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PUMP engineer

COVER STORY:

TYCON ALLOY:

Specific Market Positioning Boosts Long Term Development

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Special Topic: Water & Wastewater

In this issue of Pump Engineer magazine:

Volume 19, August 2019

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COVER STORY

Tycon Alloy:

Specific Market Positioning Boosts Long Term Development

Tycon Alloy Industries Co., Ltd. has positioned itself on the front line of the industrial field by exploring new spheres and developing new products. Instead of simply selling pump and valve products, Tycon is keen to provide value-adding services for its customers. By strategically setting up its new plant in Zhongshan, the company has updated its values to insure "safety, personnel care, process rebuilding, continuous improvement and energy saving." Tycon's goal is to better serve its staff, its clients, and the industry.

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END USER INTERVIEWS

Jim Darby has been in the process industry for a little over four decades. He began his career as a Junior Process Engineer and has progressed over the years to achieve a Senior Process Engineer position. After gaining experience in a multitude of different companies, Darby began working with Paton Engineers and Constructors in Sarnia, Ontario, and has held his position there for the last two and a half years.

When it comes to working with customers to solve lubrication and engineering problems, Adam McMurtrey relies on a lifetime of experience that goes all the way back to his childhood. For ExxonMobil's Mobil Serv program, he works closely with industries ranging from lead mines to chicken rendering plants—always with energy efficient lubrication at the forefront of every solution.

TECHNICAL ARTICLE

After 30 years of research, an engineering team in Japan has developed a hybrid-type submersible bearing that prevents burnouts during vertical pump dry-starts, exploits the elasticity of the synthetic rubber to level the pressure during typical operation, and ensures stable bearing behavior by conferring vibration control while supporting the rotating shafts. The hybrid bearing can be used for dry-start operation of vertical pumps without applying lubricating water from the outside prior to pump operation.

SPECIAL TOPIC

Wastewater treatment is not something most of the population of the United States thinks about on a daily basis. It is conducted, mostly unseen by municipalities, and goes largely unappreciated by many. However, it is a key part of everyday survival that allows humans to stay hydrated, bathe, clean dishes, launder clothing, and perform a variety of tasks that keep them alive and healthy.

MARKET REPORT

Although accounting for only a fraction of the total industrial pumps sales, desalination is a growing market for pumps and an area of significant opportunity, particularly for manufacturers of corrosion-resistant flow control equipment. Driven primarily by regional water scarcity and growing populations, the market is concentrated in the Middle East, but desalination is a truly global industry, supplying water for both residential and industrial use in more than 160 countries.

CASE STUDY

A pump working as a turbine was comparatively investigated to determine the cause of the pressure head losses in four separate cases. This study will focus on the results of measurements carried-out based on a particular order. The scope of the measurements, and their presented evaluations, are meant to be informative usable results for practice.

ALSO IN THIS ISSUE...

Dear readers,

I am pleased to present you with this month's issue of Pump Engineer magazine. In this latest edition we explore the vital role pumps play from the manufacturer, distributor and end user perspective. Our focus on the water & wastewater, which is this month's special topic, provides us with the opportunity to take a closer look at the vast array of pumps that use rollers, gears and impellers to displace fluid and sludge through a system.

Our cover story on Tycon Alloy explores how the company is keen to provide value-added services for its customers. By strategically setting up its new plant in Zhongshan, the company has updated its values to ensure safety, personnel care, process rebuilding, continuous improvement and energy saving. We explore the vital role Tycon Alloy has played as a leading supplier of stainless steel and duplex steel castings for the pump and valve industry, in the full article on page 8.

Throughout this edition, end users Jim Darby – a Senior Process Engineer, and Adam McMurtrey, Industrial Sales Engineer, provide their insights into their experience with pump processes and instrumentation as well as their advice for new end users entering the industry, on pages 16 and 36. This issue also features a number of technical articles ranging in topics from how Hybrid Bearings Enhance Performance of Dry-Start Vertical Pumps to an overview of Pressure Head Losses and Resistance Coefficients in Single Stage Volute Casing Pumps.

With such a dynamic compilation of pump focused material, I am confident that there is something for everyone in this issue of Pump Engineer. I encourage you to send me your technical articles, case studies and press releases and I look forward to continuing to meet new industry professionals in the coming months. 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 connect the pump community and reap the benefits of being a progressively innovative industry.

Yours sincerely,

Angelica Pajkovic
Editor, Pump Engineer
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EVENTS CALENDAR

August 28th – 29th, 2019
Valve World Expo & Conference Asia 2019
Shanghai World Expo Exhibition & Convention Center, Shanghai, China
http://www.valve-world.net/vwa2019/valve-world-asia-2019.html

September 9th – 12th, 2019
Turbomachinery & Pump Symposia 2019
George R. Brown Convention Center
Houston, TX, USA
https://tps.tamu.edu/

September 20th – 22nd, 2019
TechIndia 2019
Bombay Exhibition Center, Mumbai, India
http://techindiaexpo.com/Home

September 21st – 25th, 2019
WEFTEC 2019
McCormick Place, Chicago, Illinois, USA
https://weftec.org/about/about-weftec/

September 24th – 25th, 2019
International Rotating Equipment Conference
RheinMain CongressCenter, Wiesbaden, Germany
https://www.introequipcon.com/index.html

October 22nd – 24th, 2019
Chem Show
Javits Convention Center, New York, NYC, USA
https://chemshow.com

November 20th – 21st, 2019
Water and Wastewater Pumping Conference
Mott MacDonald's offices , Cambridge, UK
https://www.eventsforce.net/bhr/frontend/reg/thome.csp?pageID=45734

December 3rd – 5th, 2019
NGWA Groundwater Week 2019
Las Vegas Convention Center, Las Vegas, NV, USA
https://groundwaterweek.com/

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

Product Developments

Xylem has unveiled the Flygt N3069 stainless steel submersible pump. This pump is designed to solve the toughest pumping challenges in complex industrial applications, such as industrial food and aquaculture. Xylem is leveraging advanced techniques to respond to industrial customers' diverse pumping needs with highly customized solutions. 3D-printing techniques will dramatically reduce the lead time for customized pump orders by up to 75%. The Flygt N3069 is specifically manufactured for industrial processes containing high chloride or extreme pH levels, delivering superior corrosion resistance and exceptional pumping performance. Its Adaptive N-technology delivers higher pumping efficiency, reducing energy consumption and greenhouse gas emissions by up to 25%. The technology's pioneering hydraulic design not only prevents pumping downtime but enables more sustainable, energy efficient operations.

