OEMs. As smart pumping technologies are constantly logging numbers that provide insight into a pump’s functionality, a technician can assess the equipment and determine if it is using too much energy, or if there are processes that are starting to fail. Ultimately, these products have the ability to change how pump systems are managed; they can minimize downtimes and reduce the frequency of equipment failures.”

The Benefit of IIoT
Schneider Electric’s initiative to incorporate pump specific functions into its software is a very appealing attribute for OEMs in the pump market. “We do not give pump OEMs a vanilla piece of software,” stated Creamer. “We provide them with software that contains roughly 16 different embedded pump functions that are geared towards their particular needs. These functions can include programs that gauge, measure and get feedback on things like anti cavitation, over pressure and under pressure.”

In order to meet the expectations of such stringent specification, and ensure that a pump system is able to communicate with other devices, Schneider Electric incorporated the Industrial Internet of Things (IIoT) into its smart pumping software. “IIoT is the inter-networking of physical devices to collect and exchange data via internet protocol and a key element of smart pumping execution,” explained Creamer. By tailoring its software to match its costumer’s requirements, Schneider Electric has become globally recognized for its innovative solutions.

The Power of Connectivity
As commercial, political and environmental pressures are continually urging organizations to increase productivity while using fewer resources, the connectivity offered by IIoT has become increasingly sought after. Schneider Electric has therefore developed the EcoStruxure platform to help users leverage the benefits of IIoT. EcoStruxure is a way to bring all the benefits that make up the IIoT into one easy to understand environment. An environment where products meet applications, which provide data, that is then stored and shared in numerous ways.

The EcoStruxure architecture is based on a three-tiered technology stack – Connected Products, Edge Control and Apps, Analytics and Services – bringing energy, automation and software together. This allows for the delivery of enhanced value and safety, reliability, efficiency, sustainability and connectivity. It leverages advancements in IoT, mobility, sensing, cloud, analytics and cybersecurity to deliver innovation at every level.

Schneider Electric EcoStruxure is an open, interoperable, IoT-enabled system architecture and platform.
“EcoStruxure is a fairly new concept,” stated Creamer. “It is used to describe the connection between products. These connections can extend from the product’s baseline (the drive, the push buttons and the sensors), up to its intelligent sectors (the PLCs and mechanisms for the cloud). In other words, EcoStruxure is a summary of a smart pump process from pump application sites to the remote monitoring sites.”

Although this concept is not exclusive to smart pumping and can be used across multiple segments, Schneider Electric is able to personalize each system to make it specific to the pump world.

“EcoStruxure can be personalized to make it very beneficial for the pumping world,” explained Creamer. “First, the hardware level which is more relevant to the end user. At this level we are referring to the products involved with the pump itself. They are chosen based on their relevance to the pump’s requirements. Once the relevant drives and other products are selected, we design a smart pumping solution. The second level refers to the imbedded software that facilitates the smart pumping. This software contains highly specified functions which ultimately help the OEMs and Pump Users to develop overall solutions.”

Forward Thinking

The use of Schneider Electric’s smart pumping solutions and the EcoStruxure platform can help mitigate the number of unplanned downtime events and equipment failures a plant may experience. Supplying Pump Users and OEMs with intelligent software and an inter-networking of physical devices, gives them the opportunity to adopt a proactive and predictive, rather than reactive, approach to potential issues. The ability to activate and monitor pumps in remote locations, such as an oil rig or city sky scraper, therefore has the potential to not only reduce operating costs but also increase the efficiency and sustainability of the pumps themselves. Schneider Electric has combined the worlds of energy, automation and software to develop connected technologies and solutions to manage energy and process in ways that are safe, reliable, efficient and sustainable.

“I believe that Schneider Electric stands out as the only company to have invested intelligent technology into the pump market,” remarked Creamer. “Our focus on specialized software for pump specific applications has made us a trusted advisor in the industry and led us to create new applications for new technologies. I am excited to see what we are able to accomplish in the future.”

“I believe that Schneider Electric stands out as the only company to have invested intelligent technology into the pump market. I am excited to see what we are able to accomplish in the future.”

Schneider Electric EcoStruxure is an open, interoperable, IoT-enabled system architecture and platform.
Progressive Cavity Pumps Reduce Costs for Digesting Residual Sludge:
Lower energy and maintenance costs while simultaneously reducing downtime

Operators looking for the most reliable, low-maintenance and efficient solution for discharging digested residual sludge at a sewage plant in Germany recently began a comparison of an inclined conveyor versus four-stage progressive cavity pumps. The results show that use of the progressive cavity pumps helped the plant save significant amounts of energy and lower maintenance costs, while simultaneously reducing downtime compared to an inclined conveyor.

By Heinz Peter Sildatke, Service Advisor, and Gunter Connekert, Sales Director, CIRCOR Germany

Figure 1: Plant showing sludge silos.

Sewage Plant Looks for Cost Reduction and High Availability

The Duisburg-Kasslerfeld sewage plant serves a large catchment area in western Germany. Approximately 80 percent of the wastewater volume comes from households, with the remainder from a variety of industrial operations, including tank cleaning, beverage production and the Duisburg zoo.

The sewage plant is designed for 450,000 resident equivalent units; its dry-weather inflow is approximately 1.3 cubic meters per second (m3/s) and rainy-weather inflow is up to 4.1 m3/s. In recent years, the plant operator replaced the chambered filter presses with two centrifuges. Following this upgrade the operator had to determine the best possible methods for discharging the dewatered sludge. The
operator decided to compare reliability and economic efficiency of two methods: a centrifuge with an inclined conveyor and a centrifuge with a progressive cavity pump. As the pump solution allowed for 24 hours per day operation, it would lower costs.

The residual is stored in two silos before being transported for incineration. Figure 1 shows the two feed tubes that lead into the residual sludge silos. In the front silo, an inclined conveyor moves sludge from the top; in the rear silo, a pump moves it from the bottom.

Comparing Progressive Cavity Pump with Inclined Conveyor

Ruhrverband, the non-profit water management company that operates the plant, decided to test the performance of AE-RG series four-stage solid-substance progressive cavity pumps as the residual sludge discharge pump.

Ralf Wilms, Ruhrverband’s regional operational group leader, notes, “We wanted to know whether a discharge pump would be a more economical and reliable solution than a conventional inclined conveyor.”

The sludge contains approximately 25% dry substance, and the selected AE-RG four-stage progressive cavity pump has several design characteristics that ensure reliable continuous operation with such a high proportion of dry substances. Two force-feed screws arranged in parallel next to each other ensure continuous operation. A wide feed funnel that prevents bridging of the material is another important element to ensure movement of the sludge and disturbance-free operation of the plant. This special pump design does not require a bridge breaker, and the pump’s design height is significantly smaller than similar pumps. Even when starting, there are no disturbances because the break-out torque (starting torque) is very low. The pump is controlled by a frequency converter and runs at 30 to 60 Hertz (Hz). The low rotational speed helps the pump achieve a long service life.

The pumps can move drained sludge with dry substance proportion of up to 45%. The two edge-to-edge feed or mixing screws in the feed funnel and the extra-long stuffing housing ensure reliable filling of the pumping elements without bridging or formation of deposits. Figure 2 provides a look inside the pump.

Progressive Cavity Pump Wear and Maintenance Costs Lower than Inclined Conveyor

Since starting operations, the wear and associated maintenance costs for the four-stage progressive cavity pumps have been significantly lower than those of the conveyor. In addition, the pump requires approximately 4 to 5 kilowatt/hour (Kw/h) less energy than the conveyor. The pump moves a daily volume of approximately 55 m³ of sludge with a dry substance proportion of approximately 25%. Pressure ranges from 4 to 9 bar (58-87 pounds per square inch (psi)). Maximum discharge pressure is about 20 bar (290 psi), so the plant’s silo can be completely filled with no difficulty.

In addition to lower energy consumption, the plant has also reduced its spare parts and maintenance costs. As there is a large selection of rotors and stator elastomers operators can find the combination that best matches the pumped liquid’s chemical and physical characteristics. This results in the longest possible service life; long maintenance intervals, minimal downtime and very reliable, continuous operations.
The plant operator has found significant benefits from using original spare parts due to their significantly greater durability. Repair, assembly and technical consultation services have also proved valuable. In particular, if conditions in the plant change or if pumps will be used in other processes, the manufacturer recommends the materials that will have the longest service life and the configuration with the greatest efficiency.