Wilden® is pleased to announce the release of its new bolted plastic Equalizer® Surge Dampeners – Integrated SD Series. The new ISD Series dampeners have been specifically engineered to help extend the life and reduce the noise of Wilden 13 mm (1/2") and 25 mm (1") Pro-Flo Series bolted plastic air-operated double-diaphragm (AODD) pumps. Wilden ISD Series dampeners utilize an integrated design that allows them to be directly incorporated in the Pro-Flo Series bolted plastic manifold design. These dampeners are available in 13 mm (1/2") and 25 mm (1") sizes in Polyethylene construction, with PTFE and EPDM diaphragm material options. They feature temperature ranges from -51°C to 138°C (-60°F to 280°F) for EPDM and 10°C to 137°C (14°F to 280°F) for PTFE. With a maximum working pressure of 100 psi, they are ideal for use across a variety of markets, including paints and coatings, chemical, hygienic, and general industrial applications.

Circor has launched the Allweiler SNA (TM) series of customizable three-screw lube oil pumps for diverse API 676/682 applications. The new series allows for customized setups in 12 different ways, a choice of foot or flange mounting schemes and inlet and outlet positions can be adjusted quickly. The Allweiler SNA adapts to each design, setting a new standard for API 676/682 applications. The use of screw connections with two different flanges for the inlet and one for the outlet, rather than welded connections and intuitive pump feet, allows the Allweiler SNA to be a plug-and-play solution for connecting to lube oil applications. The most common applications for Allweiler SNA series include compressors, turbines and large-scale pumps, refineries (gas compressors, gear boxes) and power plants (oil cooling, emergency and bearing pumps). The Allweiler SNA pump is available in a bare shaft version but also as an aggregate solution with baseplate, coupling, lantern and motor.

Dulcoflex Control has extended the ProMinent portfolio with a new intelligent peristaltic metering pump. The new pump meters reliably from 10 ml/h up to 30 l/h at up to 7 bar. A brushless three-phase motor forms the heart of the Dulcoflex Control. The new peristaltic pump is also IoT-enabled, and it is fully connectible and can be linked to ProMinent's in-house developed DulconneX platform. The control system provides precise metering and reduced pump capacity with continuous metering up to 10 ml/h. Linear and reproducible metering is guaranteed under all process conditions. The thermoplastic elastomer high-performance hose used, guarantees exceptional chemical resistance and a long service life. The intuitive user interface with clickwheel ensures the simple operation of the peristaltic pump.

SCHROEDAHL has announced that the new, self-modulating TDL Automatic Recirculation Valves (ARVs) are now available in more than 35% lighter cast material. These reliable all-in-one pump protection solutions are designed to keep pumping systems in process, firefighting, refinery, power and chemical applications modulating and running smoothly. SCHROEDAHL TDL Automatic Recirculation Valves combine a high-quality main line check valve and the automatic bypass control system in an innovative and durable design. The valves' self-actuated integrated bypass control function ensures minimum flow rate, guarding pumps against overheating and cavitation. The bypass check valve also prevents reverse pump flow and allows for parallel pump installations. With extremely low valve hysteresis, TDL ARVs promote increased and reliable pump performance. Available in EN/DIN and ASTM materials, TDL ARVs also feature a compact cast housing design for lightweight installation.

Maag Industrial has released its new F-Series gear pump, which includes the DX Dosix with improved dosing accuracy and the FX Flexinox; a more flexible alternative to the existing CX and TX. The new series has a modular design, which facilitates flexible configuration and adapts better to the needs of customers and processes. The modular design also simplifies cleaning and maintenance work. The company tested several types of gear shafts in steels and plastics, PEEK and other materials to see their different advantages and flexibility. Maag had the chance to use the new Z16 with sixteen teeth for the FX and the Z14 with fourteen teeth for the DX. The key components of the new series – the gear shaft, bearing and seal – have remained the same, which allows customers to use the new F Series with existing spare parts.

Global Highlights

NEW FACILITY

Ebara Completes New Innovation Centre in Japan

Ebara Corp has built a JPY ¥1 billion (USD $9,400,000.00) Components Development and Innovation Centre in Fujisawa, Japan for dry vacuum pumps and gas abatement systems. The new lab will play an integral role in the advanced development and testing of next generation dry vacuum pumps and gas abatement systems. The 2245 m^2, two-storey facility is scheduled to start full operation in October 2019.

The new facility provides custom configuration for integrated testing and operation of both dry vacuum pumps and gas abatement systems in one location. The test data measurement system uses Internet of Things (IoT) technology. The facility also has a meeting space where employees and customers can collaborate on new ideas and technologies.

ACQUISITION

Gardner Denver Holdings Acquires Oina

Gardner Denver Holdings has acquired Oina VV AB, for approximately USD $10 million. Based in Stockholm, Sweden, Oina specializes in customized pump solutions for liquid handling processes for use in medical, process and industrial applications. Oina will be part of Gardner Denver's Medical Segment.

Oina has a strong history of delivering innovative products and building excellent customer relationships. The CEO of Oina, Anders Lovas, stated, "Oina will be able to leverage an expanded commercial and operational footprint as we continue to innovate and deliver high quality products and service to our customers." Acquisition of Oina will provide further access to the peristaltic pumps market and enhanced R&D capabilities and leverage Gardner Denver's distribution network, commercial, and operational capabilities.

NEW CONTRACT

New Pump Stations Secure Water for Murrurundi

Leed Engineering and Construction will soon begin the construction of multiple new pump stations and a 40km pipeline, enabling 2ml of water a day to be moved from Scone to Murrurundi in NSW. The construction is expected to start in August 2019 and due to be completed in mid 2020. A new, larger reservoir for Murrurundi is also anticipated to be built soon after.

The company estimates up to 600m of pipeline a day can be laid in open paddock. Two teams, each with equipment including a 30-ton excavator, will install the pipeline simultaneously starting in Scone and Wingen, and working towards Murrurundi. The pipeline design allows for drinking water reticulation and reservoirs for the villages of Blandford, Parkville and Wingen to be constructed in the future, with the local council pursuing the connection of these villages as a high priority.

PROJECT

CRI Pumps Invests in Mexican Facilities

Fluid management solutions provider, CRI Pumps, has invested USD $5 million (EU €4.46 million) into facilities in the US and Mexico. According to CRI Group's vice chairman, G. Soundararajan, the company has been developing products for these markets for over a decade. It has a focus on the US, Canada, Mexico, Central America, and the Caribbean.

The products include specialized pumps for mining applications, chemical process pumps, industrial pumps with IoT-enabled health monitoring systems, and encapsulated submersible motors fitted with lightning arrestor. The annual turnover expected from these markets in the next three years is USD $10 million. As the company has been catering to the US and Mexico markets for over a decade, supplying through distributors, setting up these facilities will enhance the technical and application support the company can provide. The resultant reduced delivery lead times will be able to cater new value-added segments in these markets.

Tycon

Specific Market Positioning

Tycon Alloy Industries has positioned itself on the front line of the industrial field by exploring new spheres and developing new products. Instead of simply selling pump and valve products, Tycon is keen to provide value-adding services for its customers. By strategically setting up its new plant in Zhongshan, the company has updated its values to insure "safety, personnel care, process rebuilding, continuous improvement and energy saving." Tycon's goal is to better serve its staff, its clients, and the industry.

Pump Engineer had the pleasure of visiting Tycon Alloy Industries (Hong Kong) Co., Ltd., to speak with Alan Tsang, Sales Manager, about Tycon's commitment to being "a leading supplier of stainless steel and duplex steel castings for the pump and valve industry."

By Laura Wang

SCR Project.

Alan Tsang joined Tycon Alloy in 2006 and has been overseeing the Europe market for over a decade. He was recently promoted from a business development role to a team management position and is now responsible for coordinating the sales teams, planning daily operations and is also involved in the establishment of corporate development strategies. "The market has changed a lot since I started at Tycon," said Alan. "There were not as many foundries, and the competition was not as intense as it is now. Stainless steel was not very popular; many pumps and valves in the wastewater facilities were still made by cast iron. Today, use of stainless steels are rapidly increasing. It just goes to show you how much can change in a short time."

Quality is Essential

After exploring the pump market and gaining further insight, Tycon realized the importance of market positioning and committed to becoming a long-term developmental strategy manufacturer. To accomplish this strategy, the company devoted itself to upholding the principle that "quality is essential."

The company started a two-way selection model with clients based on no low-end competition. "In the beginning, many clients rejected us and bought low-end products in order to survive, even if it meant they only survived for a short time," explained Alan. "The competition territory changed a lot since our inception, and those who rejected us are now realizing that quality is the priority and have come back to do business with us."

Alloy:
Boosts Long Term Development

One of the principle reasons Tycon is sought after is for its commitment to its services. "We are not simply selling our products; we are selling our service advantages under the principle of 'customer utmost'," stated Alan. "I was keen on communicating with clients when I was working in sales; effective communication helped me realize the costumers' needs and solve their problems. We can fulfill all their requirements on quality, dimension, and ensure all the details are taken care of. Basically, all of our finished products are made exactly to customers' drawings and requirements."

Improving Quality by Better Processes

Quality control is one of the critical links in business management. The fundamental element of quality control is process control, which covers all the root sources of product quality. In order to ensure that the highest levels of quality are achieved, Tycon has been taking steps to further educate the production team on process control awareness, which can enhance cultivation of employees' basic skills and their knowledge on quality awareness. Tycon is also continually improving its ability to have effective production material and production technology, including raw material management, production equipment management, production technology management, operation management and strict quality monitoring system.

Transformation Towards the Energy Industry

To tackle the fierce competition in today's market, Tycon not only aims to improve product quality but also proactively makes predictions on the coming trends. "A few years ago, we analyzed what products were available in the market. After considering all of the industrial sectors, including: chemical, oil and gas, LNG, marine, nuclear power, food and pharmaceutical, a decision was made to target specific markets," said Alan. "Our analysis indicated that the energy market had huge potential, especially in today's gas and nuclear power market. So, our research team started to develop specific products for these two sectors."

Chess in a Chinese Style

There is a common saying regarding chess games: the incompetent person will proceed without a plan; the ordinary person will take one step and look around for the next three steps; the wise man grasps the initiative of the whole game with every single step. The master player has full confidence of their success because they can set up the overall layout based on their predictions of the later steps. Tycon has been following the same practice during development and successfully secured a leading position in the market. More than that, the company also excels in the industry by giving quick response to customers' needs, and by providing in-depth understanding on the ever-changing market.

Zhong Shan New Plant.

Unilateral analysis was not the only basis on which Tycon's predictions for new products were made. Alan explained, "Customers gradually became familiar with our products. They recognized our capability in both production and research and development, and they realized our cost-effective advantages." Before long, Tycon's customers began to request that the specific requirements they needed for their applications be met, which ultimately opened Tycon's eyes to a wider market.

Thus far, Tycon has exceled in the gas, LNG and nuclear power fields. The company's products are widely used in the oil and gas offshore production and processing markets, such as: offshore gas wellhead facilities, FPSO, LNG storage and re-gasification facilites, onshore gas process facilities and more.

When considering environmental protection and world energy supply, Tycon believes it is imperative for each foundry to transform from the traditional chemical industry to the energy industry. "In order to be environmentally friendly, the IMO (International Maritime Organization) requires the application of LNG, which can minimize the exhaust air pollution. Marine vessels are traditionally powered by diesel engine, and they emit highly-pollutional sulfur oxide," explained Alan. "Several years ago, the IMO stated that effective January 1st, 2020, the sulfur content limit of fuel used by vessels operating outside the designated emission control area decreases from 3.50% m/m to 0.50% m/m (mass)." One of the solutions to achieve this criterion is to introduce purifiers, which contain water pumps.

When Tycon first heard about the IMO requirement, the company believed that such a requirement matched the inevitable trend of pollution control. "Some of our industry peers were hesitating but we developed a new product to meet these requirements specifically, during that time period," Alan continued. "Due to many uncertainties, we did not receive too many orders in the beginning, but more orders started to come in when the policy became official. We started development very early and our product has proven to be effective and sophisticated, by long-term, real-world testing."

Promoting Enviromentally Friendly Foundries

The environmental issue associated with foundries has always been a hot social topic. As many end users believe it to be a key factor to consider when choosing product suppliers, Tycon has always put thought and care into this issue. The company has been following European standards during the construction of the new plant in Zhongshan, as it believes that environmental requirements will surely become more and more strict in the future. To prepare for this, the company adopted—without any hesitation—the most stringent standard for self-discipline.

The Tycon plant features environmental care and energy savings in its design and has adopted lots of equipment characterized by energy saving and emission reduction. Tycon has also invested many resources on energy savings and emission reductions to tackle key issues including dust, ventilation, waste water treatment, waste recycling, and more.

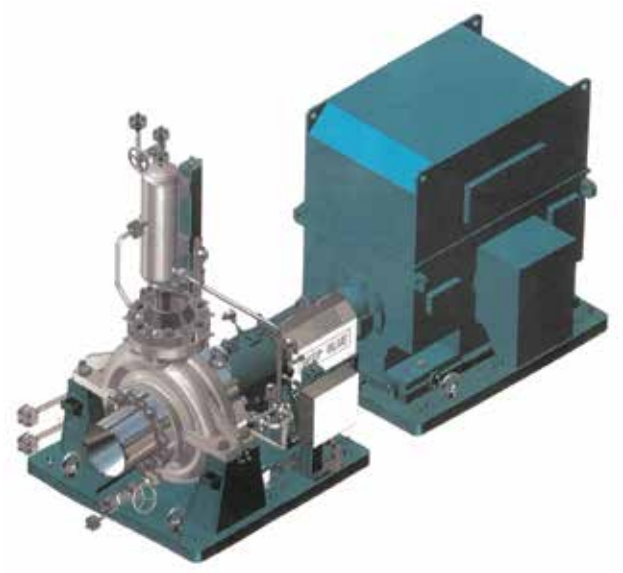
Forging Comprehensive Capability and Serving Global Markets

In order to better satisfy the diversified needs of customers all around the globe, Tycon invested many

Containment building heat removal pump of Hualong One Reactor- Nuclear.