For example, when a new flocculent is used, a durability test is conducted with several different elastomers to determine the mixture that is precisely adapted to the conditions. Getting the right combination of elastomers for the chemical and physical properties of the liquid is one of the consultation services that pays real dividends.

**Proven Results**

As of November 2018, the AE-RG pump on centrifuge 1 had been in operation for more than 20,000 hours. It had experienced one change of stator at approximately 9,300 operating hours and the first service at 16,000 hours. The pump on centrifuge 2 has been operating since January 2018 without maintenance and no failure in operation. The manufacturer anticipates that the pump will complete up to approx. 20,000 operating hours before needing overhaul. The progressive cavity pump has really proven itself.
Pump Engineer had the pleasure of speaking with George Gabriel about the various roles and responsibilities he took on while designing the basic and detailed processes of mega methanol plants. As a senior process engineer, Gabriel provided interesting insight into the various pumps that are used in methanol plants and highlighted the importance of working on a project from its inception to its completion. The years of experience as a process chemical engineer prepared Gabriel for his current dynamic role as Engineering Manager, overseeing the production of methanol from natural gas.

By Angelica Pajkovic and Sarah Bradley

With over 18 years of experience in engineering, George Gabriel has worked his way through several industries. Beginning his career as a production engineer, Gabriel established himself through a number of different roles which handled a wide variety of equipment. After two years of working with pharmaceutical water treatment systems, Gabriel became a lead project engineer engaging with ultra-membrane filtration. Following an additional few years in the emissions control sector, mitigating environmental issues, he became a lead project engineer for large offshore oil and gas projects. It was in the oil and gas sector that Gabriel truly discovered his passion.

“I have worked extensively in three industries,” commented Gabriel. “I have been in the water treatment industry, I have been in the air pollution and control industry and I have worked in the oil and gas industry, and for me the latter has been the most dynamic. Where the progress of other industries, such as fugitive emissions, is dependent on government regulations and restriction, the oil and gas sector is primarily a function of sophisticated technologies and the needs of the general populous. As there is generally more action and new inventive technologies, I find it to be very interesting and engaging.”

In 2014 Gabriel began his work with Orascom, to build what would be the first methanol plant of its size in the United States. Located in Beaumont, Texas, the facility known as Natgasoline’s Methanol Plant now produces up to 8,000 metric tons (t) of methanol a day, which amounts to roughly 1.8 million(t) a year. This yearly total currently exceeds the production capacity of all of the other methanol plants in the United States. While working with Orascom Gabriel completed his MBA in 2017, which prepared him for the next step in his career as an Engineering Manager.

**Dynamic Roles**

Gabriel was hired as one of the EPC contractors to design the entirety of the plant. When asked to take on the project he was particularly excited, as it was the first mega methanol plant to be built in the United States and he would be able to partake in its creation. Gabriel estimates that there was close to $1.6 billion invested into the project.

As the skills required to design a plant of this magnitude are numerous and highly technical in nature, it is not surprising that only few individuals,
Designing Basic & Detailed Processes for Mega Methanol Plants

An Interview with George Gabriel, Engineering Manager at South Louisiana Methanol

Gabriel included, were commissioned to design the facility. A mega methanol plant with this capacity can take anywhere from one and a half to two years to design. As most of the equipment and products are custom made, there is a significant amount of work that goes into designing each process.

“For every piece of equipment there is a unique data sheet,” explained Gabriel. “The data sheets are produced by the process engineers and used to create the feed design. Essentially they indicate the dimensions, pressure, temperature, flow, process and non-process connections size, type and quantity for all the equipment required in the plant. These data sheets are sent to a detail engineers, Mechanical, Electrical or instrumentation and control engineers to create the detail design.”

The composition of data sheets, was just one of many responsibilities Gabriel had as a process engineer. With a business background, he was also able to assist the project financial team assess aspects of the facility from both an engineering and a financial perspective. “I looked into the technical aspect of the designs, as that is my background,” stated Gabriel, “but I also took a significant amount of time assisting the project financial team to overlook the business related details and ensure that both the technical and financial sides were approached with efficiency in mind.”

Expanding Expertise

The ability to effectively create and design while maximizing investment potential was one of the more challenging parts of Gabriel’s role. Not only was he pressed to stay on schedule, but he was expected to do so while monitoring budget spending and meeting all the technical requirements and safety regulations. “Safety was the number one priority for all of the designs aspects,” stated Gabriel. “Everything we do is related to ensuring that everything will operate and function safely. If we have any suspicion, whatsoever, that something is not safe, we stop operation. We re-analyze it, make it safe and then move forward.”

Gabriel indicated that one of his ultimate objectives was to have everyone work together.

“I would overlook everything,” said Gabriel, “to ensure that, as a team, we were not doing unnecessary work. I would attempt to see if the workings of one project could be used to fuel another, in an effort to avoid reinventing the wheel. As I was able to look at every aspect from a distance, I could approach engineers from different disciplines and see if any of their work overlapped, to make things run as smooth as possible.”
Plant Specifications

A thorough understanding of the processes required for a methanol plant is necessary for the selection of pumps, valves and hoses that will give life to the production facility. Specifying the types and grades of equipment required at the plant was a collaborative effort between Gabriel and the product specific experts.

There are two prevalent types of pumps in a methanol plant; pumps for water and pumps for hydrocarbons (methanol). While a great deal of consideration is put into specifying the criteria for both pump types, the specifications for the methanol pumps tend to be more stringent.

“The most complex pumps are the Boiler Feed Water pumps known as BFW pumps, these pumps are driven by steam turbines and can pushes up to 1000 psi,” explained Gabriel. “With lube oil cooling system and a double seal to ensure there are no spills, there are a number of precautions in place that ensure it operates safely. How to specify all of these aspects, in detail, is where the challenge lies.”

As each specification has an associated cost, it is important that each request be relevant. “What makes this process especially difficult is the amount of pump knowledge required to make effective and efficient specifications,” stated Gabriel. “After my initial assessment, I tend to seek out a pump expert to go over my ideas. Together, we will discuss what I want, the reason for my choices and ultimately, the specifications for the pump in question.”

The number of valves used in a mega methanol plant exceeds expectations. When asked, Gabriel expressed that “there are literally thousands of valves involved in a project like this one. There are probably 700 control valves in this plant, and that estimate does not take into account any of the manual valves used throughout the facility.” The valves he found to be the most engaging were critical process valves; high pressure steam valves, gas valves, methanol valves and oxygen valves. Each of these valve types requires extra attention and are typically custom made to suit the projects needs.

“In an effort to reduce risk of leaks, most of our valves are designed with very specific specifications in place,” explained Gabriel. “Unique size requirements as well as the need for specialized materials results in very long lead times and a lot of planning.” In anticipation of these lead times, Gabriel would spend extra time ensuring that all the designs and specifications were exact. His diligence and meticulous work helped keep the project on track and limited the occurrence of costly delays caused by modifications to pre-existing orders.

“With critical valve processes, valve failure is not an option,” stated Gabriel. “There is zero tolerance for any valve malfunctions at this stage of the project, so all efforts are taken to ensure that nothing negative will happen.”

Sense of Accomplishment

“The most rewarding part of my job was seeing what I requested to design come to fruition,” reflected Gabriel. After completing the engineering phase Gabriel moved to the site as Lead commissioning engineer, to assist commissioning and the start-up of the Methanol plant. With his knowledge, George was a lead team player in the commissioning team. He was able to bridge the gap between engineering and commissioning, through the experience he gained as the design evolution lead to the current design. “In many cases the commissioning team was asking why this was done that way? Here I was able to assist and explain the design progress and history that lead to the current design,” stated Gabriel.

What Processes are Involved in the Creation of Methanol?

There are a number of processing steps involved in the production of methanol from natural gas. To begin, the natural gas is subject to a pre-treatment to remove sulphur compounds. The pre-treated gas then undergoes an oxygen-blown natural gas reforming either in combination with steam or autothermal reforming. This process does include fired combustion heating to convert the methane, steam and other compounds into synthesis gas (syngas).