Impeller for nuclear class 2 pump of Hualong One Reactor.

Impeller for Hualong One Reactor.



resources and obtained various certificates recognized worldwide. Each qualification is based on full range tracing, monitoring and supervision by users. The whole process, from raw material through to the final step, is qualified; the production standard is guaranteed.

Tycon has been building up its comprehensive service capability for many years by serving various markets with differing needs. Its current territory covers most of the major markets in the world, such as USA, Europe, Japan and China. In the future, the company is planning to study the South Korean markets as well. "The European market is characterized by the slow and steady method," Alan explained. "Many customers in Europe have years of business relationships with us. Their orders are mainly for projects that are not as large as ones you would find in the USA. Our strategy for this market is to focus on service. The delivery time and quality should never be compromised, in any way, because those are the most critical issues. By contrast, the American market features strong demand for inventory. Having stock on hand and ready to go is of utmost importance. The Chinese market is relatively complicated because the price-quality balance has not yet been achieved. That particular market requires that we not only have quality advantage but also a better cost performance. When you look at the Japanese market, quality criteria are extremely stringent. Long-term business cooperation is expected with guaranteed quality." Thanks to years of exercising and tempering in markets with diversified features, Tycon has accumulated comprehensive experience and effective solutions. By satisfying the various needs of its customers, the company is building trust with more customers.

Tycon is committed to being a leading supplier of stainless steel and special material castings for the pump and valve industries. "The title of 'leader' should be judged by the customers rather than industrial peers. Our vision can be considered 'accomplished' if most of our customers recognize our products and service," said Alan, matter-of-factly.

"People utmost" is the primary creed of Tycon. Since the commencement of the construction on the new plant, "safety and personnel care" has always been on the top of priority list with a wide range of influence covering each element in detail.

Building a Future Plant

Everyone at Tycon is proud and excited for the new plant in Zhongshan. "Our new plant is located on an island with beautiful scenery. The newly built Shen Zhong Bridge links up the new plant and the Shen Zhen airport directly, so it takes just half an hour to drive there! It is now in the commissioning stage and will go into production in 2020 with an expected capacity of over 10,000-ton per year," explained Alan.

The design and arrangement of the new Zhongshan plant introduced many state-of-the-art technologies and ideas. In Alan's opinion, the most remarkable idea is "digitalized management." This is the most significant improvement between the old and new plants.

As required by digitalized management, a collection of data from each piece of equipment and facility will be in place. These channels include automatic equipment, key monitoring points, personnel activity observation devices and various other management systems. This data is accurate and covers all the aspects of plant operation: production facility status, equipment replacement, maintenance, shutdown, production progress, operation efficiency, process parameter, and electrical performance. It can be used as the foundation for any subsequent scheduling, control and analysis. From standard establishment to production equipment application, key process parameters are being monitored because they are directly related to the product quality.

Continuous Improvement

Although Tycon already has an orderly business flow in place, the new plant in Zhongshan will further eliminate and simplify non-value adding steps in the process. The new plant will also improve the efficiency of production and service, as well as quality control and monitoring capabilities. Tycon's simplification has four advantages: better efficiency of product distribution link; reduced cost—ineffective budget eliminated; reduced defective/rejection rate based on reduced inefficient/low efficiency links; reduced ineffective rate and complexity of business flow. More authorization will be granted to the staff and they will be able to make some decisions within their respective scope of responsibility. Tycon hopes this will boost the employees' enthusiasm and energy and increase their job satisfaction.

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Q&A | Water and Wastewater

Pump Engineer is proud to present Q&A: Water and Wastewater Applications. This article will address common questions and challenges faced with pump applications in the water and wastewater industries. Readers are encouraged to ask questions for consideration in the future.

By Michael Huebner, Flowserve Corporation

Q: What special considerations are required for mechanical seals in water applications?

A: Water is one of the most common fluids pumped by centrifugal pumps. It is easy to consider water as simply drinking water or municipal water, but water applications reach into virtually every industry and chemical process. While these applications all fundamentally pump water, the nature of the water and the application conditions can vary significantly. The expectations for seal performance and reliability can also differ between industries and end users.

Typical Water Applications

Municipal potable water – Water supply systems provide drinking water to municipal water systems and industrial users. The quality of drinking water is tightly controlled and generally free from impurities and other chemicals. Many drinking water systems have a low concentration of chlorine and fluorine, but at normal levels, these do not impact sealing options. Most potable water systems are at ambient temperature and low pressure.

Food processing – Food processing plants use water in services ranging from cleaning and cooking to dilution and packaging. Water systems in plants will be tightly controlled and may be subject to cleaning or sterilization cycles. It is essential to understand all applications conditions when selecting materials of construction for these applications. There are some seal models which are specifically designed to minimize cavities and crevices to allow for more thorough sterilization and cleaning in place. When selecting seal materials, the requirements and regulations for equipment in direct contact with food or drinking water must be considered.

Waste water and sewage – Water carrying a significant concentration of solids or contamination requires seal solutions which will not be impacted by debris collecting around the seal. Seals designed for slurry applications, or bellows seals, are commonly used to prevent the seal from hanging up in operation. Depending upon the nature of the contamination, hard face material combinations may be required to minimize face damage. The design of the seal chamber and the appropriate selection of the piping plan can significantly improve seal reliability.

Cooling water – Cooling water systems are used through many manufacturing, refining, and chemical process plants. The cooling water is used to control the temperature in the equipment and processes and is recirculated throughout the plant. Cooling water can vary in quality and can contain rust, dirt, and organic materials. Most plants have an adequate water treatment program to prevent this from impacting seal reliability. Cooling water systems generally operate at relatively moderate temperatures and low pressures.

Figure 1: Example of split seal.

Boiler systems – Water is used in steam generation systems to transfer heat and generate electricity. Since water is converted to steam, the water quality is tightly controlled to prevent fouling and corrosion in the water system. Boiler feed pumps and circulation pumps can operate at high pressures, speeds, and temperatures. For these reasons, the seals are often highly engineered designs and require piping plans which reduce the temperature in the seal chamber (i.e., Plan 23).

Water injection/seawater injection – Oil recovery in established fields often rely on water injection to maintain the formation pressure and increase the amount of oil production from the well. These applications often involve pumps operating at very high pressures and speeds. Water quality can also be challenging since the injected water may be produced water, seawater, or river water.

Challenges With Water

In many ways, water is an excellent fluid for pumping and sealing. It is chemically compatible with a wide range of metals and elastomers. It is generally a low safety risk and it is easy to decontaminate exposed components. Leakage from many water applications is not an environmental hazard and only represents a housekeeping concern.

As a sealed fluid, though, water can present some significant challenges. Water is a poor lubricant. At

lower temperatures, water has an adequate viscosity to lubricate the seal faces and allow for a flexible selection in seal face materials. As the temperature increases, the viscosity decreases and sealing challenges become more significant. Above 70-82°C (160-180°F), it is a common practice to apply piping plans to reduce the temperature in the seal chamber to improve reliability.

Water also has a relatively small range of temperatures where it is suitable for sealing. Water freezes at 0°C (32°F), so pumping and sealing systems must be protected from damage caused by low-temperatures. This concern is valid not only for normal operating conditions, but also standby conditions where the equipment may reach ambient temperatures. At higher temperature, the vapor pressure of water may cause flashing or boiling in the pump or between the seal faces. While it is possible to suppress vaporization in the seal chamber through pressurization, the water will still flash as the pressure drops across the seal faces.

Water is often not just water. Contaminants and solids in the form of abrasives, rust, process contamination, and water treatment chemicals can all impact the quality of the water and mechanical seal performance. In most cases, seal material selection is the primary consideration, but in some cases, more specialized piping plans may be required.

Sealing Options

The wide range of water applications along with the relatively benign nature of water allows for a wide range of sealing options.

Packing – Packing is often considered an inferior sealing option, but modern packing is a highly engineered product and can be a suitable selection for many water applications. Packing is relatively inexpensive and easy to install. It may however require more operator intervention and have higher leakage rates than other sealing options. Most end users can tolerate higher process leakage rates with water, so this is an acceptable solution in these applications.

Split seals – Split seals are mechanical seals which are axially split and can be installed and replaced without disassembling the pump. This makes the selection of split seals ideal for applications where it is difficult or costly to remove or disassemble the pump. Split seals can have higher leakage rates than traditional mechanical seals, but this is more easily tolerated with water as the process fluid. Split seals are most commonly applied in lower duty conditions (e.g., low pressure, ambient temperatures, etc.), but highly engineered designs have been used in more demanding applications.

Figure 2.

Pre-engineered seals – ASME B73 pump designs are commonly used in water services. Due to the standardized nature of these pumps, most seal OEMs have created pre-engineered seal cartridges that are available off-the-shelf for these pumps. These seals can be applied in most water applications and provide a quick turnaround, cost-effective sealing option for these services.

Standard duty seals – Not all water applications are at low pressures, speeds, or temperatures. Many higher duty pumps are designed to API 610 standards and require a more robust sealing solution, often complying with API 682. The seal designs are easily customized to support the different piping plans (e.g., Plan, 21, Plan 23, Plan 32, etc.) or provide other features which may be required for these services.

Highly engineered seals - The most demanding applications, such as boiler circulation or water injection, require seals that are specifically engineered for the equipment and application conditions. These seals are often installed in pumps with large shaft diameters and operate at high speeds. The seals often require specialized design features to address challenges with the cooling of the seal faces and circulation of the piping plans.

Piping Plans

The selection of the piping plan is a critical step in the design of a sealing system. The wide range of applications conditions means that there is no single piping plan which should be used in all water services. There are however, several plans which are selected for common water applications.

Piping Plan 02 or Plan 03 – Many water applications are at a low temperature and pressure. In these applications, there is little heat generated and no need for forced circulation to control temperatures in the seal chamber. A Plan 02 is a closed-in seal chamber with no flush while a Plan 03 is defined as an open or tapered bore seal chamber. With these piping plans, the seals are installed directly in the pump, without additional piping connections or instrumentation.

Piping Plan 11 – The use of Plan 11 creates a circulation of process fluid from a high-pressure region of the pump, through the seal chamber, and back into the pump. This forced circulation effectively removes seal-generated heat and allows the seal faces to be exposed to water at process temperatures. This is the most common piping plan for mechanical seals and would be used in most medium and high duty application conditions.

Engineered seal face features and advanced face materials now allow Plan 11 piping plans to be used in higher water temperature services. These options include using hydrodynamic features such as waves or face grooves to augment the fluid film. Face materials such as diamond coatings may provide additional tolerance for partial contact on low viscosity fluids. End users should consult with the seal OEMs to see if these solutions are suitable for their application.

Figure 3.

Piping Plan 23 – In high-temperature applications, the water properties may not be suitable for reliable seal operation. The Plan 23 reduces the seal chamber temperature in the seal chamber by circulating fluid from the seal chamber, through a seal cooler, back into the seal chamber. This lowers the temperature around the seal and effectively creates a cool environment in the sealing system. This is the most effective and efficient method for reducing process temperatures at the seal.

Piping Plan 32 – Some applications use a single seal (Arrangement 1) even in applications where the fluid has undesirable properties. In some services, leakage with trace amounts of contamination (e.g., hydrogen sulfide) can cause environmental or safety concerns. In other applications, contaminants in the process water may cause damage to the seal faces (e.g., catalysts). If the process fluid is water-based, it is often acceptable to use a clean water injection to effectively prevent contaminations from entering the seal chamber or leaking to the atmosphere.

Conclusions

Water services are found throughout industry, and the application conditions can vary significantly. Fortunately, there is a large installed base of seals for these applications, and the seal OEM can provide significant insights into the most reliable solutions for these services.

About the Author

Michael Huebner is a Principal Engineer at Flowserve Corporation in Pasadena, Texas. He has over 30 years of experience in the design, testing and application of mechanical seals both in the USA and Europe. He has authored numerous articles and lectured extensively around the world. He has a BS in Engineering Technology from Texas A&M University. Michael Huebner has been a valued contributor to Pump Engineer since his first submission in June of 2015. Pump Engineer would like to thank Micheal for his continued dedication and looks forward to receiving more dynamic articles in the future.

Four Decades of Success in the Processing Industry

An Interview with Jim Darby

Jim Darby has been in the process industry for a little over four decades. He began his career as an Junior Process Engineer and has progressed over the years to achieve a Senior Process Engineer position. After gaining experience in a multitude of different companies, Darby began working with Paton Engineers and Constructors in Sarnia, Ontario, and has held his position there for the last two and a half years.

Pump Engineer had the pleasure of sitting down with Darby to discuss his experience with pumps and pumping applications over his many years in the industry.

By Brittani Schroeder and Angelica Pajkovic

Jim Darby grew up in small town Cardston, Alberta in a farming family. As a member of Scouts Canada, Darby was always hiking and constructing bridges out of pine trees and rope. He was fascinated by his grade seven study of siphons, and how water could move from one vessel down to another. Later in his youth, his parents moved his family to Calgary, and Darby spent a fair amount of time on the University of Calgary campus learning about their faculties during open houses. He always found great interest in the engineering faculty presentations.