The syngas goes through a two-step reactor, which is called methanol syntheses, to produce the row methanol. The row methanol is then routed to a three-column distillation unit to remove impurities. The final product is 99% pure methanol, which is supplied to third parties to produce gasoline or industrial chemicals.
“I started with a green field and ended with a running plant in front of me. It was an amazing feeling.”

The ability to go to a site and observe all the different procedures of a project is highly beneficial for a process engineer. It provides them with the opportunity to assess what they are designing and asking for. “By being on site as lead commissioning engineer I was able to analyze if everything I requested made sense and could modify my requests if I saw something that could be done more efficiently,” said Gabriel. “It was an excellent way to gain experience.”

Moving Forward

Since the completion of Natgasoline Mega Methanol Plant in April 2018, Gabriel has become an Engineering Manager, at South Louisiana Methanol, overseeing the engineering and design of a new, 8,800 t/a day, methanol plant in the Louisiana area. With that capacity the plant is considered to be the largest producing methanol facility in the world. In George’s new role he is leading the owners engineering team and overlooking the EPC contractor, to ensure on time and safe delivery of the plant.

As methanol is a raw material for so many industries, and can be used in a wide range of products, it has become a ‘clearer solution’ for a number of companies. The experience Gabriel gained, from working on the first mega methanol plant, can therefore be considered invaluable as it provides him with a great understanding of how all the processes of a plant function. The transferability of his skills and the progressive nature of the industry has provided Gabriel with an excellent opportunity to continue working towards a ‘clearer solution.’ His proficiency with many of the products found in these facilities, coupled with the ability to impart knowledge about what methanol is produced from and what it is used for, has made Gabriel an ideal candidate for the dynamic role of Engineering Manager.

“The most rewarding part of my job was seeing what I requested to design come to fruition.”
Revisiting Structured Failure Analysis to Solve Pump Problems: Part 2

The reoccurrence of pump failures is (usually) an indication that the root cause of a problem was not found. Alternatively, if the cause of the problem is known, then someone must have decided not to attempt to resolve the problem. Pursuing a structured failure analysis approach is necessary to solve problems. Guessing or “going by feel” will never do.

By Heinz P. Bloch

An analyst can attempt to discover the root cause of an issue by remembering that all pump failure events fit into one or more of the seven cause categories listed in Part 1; these are repeated in the italicized/underlined words found in the example below. The “mapping” of parts, is not to be overlooked. This includes collecting data through careful electronic measurements and the issuance of procedure cards, Figure 5.

- Assembly/Installation Defect? Suppose we have no data and defer it for possible consideration later
- Off-Design or Unintended Service Conditions? No; we rule it out
- Maintenance Deficiencies (Neglect/Procedures)? No, since no maintenance (PM) is required on a coupling hub
- Improper Operation? No, because we have ascertained that operator activities were in accordance with our established standards

At this stage, the analyst would determine what needs to be investigated further or requires a follow-up examination. As pump repair and rebuilding may involve significant (but cost-justified) re-engineering (Figure 6), the analyst may decide to work with a Competent Pump Repair Shop (CPRS) to define the appropriate course of action. In virtually all instances the analyst considers working with a CPRS in collaborative efforts with the aim of compiling:

Figure 5. Critical dimension records and work procedure card in shirt pocket format are helpful for failure avoidance (author’s photo).

Suppose that there is a pump shaft on which the coupling hub was found to be loose. An analyst’s first order of business is to determine in which of the seven cause categories they would likely find the cause of the problem, and which of the seven cause categories could be eliminated with a high degree of confidence:

- Design Error? Unlikely, since other couplings are designed the same way and we have verified that they are holding quite well
- Material Defects? No, since a thorough metallurgical exam checks OK
- Fabrication Error? No, because the hardness checked OK; dimensional correctness was verified and had been recorded upon installation, three years ago

Figure 6. Re-engineering a high-pressure process pump (Source: HydroInc, Chicago, Illinois).
(a) A checklist of possible assembly errors: Following discussions with maintenance personnel it might be concluded that none apply in this instance.
(b) A checklist of possible installation errors:
- Force: The product may have an overstretched hub or it could have had insufficient axial advance on taper (insufficient interference fit)
- Reactive Environment: None found; normal chemical plant location
- Time: Ascertained that run length was not excessive; the hub failed after just a few weeks of operation
- Temperature: Suppose the coupling was heated to facilitate installation. How was the heat applied? What tells us that the temperature was within limits? The temperature could have been too high (causing overstretch) or too low (not allowing dilation to result in sufficient axial advance)

From the list above it becomes clear that the pump failure analyst must determine in which cause category there is a deviation from normal. Working together, the analyst and the contracted CPRS must determine which item needs to be modified, and how this modification must be implemented to prevent repeat failures. As shown in Figure 7, both modern construction materials and well-proven technologies, are considered in upgrade work. With data one can define the root causes of a problem. Without data one can, at best, determine a probable cause. With knowledge, one can get away from the proverbial pitfalls of “business as usual.”

Change Analysis
Change analysis parallels and supplements the structured comprehensive approach. Change analysis seeks to identify what is different in a defective item when compared to an identical but unaffected item. The analyst probes into when, where and why the change occurred. The analyst then outlines a number of possible remedial action steps and chooses the ones that best meets the defined objectives. These objectives must prioritize highest safety ahead of fast implementation and other seemingly urgent achievements. The analyst may pick from a list that includes: lowest life-cycle cost, present value, highest initial quality, meeting certain industry standards and a number of other objectives.

The aim of achieving the lowest life-cycle cost, as a primary objective, usually makes considerable sense. Calculating this parameter entails determining the cost of staffing a pump selection or reliability review with dedicated and knowledgeable individuals. Life-cycle cost analyses must also include the value of downtime avoidance and mean time between failures (MTBF) extensions, as well as the value of avoided fire and safety incidents.

Recall that fewer pump failures translate into fewer fires and decreased insurance premiums. Failure avoidance creates goodwill and enhances a company’s reputation. Having to cope with fewer failures also frees up personnel whose proactive activities prevent other failures.

Figure 7. Upgrading to superior construction materials and novel (but proven) geometries benefits pump users (Source: Boulden Company, Ellange/Luxembourg and Konshohoken/Pennsylvania).

What Choices Mean in Analysis
Any choice made when analyzing a failure will have advantages and disadvantages. When pumps and process pump applications are involved, the most elementary choice requires opting for two out of three broad-brush deliverables: Good, Fast and Cheap. Take any two, but do not expect to ever obtain all three.

Whenever confronted with the two-out-of-three choice, analysts need to remember that if an analysis or repair is good and fast, it probably will not be cheap. If it is good and cheap, it probably will not be fast and, if it is fast and cheap, it probably will not be good. In cases were the analyst is persuaded to pursue the fast and cheap route, they should brace themselves for the possibility of repeat failures that can cost a small fortune and bring on all kinds of other misery.

Over the decades, experts have come to realize that pump failure statistics are rarely very scientific. The statistics are, however, experience-based and should not be disregarded. If an individual’s MTBF hovers around average, the repeat offender should be identified and subjected to an uncompromising improvement program. In the hydrocarbon processing industry, about 7% of the pump population consumes 60% of the money spent on pump maintenance and repair. Getting to the root causes of failures on this 7% will ultimately save money.

It can be said that all successful and cost-effective failure analysis methods are a product of structured approaches which give focus to an otherwise scattered search for the causes of equipment failures. Structured analysis approaches are repeatable; they are not hit-or-miss guesses. A successful approach guides the analyst through a sequence of steps and it invariably accepts the premise that all problems are ultimately caused by the decisions, actions, inactions, omissions or commissions of human beings. A successful approach...
is objective; it seeks explanations but does not tolerate compromises and excuses.