"My brother and I went to a lot of science fairs when we were young. Most were put on by the local Board of Education. We were always fascinated by the way things were put together and my brother even built a digital computer out of old rotary phone equipment once," Darby recalled. All his experiences from building things as a child led him to choose engineering as his field of study.

Darby has been a Process Engineer from the very beginning. His first position as a Junior Process Engineer was at DuPont Canada. From there he spent a short time at Ethyl Canada before moving onto Polysar/

LANXESS, where he spent 27 years honing his many skills. Although he has always been willing to step into other roles when his colleagues needed him to, process engineering is what he likes to focus his attention on.

"There are a lot gray areas between where process ends and instrumentation begins. I provide the process information and the instrumentation engineers provide the information on the instruments and together we determine the best instrument for each job."

Day-to-Day Experiences

Darby currently works for Paton Engineers and Constructors. Paton's strong commitment to customer satisfaction and innovation has given them the reputation of being a high-quality engineering house in the industry. Darby is only one of two process engineers on Paton's staff. "I am working part-time right now as I

get ready for retirement, but I am still very involved in the projects. Last year we were working on a shutdown system for a major compressor train, and most of the job was instrumentation, but the final control element was a hydraulic system," Darby explained. "I had to make sure all the pipes and pumps were designed so that if something went wrong, there would be a quick shutdown so that no further damage could occur."

Paton Engineers and Constructors is a small firm, so each person helps where they are needed. "Sometimes our business development person will ask me to research and investigate because she is not as well-versed in the process as I am," said Darby. In these situations, Darby and a colleague would approach a customer to ask them for the key details of a project. Once they had gathered all of the necessary information the pair would bring back the facts to prepare a business proposal. From there, Darby would wait to see where the proposal goes.

Another area Darby works closely with is the instrumentation team. "There are a lot gray areas between where process ends and instrumentation begins," he explained. "I provide the process information and the instrumentation engineers provide the information on the instruments and together we determine the best instrument for each job."

Designing the Pump Systems

"Pumps and pipes are my bread and butter," admitted Darby. When Darby is designing a pump system, he receives all information about the pump from its manufacturer, including characteristics and how much pressure it will hold. "You have to remember that in the case of a positive displacement pump, the pump will keep pushing through the same volume of liquid regardless of what it is bumping up against," Darby explained. "If the liquid does not have somewhere to go, or if the discharge is blocked, the pump will keep pumping until it eventually breaks the weakest part of the piping system." As a result of this, his main concern is for the safety of the people working with the pumps.

One of the main issues Darby attempts to prevent is setting up a pump system for customers and having it not work properly when they go to use it. "You go out and build this lovely system, you charge the client all this money, but then they go to press the button and it does not work the way it is supposed to," said Darby. In order to mitigate the potential that an issue will occur, Darby and his colleagues do a number of checks on every design. These are formalized in company procedures and results in close to error free designs. If an issue does occur, he provides technical support to the operations personal, and helps them go through the whole system to find a solution.

One example of a problem Darby faced was with a pump that required temperature specific operating conditions; the pump needed the temperature of the fluid in the feed drum supplying the pump to be 70°C to have the necessary vapour pressure to generate the necessary suction head for the pump to work properly. As the pump was stationed in Canada, where the winters are sometimes very cold, the pump would not operate properly when it was first started in December. With the colder weather, there was a lot less vapour pressure and so the suction pressure was reduced. The pump was generating the proper total dynamic head but with the reduced suction pressure the discharge pressure

was also reduced and there was not enough discharge pressure for the fluid to be pumped to the next vessel. To the operators it looked as if something was wrong with the pump when in actual fact there was something wrong with the conditions in the feed drum for the pump (too low a temperature).

"To solve this problem we heated the feed drum up with some steam, and once we got the drum warm enough the pumps worked fine. Once the whole unit was up and running, new hot material started to flow into the feed drum for the pump and we were able to keep the feed drum at about 70°C; the whole process was effective but it was hard work getting there," Darby recalled. "It was like getting your car started in the winter mornings; it is hard to warm up the car, but once it is warm it stays that way and runs like a charm."

A Jack of All Trades

Although he specializes in pumps, Darby has had some interesting experiences with valves throughout his career. "I work with everything that has fluid in it," Darby explained. "Valves, pumps, pipes, you name it." One valve related issue Darby had the opportunity to focus on was a situation where a plant had a valve that would close too quickly. "The issue became apparent when a plant technician got splashed by hot water from a pressure relief valve. He had no warning that this was going to happen and fortunately escaped serious injury. I was asked to investigate as there was no indication as to what had caused the pressure spike that caused the pressure relief valve to open."

The pressure relief valve was in a piping system that was fed by a pump on the other side of the plant about 400 meters away. "After a lot of system analysis, I realized we had water hammer occurring," Darby recalled. "Looking at all the elements that might cause this, I determined that a valve, about 100 meters away from the pressure relief valve, was able to close quick enough to cause the water hammer. It was the resultant pressure spike that caused the pressure relief valve to open. The valve was closing too quickly, and so I knew we had to slow it down. Working with the instrumentation engineers, we slowed the speed of the valve actuators down to the point the water hammer would not occur."

"I get really motivated by young minds. You never know what could be coming down the tubes next and I feel privileged to get to be able to offer them advice as they make their way into the industry."

In the brief time that Darby worked as an Instrumentation Engineer, he gained significant experience working with valves. One of his principle tasks in this position was to design a control valve. For this he had to gather the pertinent process data, determine what the valve needed to do and specify a valve for this purpose. "It gave me a good appreciation for the difficulties the instrumentation engineers face and it provided opportunities to talk with suppliers and others I would not normally communicate with in my role as a process engineer. If the proper person had designed it, the valve probably would have been a nice compact-looking unit, but the main point is that I got the job done," Darby admitted.

"The one thing I stress for future end users, though, is whatever you do, it ought to be fun. If it is not you will come to hate your job, which is doing a disservice to yourself and to your employer."

Giving His Knowledge to Others

When Darby started at Polysar/LANXESS in 1981, the company had over two thousand employees at its Sarnia, ON site. Now the company has under five hundred there. "There used to be a number of large chemical plants here but now it is mostly open ground or grassland," he said. With the closing of these large plants, engineers have started retiring and taking their years of knowledge with them. Darby revealed that he learned a lot from the engineers that worked around him, and now they have gone down different paths — some have moved away, some have retired, and others, regrettably, have passed away.

"It is quite difficult for a young engineer coming out of university because finding a job is hard in the current market. Companies want to hire someone with expertise, but obviously these recent grads do not have that experience yet. Sometimes they end up taking positions they do not necessarily want," explained Darby. In an attempt to help emerging engineers choose a career path they are genuinely interested in, Darby tries to transfer as much of his knowledge to the young engineers he works with as possible. He wants them to understand what they are working towards and attempts to give them as many tools as possible to achieve their goals. He does not see the point of having such a large reservoir of knowledge if there is no one to pass it down to. "I have considered writing a book and putting my knowledge down on paper," Darby admitted. "Maybe my family will read it and see what I have been doing for the last forty years. Maybe new engineers can read it and save themselves time by learning from my time in the industry."