It is fitting, then, to conclude this text by pointing to Figure 8. This illustration attempts to convey that there are many parameters that interact to cause repeat failures in pumps. Many of these are classified as hydraulic issues and a significant amount of work has been done to improve pump hydraulics. The majority of what the author chose to call elusive failure causes is, however, linked to mechanical issues. Users have become accustomed to maintenance routines that rarely question the adequacy of a vendor’s design. Failure causes become elusive whenever users and manufacturers overlook, forget or deliberately disregard the laws of physics. We can certainly visualize, from Figure 8, what will happen when a competent pump engineer selects a pump to operate in the center of the curve, but each of three other individuals in the approval chain adds 10 percent fat “just to be safe.” The pump will be oversized and problematic for years to come.

An attempt was made, in this article, to point out that process pump vendors occasionally provide barely adequate designs. Vendors are left with the impression that users are unwilling to pay for a superior design. Over the past two or three decades, pump manufacturers have right-sized, down-sized and economized the way they do business. Some vendors and manufacturers no longer employ process pump experts. The user-purchaser may belatedly come to realize that he has become the manufacturer’s quality control inspector and might experience multiple failures before they accept this fact. This realization ultimately results in the user allocating money to ward off this eventuality by suitable pre-delivery inspections.

Timely and competent up-front action by the owner-purchaser is indeed one of the keys to failure avoidance. This up-front action includes developing detailed specifications for process pumps and some of their key components. Once a process pump arrives in the field, it must be properly installed and maintained. To be effective, the facility must adopt work processes and procedures that harmonize with best-of-class thinking.

To avoid repeat failures, pump owner-operators must deliberately push certain routine maintenance actions into the superior maintenance category. Superior maintenance efforts will lead to (or are synonymous with) pump reliability upgrading. As mentioned earlier, combining pump maintenance with systematic upgrading should be entrusted to a Competent Pump Repair Shop, or CPRS.

Before one can apply practical wisdom, one must acquire knowledge and understanding. Perhaps this article has helped move the reader in the right direction. Insight results from combining knowledge and understanding. Insight never fails.

Check out part 1 of this article in the previous December 2018 issue of Pump Engineer.

Figure 8. Staying near the center of this Barringer-Nelson “Reliability Curve” is a wise course of action for reliability-focused designers and operators.

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About the Author

Heinz P. Bloch earned BSME and MSME (cum laude) degrees from the New Jersey Institute of Technology (1962). Since retiring from Exxon Chemicals USA as their Regional Machinery Specialist, he worked as a consulting engineer and course presenter at plants and universities. His courses and conference papers drew attendees worldwide on six continents. He has authored or co-authored 20 textbooks on machinery reliability improvements; these have been published in 45 Editions, some with translations into Russian, Spanish, Portuguese and other languages.

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Pumps For Fracking Sand

Hydraulic fracturing has increased in many parts of the world as other energy sources, such as coal bed methane production, stagnate or decrease. Shale gas fracking provides a valuable source of energy for countries that effectively make use of it. However, due to a variety of geographical, political and technological factors, certain countries and regions find fracking more accessible and available than others.

By Robert McIlvaine, President & Founder, The McIlvaine Company and Hailey Ardell, Assistant Editor

The United States remains a leader in fracking. According to the 2018 BP Energy Outlook, despite the U.S.’s continued ability to produce substantial amounts of shale gas, it will be unable to contribute as significantly to exports as it has done in the past. U.S. oil and gas production is projected to increase to approximately 18% of global production by 2040; this is a significant increase from the 12% experienced in 2016. U.S. oil and gas exports, however, are only projected to make up roughly 9% of the global market in the same time frame.

The pressure pumping of proppant, for shale fracturing, is one of the largest markets for pump suppliers. As the sand, which is required for fracturing, needs to be excavated and cleaned, it also entails a sizable pump investment. The excavation and cleaning of sand is therefore a smaller yet fast growing market segment.

The techniques developed in the U.S. to fracture shale, for the purpose of extracting oil and gas, are the foundation of the success of the U.S. economy in the last decade. Developers have continually attempted to reduce the associated costs with new techniques, such as horizontal drilling. The primary challenge for designers of these sand plants is that both the parameters of the incoming sand and the proppant end use change continually. Water use has to be integrated with the changing production needs.

Bob Carter, President of IAC and a supplier of sand plants, indicates that pump flow control and energy minimization are both important parameters in the optimization of the process, especially as sources and end uses change. The need for pumps starts with sand excavation. A pump can be attached to an excavator and the sand can then be pumped to the processing plant.

Additional pumps are needed in the sand manufacturing process. Wet processing typically begins with either a
horizontal or inclined primary vibratory screen in either a two- or three-deck design. While making the coarse-end separation that is required, the vibratory screen also provides the introduction point for the addition of water into the process. Water addition begins in the sluicing feedbox and continues with spray bars as the material crosses the screens. The introduction of water in this manner completely hydrates the sand. After exiting the screening process, hydrated sand in slurry form enters a sump and pump arrangement. The pumps used in this process are typically rubber lined due to the abrasive nature of silica sand.

The sump and pump arrangement typically sends the slurry to a large-diameter hydrocyclone, the primary function of which is to provide feed material to a hydraulic classifier at an ideal density and in a manner that provides even distribution of the slurry into a stilling feed well.

There a number of other smaller pump requirements. A dosing pump is a prime example of an additionally required pump. It is needed to transport the flocculants used to separate the clays from the desirable sand fraction. More pumps are also needed to meet the demands associated with water reuse.

Ultimately, the market is expected to grow at robust rates in the U.S.. Presently, Argentina and China are smaller markets but promise to be substantial in the future.

Manufactured frac sand plant image courtesy of IAC.

The transport of sand with the correct fracking features from Wisconsin and Minnesota to West Texas, is very costly. In response to this expenditure, one of the most recent cost reductions efforts is to manufacture high quality sand from the lower quality resources available in the region.

The West Texas Permian Basin is relatively arid and its freshwater supplies are limited. The new fracking sand mining plants in the basin, add to the large water demand already caused by the fracking process. One possible solution for the fracking sites is the use of treated municipal wastewater. Another potential solution is the treatment and use of brackish water. Although these are both potentially viable options, fresh water will remain the main source for the foreseeable future.

Overall, conservations addressing these issues have become a high priority. Fracking sand plant suppliers have risen to this challenge by designing systems which reuse as much as 98% of the process water needed.

About the Author

Robert McIlvaine is the President and Founder of The McIlvaine Company, which publishes reports across worldwide pump and valve markets. He was a pollution control company executive prior to 1974, when he founded The McIlvaine Company. He oversees a staff of 30 people in the USA and China.
Tips for Maintaining Brewery Equipment: An interview with Justin Farmer, Maintenance Manager at Rhinegeist Brewery Facilities

Justin Farmer has worked in food and beverage processing for more than half of his life. As a teenager, he learned from his father, who was a master electrician, an industrial maintenance manager and engineer. He started at the bottom but quickly earned the experience and knowledge to work his way into a leadership role at Rhinegeist Brewery in Cincinnati, Ohio, where he is transforming the maintenance and reliability programs of the historic brewery.

By Michelle Segrest, Contributing Editor

Justin Farmer has seen maintenance and reliability from every angle. While working with his father in the maintenance department at a tortilla plant in Northeast Georgia when he was 16 years old, Farmer had the opportunity to learn all about maintaining pumps and valves from senior mechanics. “They taught me the basics like motor replacement, gear replacement and how to repair failed transfer systems,” the 35-year old Facilities and Maintenance Manager said. “There was a great amount of knowledge to be learned. Of course, I was one of the young ones, so I didn’t get a lot of the good jobs. I started at the bottom working in the water treatment pit. Most of my friends were out having fun and I was working my tail off. But this was how I could spend time with my father.”

Farmer spent the next 16 years working primarily in the bakery industry. After graduating from high school, he studied for three years at the Military College of Georgia in Dahlonega, Georgia. He then went to Arizona State to complete his electrical engineering degree. While there, he worked at Papa John’s Pizza as an industrial maintenance technician. “I was one of the few there who had a controls background, so they worked with my crazy school schedule for three years,” Farmer reflected.

A welder from Altra welds an “I” beam that will be installed as part of the brew pad extension. (All images courtesy of Rhinegeist Brewery)
He left the industrial maintenance field for about a year and did industrial layout and design for a large engineering firm. “I hated it,” Farmer said. “I can’t sit behind a computer every day doing load calculations. It was mind numbing for me. I transferred back into the maintenance field working for bakeries. Four years later I went back to Papa John’s as Maintenance Manager where I worked for three and a half years.” His experience includes working in multiple tortilla plants across the U.S.—La Fronteriza in Toledo Ohio, Tia Rosa in Compton California and Don Julio Foods in Clearfield Utah.

While at Papa John’s, Farmer’s primary task was to build the maintenance department from the ground up. “I had a lot of leeway. I was able to decrease the downtime and set up some solid procedures. Then I went to Café Valley making croissants, cakes and pastries. I spent two years building that maintenance department—contributing to improvements in inventory control, PM management, scheduling and automation and capital projects. When we began to get efficient, the company went through a management change, so I went to Schwan’s pizza in Kentucky for one and half years. Then I found Rhinegeist Brewery.”

This was different from a bakery, and Farmer was excited about the opportunity. When he arrived, there was no maintenance department. “They had one technician working around the clock to maintain the growing production plant,” he said. “This company has grown on average 50-60% each year, so there have been many opportunities to manage more maintenance with this growth.”

**Facility and Maintenance Team**

Rhinegeist translates to “Ghost of the Rhine” and refers to its building in the historic Over-the-Rhine Brewery District in Cincinnati. Built within the skeleton of the old Moerlein bottling plant that was built in 1895, Rhinegeist now brews many different varieties of beer. Rhinegeist pulled its name from the fact that the original settlers were of German descent who said that the Ohio River reminded them of the Rhine River in Germany, and “Geist” is German for “ghost,” which shows the reflection to the past history of beer production in the area.

At the turn of the 19th century, Over-the-Rhine was home to nearly 45,000 inhabitants—most of them of German descent—and 38 breweries. Leading this vibrant brewing scene was Christian Moerlein Brewing Company, the city’s largest brewery, which extended over three city blocks and produced more than 300,000 bbl annually. The company’s old bottling plant, located at 1916 Elm Street, is home to its modern-day brewery.

The facility holds about 30 fermenting vessels, eight bright tanks (where beer is stored before it is processed) and a small JV deck (which is like a micro-brewery). The main brew house runs 60-barrel batches, and Farmer makes the most of his six-member maintenance team. It includes an inventory/parts/CMMS specialist (who handles PM planning and inventory management), a fabrication technician, one universal technician, an experienced pump and boiler specialist and Farmer.

The building is old, which presents many maintenance challenges, however, most of the processing equipment is less than two decades old. The oldest equipment includes some processing tanks, a kettle and whirlpool that are 20 years old. The company invests in stainless steel piping, which is ideal for beverage processing because it does not expand and contract, creates less wear on joints, has fewer leaks and does not stress as easily.

Farmer and his team are responsible for maintaining various types of pumps and valves.

The facility has hose pumps for chemical dosing in the CIP loops, centrifugal pumps for transferring the beer from tank to tank, CIP recirculation pumps and load pumps to transfer in cider-based entities like apples for brewing different flavored beers. There are progressive cavity pumps used to transfer spent grain, pneumatic diaphragm pumps used for transfers and metering pumps for chemicals.
Challenging Maintenance

When trying to diagnose a pump, Farmer said his team monitors pressures with gauges on the inlet and outlet and collects daily readings. “We can put this data into a graph and identify trend lines that show fluctuations,” he said. “Pressures may decrease, which means the impeller is starting to wear or a mechanical seal is starting to fail. We plan to put these monitors on more of the pumps so we can monitor them on a more regular basis to predict failure rather than react to failure.”

Preventive maintenance has become the name of the game when maintaining the many pumps and valves at Rhinegeist Brewery. Farmer’s team ensures there are functional pressure and flow switches in place. “In a typical brewery, when you start up you do not have all the fancy bells and whistles,” he explained. “We are starting to implement new systems that have flow sensors that help to ensure that the pump will not run dry. This is a nice safety net. Amperage alarms on the drives will throw an alarm. If the top drive motor starts to fail or have heavy binding, it will alert us as to an amperage fault or an over current.”

Farmer also believes in the advantages of having a solid CMMS system. “We must manage our critical spare parts inventory carefully,” he said. “If you do not have the right parts, you will experience extreme downtime, especially since most of our parts come from Europe with long lead times. This puts you at the mercy of having to hold a lot more parts in stock. We went through an asset identification process and now we are writing work orders within the system. Anything we may have to work on is now labeled with an asset number. We are starting to input standardized PMs. This will be a growing and constantly evolving entity because we’ve identified the PMs from the manufacturer, but we’ll add in other things we identify on a daily basis.

Farmer offers advice to young technicians on key focus areas when it comes to maintaining pumps. It is important to understand how each of the different pumps work, Farmer said. “I have YouTube videos that I have the guys watch to be sure they understand how a centrifugal pump works, how a hose pump works or how a progressive cavity pump works. If you do not understand how something works, you can not expect to be able to troubleshoot it or fix it.”

It is also important to read pressure gauges to see if the pump is cavitating or if the pressure has dropped outside of normal operation.

Food and Beverage Processing Challenges

In brewing, there are not many contamination points thanks to a facility that operates on a closed loop system. “With bakeries, you have to do a lot more heavy cleaning on the contact areas to make sure you control bacterial growth or anything that could affect the end user,” said Farmer. “Here in the brewery, everything from grain transfer to enclosed tubing all the way through the mill, everything is fully enclosed in sealed vessels. When everything is transferred, we run a clean-in-place (CIP) loop.”

The team, on a daily basis, opens the vessels and swabs the ports for quality assurance to ensure there is no bacterial growth or contamination. This is performed on the canning and keg lines as well. “We will run a CIP loop on every changeover depending on grains. We do not have to worry about too many allergens, but we do have to worry about some. We also monitor temperatures with alarms for caustic levels and flow rates.”
Learning From Experience

In addition to learning from his father, a corporate engineer for Papa John’s in Louisville, Farmer said he feels lucky to have begun his career at a time when there were still a lot of experienced skilled laborers in the workforce.

“The biggest thing my Dad taught me is that you can never ask anyone to do something you would not do yourself,” Farmer said. “Coming up as a maintenance technician, getting an engineering degree, then becoming a team leader, I can understand the other guy’s point of view. It’s important to me to be sure they have the tools they need to do their job. I want to give these guys a work environment that makes them excited about coming to work. I want to give them the tools they need so that a 30-minute job does not become a 2-hour job.”

Even with his father’s influence, Farmer was able to discover his own path and the lessons learned along the way have stuck with him. “My father always said you should be fair and consistent and consistently fair across the board in everything you do. I’ve lived by that every day of my life.”

Finding good quality technicians can be challenging, Farmer said. “A lot of people are brought into facilities to be maintenance technicians, but they do not receive the proper training. I’m a big advocate for pushing people to have an education. Every company should make an investment in the people they hire.”

At Rhinegeist, Farmer continues to work on major improvements. “We are working on safety standards, proper operating procedures, etc. We build large binders for new hires with training SOPs. It includes the top ten failures on each piece of equipment. New technicians can learn how to change a piece of equipment with pictures and graphics that easily explain procedures. When you have a new hire you can just hand him the book and then be available for questions. This gives them the opportunity to become independent very quickly.”
Q: Relative to mechanical seal, what is unique about slurry applications?
A: A “slurry application” is a relatively general term and can incorporate a wide range of processes in a variety of industries. Slurry applications in general, however, imply a process fluid with a relatively high concentration of solids. In the chemical industry, this may be a solvent with a high concentration of polymers or plastics. In a mining application, the solids may be ore or various solids from the processing stream. In the power industry, this might be solids from an FGD (flue gas desulphurization) unit. In general, any process stream where the solids significantly impact the fluids properties might be considered a slurry. In many industries, fluids with a greater than 1% by weight concentration of solids is considered a slurry.

Q: How can a slurry impact the performance of a mechanical seal?
A: Again, the nature of the impact depends a great deal on the specifics of the applications. In general, however, there are several areas to consider.

The nature of the process fluid – The mechanical seal will operate on a thin fluid film between the seal faces. The properties of the solvent, or carrier, in the slurry must be understood and the seal must be designed accordingly. Carriers can be as varied as high temperature water, low viscosity solvents, or cool oil; all of the carriers may have different considerations.