A Mentor for New Engineers

Darby has done a fair bit of mentoring throughout his career. "Students come out of third year from some of the Ontario universities and they need to complete a co-op before they graduate," he explained. Darby thinks of himself as a mentor or sponsor for these students, especially when they come to him for help on a project. "A young man was a co-op student a few years ago, and we worked together really well while he was here in Sarnia. He went back and graduated, and I did not hear from him for a very long time. Then, I got an email from him asking if he could pick my brain on a few topics, and we got to catch up a bit. It was really great to know that he was doing well in his career," he recalled. Darby has been used as a reference by many emerging engineers in the industry.

As part of their coursework, engineering students from Western University, in Ontario, who are enrolled in the green chemistry course of studies for chemical engineers are put into teams of three to five and are tasked with fully designing a plant; this includes deciding what product they are going to make and how they are going to make it. "They have to think of safety regulations, the economics of the plant and business, and at the end of the project they prepare a report for grading by their professor. To make it more interesting, they also have to present their design before a panel of judges. The general public are invited to the presentations and the employers here in Sarnia go and attend these presentations because it is a great way to see which students should be hired after graduation," said Darby. This event includes prize money for the top teams. The total prize money handed out is typically around CAD $20,000.

Darby likes to attend the pitch sessions to listen to the ideas of the younger generation. "I get really motivated by their young minds," he said. "You never know what could be coming down the tubes next and I feel privileged to get to be able to offer them advice as they make their way into the industry. The one thing I stress for future end users though is whatever you do, it ought to be fun. If it is not, you will come to hate your job which is doing a disservice to yourself and to your employer."

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Desalination: A Growing Market for Pumps

Although accounting for only a fraction of the total industrial pumps sales, desalination is a growing market for pumps and an area of significant opportunity, particularly for manufacturers of corrosion-resistant flow control equipment. Driven primarily by regional water scarcity and growing populations, the market is concentrated in the Middle East, but desalination is a global industry, supplying water for both residential and industrial use in more than 160 countries.

By Matjaž Matošec, Research Manager, Resolute Research

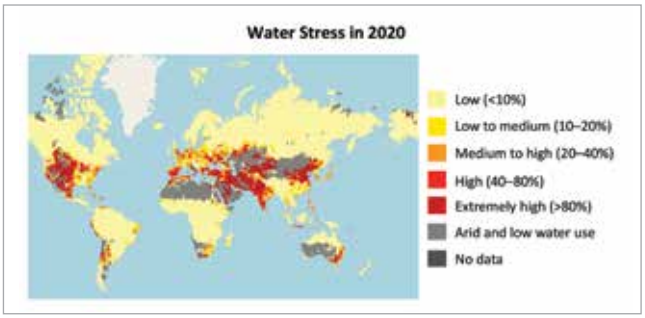
The total number of desalination plants worldwide, including those already under construction, is more than 20 thousand. This sizeable fleet of facilities includes plants of all types and sizes, ranging from micro facilities catering to industrial, commercial and residential clients to mega-sized plants operated by municipal, regional and national water utilities responsible for supplying drinking water to customers in large urban areas. Municipal desalination represents only about a quarter of all plants, but because municipal plants generally have larger capacities than those for industrial and other clients, they account for around 60% of total installed capacity. Similarly, more than 60% of desalination capacity currently under construction has been commissioned by the utility sector. For these reasons, the following discussion will focus on the municipal desalination market.

Market Drivers

The growth of the desalination market reflects several factors, all of which are driving demand for drinking water. The rapid population growth and increased urbanization, particularly in the coastal regions of many developing countries, is putting strain on locally available freshwater resources, making seawater desalination the obvious solution to overcoming water shortages, and in many cases a necessity. Additionally, rising population and economic growth are increasing the demand for food and in turn drive water-intensive agricultural production, forcing urban water users to develop new water resources.

Groundwater depletion caused by sustained overexploitation of groundwater resources is another negative development inextricably linked to demographic trends, creating increasing demand for brackish water desalination.

Last but not least, global warming and changes in climate patterns are increasing the frequency and severity of droughts which are no longer restricted to arid regions but are affecting large parts of our planet. These droughts are placing water security high on the political agenda of many countries and are oftentimes rendering desalination the only viable alternative for water resources.



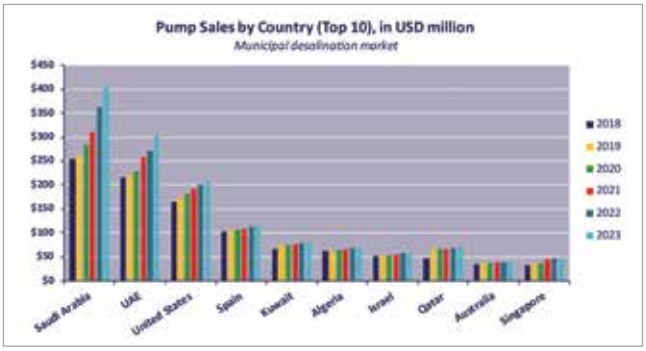
Source: World Resources Institute – Aqueduct Water Risk Atlas.

Geographic Opportunities

According to the United Nations, over two billion people live in countries experiencing high water stress. Furthermore, nearly half the global population are already living in potential water scarce areas at least one month per year and this could increase to more than five billion in 2050. While about 73% of the affected people live in Asia, countries in the Middle East and North Africa (MENA) experience the highest levels of water stress.

It is therefore no surprise that the MENA region is the largest market for desalination, accounting for about 61% of the municipal capacity currently installed worldwide, and for nearly 75% of the municipal capacity under construction.

On the country level, Saudi Arabia is the largest market, followed by the United Arab Emirates and the United States. These three countries are also the fastest-growing desalination markets, providing attractive opportunities for both new and aftermarket pump sales.



Source: Resolute Research Pump Product Database.

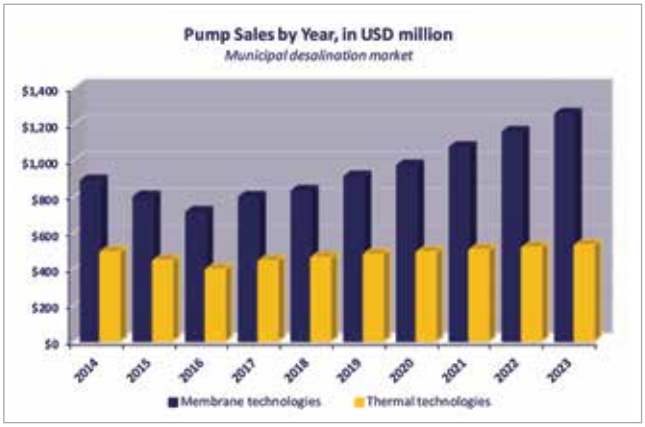
Other major markets include Spain, Kuwait, Algeria, Israel, Qatar and Australia, with significant new capacity expected to come online by 2022. This is also expected in Oman, Egypt, China, Morocco, Singapore, Iraq, India, Kenya and Tunisia.