The nature of the solids – The solids in the slurry will also affect seal performance. Hard solids can cause erosion or damage to the seal faces. Soft solids (e.g. plastics) may smear between the faces. Larger size solids can cause aggressive erosion of rotating components and small particles may migrate into the film between the faces.

Concentration of solids – The concentration of solids will be one of the most critical considerations in making sealing decisions. High concentrations can obviously cause more aggressive erosion. It can also cause an accumulation, or packing, of solids around and within the mechanical seal.

Q: What are some common failure modes for mechanical seals in slurry services?
A: Hang-up – One common failure mode is hang-up which is caused by solids. The mechanical seal faces must be free to flex axially to compensate for seal wear and equipment motion. Hang-up occurs when the solids from the slurry migrate and collect in the region of the springs and dynamic gasket. This can prevent the flexible sealing element from moving axially and ultimately result in a seal failure.
Solidification – Solidification occurs when the solids build up in the seal chamber and contact the rotating parts. This can occur during operation or when the pump is stopped and solids settle in the seal chamber. Solidification can cause hang-up or may prevent fluids from reaching the seal faces.

Erosion – Erosion is also a major factor limiting seal life. Seal OEMs attempt to limit erosion through material selection and design features. Many slurry applications (e.g. mineral and ore processing) however, are so aggressive that erosion of pump parts will limit the service life of the equipment.

Gas Entrainment – Another failure mode, somewhat unique to slurry applications, is gas entrainment. This is often caused by sparging in the suction vessel. Some applications inject gases near the pump suction line to improve mixing of the slurry. These gases can be pulled into the suction line, collect around the seals and cause a seal failure due to poor lubrication.

Q: What is unique about the design of a slurry seal?
A: Compared to a typical mechanical seal, slurry seals are better equipped to handle the issues associated with solids. A typical slurry seal often isolates critical secondary seals (o-rings) and springs from the process to prevent, or eliminate, hang-up issues. Some slurry seal designs may eliminate the dynamic gasket by using an elastomer encapsulated cone spring or using an elastomeric spring element as both the spring and dynamic gasket.

Slurry seals are also often designed to minimize the area of exposed rotating surfaces. These surfaces are generally smooth and free of disruptions, holes, slots, or other features which can cause turbulence and encourage erosion.

In some larger slurry pumps, the shaft must be periodically adjusted to compensate for wear on the pump components. The slurry seals must either have the ability to allow for the shaft motion or to allow the seal to be reset to its correct location after the shaft adjustment.

Q: Are seal chambers in slurry pumps different than in typical centrifugal pumps?
A: Most industrial centrifugal pumps have a cylindrical bore seal chamber with a bushing or restriction at the back of the seal chamber. In a slurry application, this style of seal chamber would allow solids to collect around the seal and prevent them from migrating back into the pump. This would make it difficult to fully vent or drain the seal chamber and would create excessive erosion around the seals.

Slurry pumps are often designed with a tapered bore opening up into the pump casing. This design minimizes areas for solids to collect around the seal. It can also reduce velocities around the seal to minimize erosion. The specific design of the tapered bore has been developed over many years and may differ slightly between different pump OEMs or seal models.

Q: Is material selection for slurry seals different than other applications?
A: Slurry seals have many of the same material considerations as typical seal applications, with a few slurry specific considerations. All of the materials must be rated for the temperatures of the application. All materials must be chemically compatible with the process fluid and any other chemicals in the application.

The selection process for metallic materials in slurries must also consider the erosive nature of the process. Alloys such as 316 SS are often upgraded to duplex stainless or high-chrome irons if a higher hardness is required. If corrosive environments such as chlorides or extreme pH’s are encountered, alloys such a duplex stainless or nickel-moly-chromium alloys may be required.

Most slurry applications will be damaging to softer mechanical seals faces (e.g. carbon). For this reason, slurry seals will almost exclusively use a hard-vs-hard face combination. Silicon carbide vs silicon carbide is a common combination, but other materials have been used.
Q: Can typical piping plans be used in slurry services?

A: In practice, only a few piping plans are used in slurry applications in the field. In most cases, this is due to the high concentration of solids. Solids will tend to plug small lines preventing fluid circulation. High fluid velocities in these lines will also cause erosion on flow control elements (e.g. orifice) or can erode through the piping/tubing itself. The following piping plans have been used successfully depending upon the application conditions.

**Plan 03** – This piping plan describes the mechanical seal installed in a tapered bore seal chamber. The fluid circulation through the seal chamber provides cooling for the seal faces and prevents a build-up of solids around the seal. This is the most commonly used configuration for slurry seals.

**Plan 31** – The Plan 31 utilizes a cyclone separator to remove solids from the process fluid and inject the clean stream of fluid into the seal chamber. This can provide cooling for the seal and improve the environment in the seal chamber. While this piping plan seems to address many of the challenges associated with slurry sealing, it is only useful in a limited number of applications and with fluids with a very low concentration of solids.

**Plan 32** – Plan 32 incorporates the injection of clean external fluid into the seal chamber. This clean fluid can help either isolate the seals from the process fluid or dilute the concentration of solids to a point where seal performance will improve. In many cases, an external source of injection fluid is not available at the pump location. In almost all cases, the addition of an external fluid creates additional costs associated with removing the fluid later in the process. For these reasons, a Plan 32 is used in only a limited number of slurry applications.

**Plan 62** – Plan 62 describes an external flush to the atmospheric side of the seal. In many slurry applications, the seal leakage will contain a small concentration of very small particles from the process. If the carrier evaporates, the solids can build-up on the atmospheric side of the seal and eventual degrade seal performance. A small flush of water in this area can minimize the build-up solids.

**Conclusion**

There is a huge base of installed slurry applications around the world. The nature of these applications has led to a wide range of sealing solutions which have proven to be reliable. The nature of these solutions, however, may be very specific to each application. For questions about specific slurry challenges, the end user should contact their seal OEM for a specific engineering review.

**Figure 3: Example of slurry seal with elastomeric bellows element.**
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API 610 Pumps for Boiler Feed Water Service: Options and Design Features

Specifying the correct features and options on API 610 centrifugal pumps going into boiler feed systems is the first step in optimal reliability. Boiler Feed Water applications are one of the most difficult process fluids that centrifugal pumps can encounter. There are a number of primary areas to focus on, when considering boiler feed water pumps, in order to achieve a state of optimal reliability.

By Brian Verdehem, Director Engineered Pumps DistributionNow (Power Service/Odessa Pumps)

Most boiler feed water pumps (BFW) around the world have a centrifugal pump design. This pump design uses multiple stages of impellers to create the pressure needed to move process water through a boiler loop. Customers often use an API 610 BB3 pump design for this service, as it is common for boilers with a 1,000 HP to 2,500 HP power range and a temperature range from 200°F-400°F. Other centrifugal multistage pump designs can be used for this service range, but for this article we will concentrate on the API 610 BB3 design, which is an axial split case multistage centrifugal pump.

**Pump Construction Material**

Boiler Feed Water is often deionized which can make the water corrosive, especially at higher temperatures. Avoiding the use of high carbon-based steel or iron in the pump’s construction, especially in the pressure containing components, is generally advised. The use of 300 series stainless steel may not be necessary and can result in unnecessary costs to the pump, as it would increase material costs; this becomes evident when considering the amount of material that is involved in a BB3 pump design. Thermal expansion properties of 300 series stainless steels can also cause problems with the pump assembly at higher temperatures that are commonplace in BFW services.

API 610 Material Code C-6 is therefore a common material option for API 610 Annex H. C-6 material is a 12% Chrome material (ASTM A487 Gr. CA6NM for
the Pump Pressure Casing) which has a high corrosion resistance to most boiler feed water qualities. The material has an attractive cost vs benefit ratio for most BFW systems and its thermal properties are ideal for higher temperature applications. As the pump is continually subjected to process water, it is best to conduct a water sample analysis on the water that is to be used in the boiler to ensure that the most appropriate construction material for a pump is selected.

**Mechanical Seal Design & Flush System**

Single cartridge mechanical seal designs are commonly used for BFW services in lieu of double tandem seal designs. Single seal designs have proven to be reliable if they are configured properly for the application. As water is an extremely poor lubricant for the mechanical seal faces, especially if the water has an elevated temperature. Mechanical seals generate frictional heat when in operation. Special attention should be given to the mechanical seal face materials and the cooling flush system that is used to cool the seal.

For most BFW fluids, a carbon face material can be used on the seal rotating face in conjunction with a Silicon carbide face material on the stationary. If there is a high content of solids or slag in the BFW system it can cause failure to the carbon seal face. It is therefore essential to manage the boiler feed water quality and limit the amount of solids entrained within the water loop.

It is important that a mechanical seal is used with an efficient seal flush system. The flush system should remove heat from the seal chamber environment, which arises due to the mechanical seal face friction; the cooler the water is around the seal faces, the more heat can be removed from the seal face friction dynamics. Without efficient heat removal from the seal environment, the seal will overheat, fail and cause the process water to leak to the outside environment. A cool running seal, is a happy seal. To attain this, the incorporation of a bypass flush with a heat exchanger is recommended. Two flush systems come to mind: the API/CPI Plan 21 Flush and a Plan 23 Flush both provide efficient heat removal for the water bypass seal flush.

The Plan 21 is configured to bypass a small amount of the boiler feed water in the pump from a high pressure point on the casing and bypass it through a heat exchanger where heat is removed. The sub cooled water then goes into the seal chamber where it can efficiently remove heat from the seal faces. The water then recirculates back into the pump fluid process. There is, however, a dark side to the Plan 21. If the water quality has even a slight solids content, the coil within the heat exchanger can become foaled quickly and the bypass flow is reduced. This occurrence results in a loss of cooling and causes premature seal failure. The limited retention time of the water in heat exchanger on the Plan 21 can also affect the temperature differential throughout the exchanger. The flush flow rate can be very difficult to control, which can result in a less than desired temperature delta across the exchanger.

It is recommended that the Plan 23 be considered over the Plan 21. The Plan 23 flush system does not take bypass from the high-pressure side of the pump. The Plan 23 functions by partially isolating the water within the seal chamber environment from the rest of the process water via a throat bushing in the seal chamber bore. Recirculation of the water is accomplished by using a seal with a pumping ring feature, which provides just enough kinetic energy to the flush to circulate the water through the heat exchanger and back to the seal. This allows the isolated water within the seal chamber to constantly circulate, providing a much greater cooling effect on the mechanical seal faces. A throat bushing in the seal does an efficient job of keeping process solids from migrating into the seal chamber. Plan 23 flush system has proven to be a very reliable flush plan in these BFW applications with the subject temperature range.

Subjecting all of your fluid properties and pump hydraulic variables to a mechanical seal subject matter expert, to get a recommendation on the seal design and flush system, is highly advised.
Wear Ring Considerations

Wear rings are an essential component of the subject pump’s design and application. Typically, the pump impeller will have wear ring surfaces that are either renewable or integral; the casing will have stationary wear rings that mate with each impeller rotating wear ring. The radial running clearance between the two rings affects the internal recirculation of the process water in the pump. The amount of fluid that recirculates across the ring clearance has a direct effect on the pump’s efficiency.

In a construction using C-6 material there will typically be 400 series stainless steel wear rings in the pump. The pump manufacturer will harden the 400 series rings so that there is at least a 50 Brinell hardness differential between the impeller and casing wear rings which helps prevent galling between the two rings during operation. Running clearance on these rings can be quite high at an elevated temperature. API 610 recommends running clearances greater than the pump OEM manufacturer’s clearances, especially as process temperature increases. High running clearances can provide improved reliability over time. As dry running a pump with metallic rings installed can cause catastrophic failure to the pump in less than one minute, special measures should be taken to prevent dry running the pump when metallic wear rings are installed.

Today there are a number of options on wear ring materials for customers to choose from in lieu of the traditional metal-to-metal ring combinations. Over the past two decades there have been many composite thermoplastic wear ring materials that have been introduced to the market. These composite materials are typically used on the stationary casing wear ring component. The composite material is installed inside of the metal ring as shown here. Composite material is also recommended for the stationary center bushing component on the API 610 BB3 design. Most composite rings can operate up to 500°F, allowing it to operate in most Boiler Feed Water applications.

With a composite wear ring on the stationary ring, running clearances can be taken to much tighter values, when compared to a metal-to-metal ring clearance. For example, the API 610 requires a .020” diametrical running clearance on a ring that is 8.000 inches to < 9.000 inches in diameter. Composite wear rings can accommodate a .011” diametrical running clearance on that same ring dimension. This ultimately improves the efficiency of the pump. In addition to its ability to run a tighter clearance, the composite ring also has a low coefficient of friction. This low coefficient prevents excessive heat buildup during an upset or temporary dry run condition. There are many case studies in the industry which show customers who have prevented a catastrophic and costly pump failure by having composite stationary wear rings installed on their pumps.

Composite rings come at a price. They can often add $15,000-$25,000 to the cost of a large API 610 BB3 pump. I will add that not all composite wear rings materials are created equal. Some will have different radial thermal expansion properties than others. It is encouraged that a pump subject matter expert conduct research before one decides on the type of composite ring material to use. Finally, caution is strongly recommended if using composite wear rings material in fluids with high solids content. If there is heavy scale or high solids in the boiler feed water, it is best to stay away from the composite ring materials. The thermoplastic base material can wear quickly in a high solids environment.

Benefits of Composite Wear Rings

- Composite wear ring materials are engineered to reduce or eliminate the risk of ring seizure
- Composite wear rings can improve pump efficiency by 1% or more providing energy cost savings
- Composite wear rings can survive temporary dry run pumping conditions

Bearing Design and Cooling

The API 610 BB3 pump design comes in many different bearing configurations. The thrust bearing is located on the non-drive-end of the pump, and it constrains the hydraulic axial thrust load generated within the pump, during operation. Depending on the amount of thrust being generated, and the horsepower of the machine,
the pump manufacturer will be able to determine if a ball (roller) bearing, or more complex tilted pad bearing design, is required. The drive end radial bearing can come in ball (roller) bearing or sleeve bearing design. The customer can often request what configuration he/she prefers on the drive end (motor end) of the pump shaft. The sleeve bearing on the radial drive end side of the pump is more typical on the subject pump design.

I often have customers asking what I recommend for the best oil grade on ring oil applications. Ring oil lubrication method is when the bearing housing has an oil sump and a forced lubrication system is not in place. For pumps with an oil sump and ring oil configuration, pump manufacturers will often recommend an ISO Grade 100 oil for process applications that exceed 180°F. One should review his/her pump manufacturer’s operation manual for recommended oil grades for the pump.

I also get asked at what process water temperature to install an immersed cooling fin in the oil sump to pull heat out of the oil sump on ring ball (roller) bearing configurations. Avoiding the use of any cooling coils to cool the lubrication oil on a boiler feed pump is generally what I recommend. I have seen plenty of cases where the cooling water is circulating through the coil when the pump is turned off. This causes the oil and bearing housing to cool below the dew point of the ambient air. This in turn results in water condensation forming on the interior of the bearing housing. If the condensed water gets into the oil, it compromises the oil quality, resulting in bearing failure. Water contamination is the Achilles heel of oil quality. The use of a synthetic oil, in lieu of a cooling coil, is often recommend. With the right synthetic oil selection, a system will operate with process fluid temperatures up to 700°F without cooling the bearing lubrication. I recommend an external forced oil lubrication system, or an oil mist system as the primary lubrication method on this type of pump BFW application. It is important that pump OEM recommendations are followed closely to ensure that the best lubrication path is provided for the machine components based on the system variables.

Selecting proper design options on boiler feed pumps is essential for long term optimal reliability. An API 610 BB3 on boiler feed water service can easily get five or more years of mean time between repair (MTBR), if properly configured, installed and operated within its design parameters and manufacturer’s recommendations. Working with a pump and service provider who understands the challenges involved with boiler feed water service can also be highly beneficial.
United States – Pennsylvania: Pump, Rotary
Description: Pump, Rotary
Contact point: vincent.ambrosini@dla.mil
Time limit for receipt of tenders or requests to participate: February 25, 2019
Language in which tenders or requests to participate may be drawn up: English

Syria – Baniyas: Providing Spare Parts for Pumps
Description: Providing Spare Parts for Pumps
Contact point: 963-43-711100 / 711101 / 711102, brc3@tarassul.sy
Time limit for receipt of tenders or requests to participate: March 10, 2019
Language in which tenders or requests to participate may be drawn up: English, Arabic

India – Jharkhand: For Spares for Centrifugal KSB Pump
Description: For Spares for Centrifugal KSB Pump
Contact point: 91-0657-2730122, jadpur@uraniumnrc.gov.in
Time limit for receipt of tenders or requests to participate: February 18, 2019
Language in which tenders or requests to participate may be drawn up: English, Hindi

South Africa – Johannesburg: Refurbishment and Supply of Spare Rotating Elements for Pump Set
Description: Refurbishment and Supply of Spare Rotating Elements for Pump Set
Contact point: bineke.randwater.co.za
Time limit for receipt of tenders or requests to participate: March 5, 2019
Language in which tenders or requests to participate may be drawn up: English

United States – Pennsylvania: Housing, Liquid Pump, In Repair/Modification Of
Description: Housing, Liquid Pump, In Repair/Modification Of
Contact point: david.torres2@navy.mil
Time limit for receipt of tenders or requests to participate: March 4, 2019
Language in which tenders or requests to participate may be drawn up: English

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To submit a project or tender, please contact Angelica Pajkovic (a.pajkovic@kci-world.com).
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Jersey’s Shining Sludge Plant Sets Standards

By Christopher French, Freelance Journalist

For those with an interest in exemplary engineering standards of management, research, design, efficiency, easy maintenance and high performance, Jersey’s new sewage treatment works (STW) is an impressive facility.

When the time came to replace the island’s STW sludge plant, built in 1959, to meet future environmental standards and a population already in excess of 105,000, customers and main process engineering contractors found that their respective drivers to meet a 2035 design horizon had plenty in common.

From the outset, Jersey’s Department for Infrastructure, together with Doosan Enpure Ltd., knew that due to the logistical challenges faced by the island, the aforementioned criteria of efficiency, ease of maintenance and high performance was crucial, particularly for the plant’s pumps and mixing systems. As fog or high winds can stop goods from reaching Jersey, Bellozanne STW had to be self-sufficient and have back-up.

“The new plant gave us the perfect opportunity to engineer out old unwanted problems”, said Bob King, Senior Engineer (Waste Strategy - Mech & Process) at the States of Jersey’s Department for Infrastructure.

“For example, we used to have ongoing issues with very costly maintenance for compressors, which went down if there was even a small amount of foam in our old gas mixing system. We also suffered from ragging and problems with pipework and fittings that simply were not of a design.”

Weighing up Bellozanne’s drive towards a highly robust plant, where downtime would be a thing of the past, Doosan Enpure was also busy sourcing kits that would meet key requirements, especially for low maintenance. Michelle Macleod, Principal Mechanical Engineer explained:

“We agreed straight away that for the three new anaerobic digesters, all pipework and moving parts should be on the outside of the tank”, she said.

“Externally-mounted equipment would improve health and safety by eliminating the need for working at height, and in confined space entries.”

Together with Gary Davies, Principal Engineer at Bellozanne STW, Bob King carried out several field trips to research suitable mixers, seeking equipment that would also mix the whole tank away from systems that provide little or no rotation.

“Eventually we visited Landia in Denmark,” continued Bob. “In addition to seeing the GasMix digester mixing system, we were impressed by the set-up and the people. This gave us confidence in the type of service and back-up that we were going to get. We did not want any breaks that would interfere with our gas production and getting the lowest possible price was not our objective, not for one second. We were making decisions based on what was most appropriate for the long-term. A mixing system that could produce the most gas yet be the lowest on maintenance made perfect sense.”

Utilising its proven chopper pump to break down particle size, Landia’s GasMix includes multiple venturi nozzles. When the chopper pump is running, thick liquid from the bottom of the tank is drawn into the pump where all solids are chopped. This accelerates the digestion process and prevents clogging of pipes and nozzles.
In the first stage of the mixing process, the liquid is injected into the upper half of the tank while biogas is aspirated from the top of the tank and mixed into the liquid.

In the second stage of the mixing process, the liquid is injected into the lower half of the tank, causing powerful mixing of the tank’s contents. The physical processes of the this system causes considerable force to be applied to the substrates. It also increases gas production because there is a larger surface area for the attachment of microorganisms or the hydrolytic enzymes that they produce, thus allowing a faster and / or more complete hydrolysis of particulate matter.

At the old Bellozanne plant, lime that caused a distinctive rotten fish odour was used to enhance the treatment of sludge at a cost of £80,000pa. Now the Doosan Enpure’s established pasteurisation technology that holds the sludge at 55 degrees C for a minimum of 4 hours, prior to passing to the anaerobic digesters.

“"In addition to the pasteurizers,” stated Gary Davies, “the investment in our CHP resulted in minimal flaring of gas. It all goes to the CHP which allows us to use the excess heat to heat the sludge. The whole focus of our operation has changed, because we continually look at gas production and see how, if possible, we can tweak it to make it better. We often check to see if we can thicken more, thicken less and whether we can change feed rates, to look at what is coming in and what is being washed away. The pasteurizers make a positive difference in presenting the digesters with much better material; we now have far less grit/silt and rag to deal with.”

One area that did require more work than mere fine-tuning was the new plant’s heat exchangers. As the heaters were continuously furring up, they required cleaning every week, which went against Bellozanne’s quest for low maintenance.

“"Initially we blamed the exchangers, as perhaps most operators do” said Bob. “We tried linking them in series, in parallel, but eventually we found the remedy by introducing an air-line. Our heat exchangers now have no trouble reaching their required temperatures and require very little in the way of cleaning. The downside to this remedy is the additional wear to the pasteurizer mixing pumps, caused by aerated sludge. This issue was addressed by upgrading to hardened impellers to improve service life.

Bellozanne and Doosan Enpure also chose Landia pumps for the three separate tanks that each hold a different sludge: digested sludge, thickened sludge (fed to the digesters via pasteurizers) and unthickened sludge that comes off the final clarifiers which is then thickened and added to the thickened tank to maximise overall residence time. As with the chopper pumps on the GasMix systems, none of the pumps selected have required any spare parts since their installation three years ago. The digesters will never have to be emptied in order to inspect or service the
mixing equipment, so there is no prolonged downtime. In addition to this major Health & Safety advantage, there are also economic advantages in that servicing of the GasMix system can be completed while the biogas production continues uninterrupted.

Powerful mixing performance is ensured in all areas of the tank by one or more top gas/sludge ejector type nozzles and the bottom mixing nozzle. This provides a more efficient anaerobic process and thus a quicker gas production. The combination of biogas and liquid recirculation for the mixing process also improves the actual quality of the biogas, which in turn can be used to increase power production.

Dave Garnett, Technical Specialist (Wastewater) at Doosan Enpure says that Bellozanne is achieving high Volatile Solids (VS) destruction at an average of approximately 60%.

“While the new pasteuriser technology is beneficial to the system, the chopper pump’s mixing ability and the high temperature feed to the digesters are the critical components which ensure that everything is distributed properly. We know the GasMix is working very well because we are seeing plenty of energy produced by the CHP, which is making a big reduction in OPEX. It is interesting that many digesters in the industry run on 2 to 2.5% solids, when with a simple retrofit to a superior mixing system, they could increase to 4% and see an immediate pay off.”

Further evidence of the plant’s enviable performance comes in the shape of the sludge cake. Without lime, there was initially some concern about how consistent it would be, but according to Bob King, the plant now produces a far better product.

“Overall, we now have a far more complex and efficient plant; our investment in quality equipment is saving us money,” stated Gary Davies. “Not everybody understands the drivers when on an island. There is no point supposedly saving £1M on CAPEX if it’s then going to cost you an extra £3M in maintenance. This plant’s performance proves that we are winning the argument.”

About the Author

Christopher French is a freelance journalist who specializes in wastewater/biogas.
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