Technology Trends

While there are a number of desalination methods, two processes, namely membrane and thermal, are prevalent. The most widespread membrane technology is reverse osmosis (RO), while the predominant thermal technology is multi-stage flash (MSF). RO is a process whereby feedwater is forced through a semipermeable membrane at high pressures to remove salt and other impurities. MSF, on the other hand, is a multi-stage distillation process that involves evaporation and condensation, resulting in the generation of brine and distilled water.

Historically, there has been a preference for thermal technologies in the Middle East and North Africa. Particularly in Saudi Arabia and the United Arab Emirates, which together account for nearly 70% of global municipal MSF capacity. However, while highly reliable and capable of producing extremely pure water from the saltiest seawater sources, MSF requires large amounts of energy and is characterized by higher capital costs and larger footprint than RO. These factors have led to the dominance of RO technology which now represents more than 60% of the total installed utility capacity and 85% of new capacity currently under construction.

Accordingly, the RO market will generate the majority of new and aftermarket pump sales in the desalination industry, whereas the thermal market is expected to plateau, with pump sales limited largely to maintenance, repair and overhaul (MRO) parts.



Source: Resolute Research Pump Product Database.

Pump Requirements for RO Systems

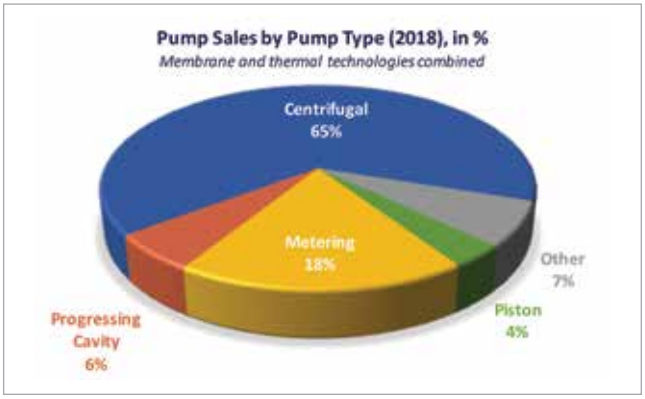
Reverse osmosis desalination requires a wide spectrum of pump technologies capable of handling seawater/brackish water, pure product water, concentrated brine, and treatment chemicals. Depending on the application, these pumps may be high or low pressure, high or low flow, and are often subject to highly corrosive media.

Jebel Ali M-Station is the largest power and desalination plant in the United Arab Emirates and the fourth largest desalination plant in the world, with a desalination capacity of 636,440 m³/d. M-Station is located within the Jebel Ali Power Plant and Desalination Complex on the outskirts of Dubai, which accommodates multiple other large-scale desalination plants with a combined capacity of 1.72 million m³/d. All plants use thermal MSF technology and are operated by the Dubai Electricity & Water Authority (DEWA) which is responsible for providing drinking water to more than three million residents of the sprawling city of Dubai. Earlier this year, construction on a new desalination plant at the Jebel Ali Power and Desalination Complex commenced. The plant with a capacity of 181,840 m³/d is expected to become operational by May 2020 and will use RO technology, reflecting the general industry trend toward membrane processes. Photo © Haider Y. Abdulla – stock.adobe.com

High-salinity media such as brine (a by-product of the desalination process) are highly corrosive, necessitating the use of special materials capable of withstanding chloride-rich environments, most typically 316L or duplex and super duplex stainless steels. Corrosion protection is required not only to combat salinity contained in the water, but also the salinity that presents in the air. The necessity of this protection becomes clear when considering that the majority of desalination plants are situated in coastal areas where the atmosphere can be very humid and corrosive.

At the highest level, major pump applications include:

- Source water intake: These pumps handle seawater or brackish water, and are high-capacity pumps, often vertical-shaft centrifugal pumps constructed of corrosion-resistant alloys. They move intake water through a series of pretreatment stages to condition the water prior to RO membrane filtration.
- Membrane feed: The RO membrane feed pumps are high-pressure, high-flow pumps that may be either multi-stage centrifugal pumps or reciprocating positive-displacement pumps, depending on plant size and other considerations. For seawater applications, pump pressures of 1,000 psi or higher are required in the RO stage; lower pressures are required when working with brackish water. Usually, multiple RO stages or "passes" are required for effective filtration, with additional pumps required for each stage.
- Product water transfer: After passage through the RO filtration stages, the pure product water is transferred into tank storage for post-treatment and pumping into the water distribution system.



Source: Resolute Research Pump Product Database.

- Brine transfer and disposal: The concentrated brine or reject water is highly corrosive, and is handled by pumps constructed of corrosion-resistant materials. Centrifugal pumps are most often used for brine disposal back into the sea, while other types of high-pressure multi-stage centrifugal pumps or positive-displacement pumps may be used for injection into disposal wells.

Chemical Dosing

Desalination in general and RO systems in particular require several types of water treatment involving not only mechanical filtration but also the use of chemicals for membrane protection and post-treatment of desalinated water.

Chemical pretreatment of feedwater is designed to remove solid and organic contaminants ahead of the RO membranes, to prevent scale formation and membrane fouling. This process involves, among other things, the use of various coagulants and flocculants to precipitate solids, chlorine dioxide to kill microbes, and treatment with sodium bisulfite to eliminate any traces of residual chlorine in the feedwater that can seriously damage RO membranes. These chemicals are injected into the feedwater by precision dosing pumps operating at low flow rates and relatively low pressures.

Periodic backflushing of membranes with mild citric acid is also used to remove scale and keep the RO membranes operating at peak efficiency over the life of the membrane cartridge.

Post-treatment of product water also involves the addition of various chemicals, including minerals essential for potable water (remineralization with calcium hydroxide and other chemicals), caustic soda to adjust pH, and sodium hypochlorite for disinfection, plus other chemicals for the protection of distribution piping networks.

The wide usage of chemicals in desalination requires the use of metering pumps and associated isolation valves which are often supplied in engineered polymers or lined with PTFE or PFA to provide corrosion resistance.

Industrial Market

As previously mentioned, desalination is a growing market, which is true also for the industrial sector. The power generation industry accounts for the largest installed desalination/ultrapure water capacity, followed by upstream oil & gas, refining, mining and other industries. Major industrial markets and applications for reverse osmosis (RO), microfiltration (MF) and ultrafiltration (UF) membrane technologies include:

- Boiler feedwater treatment across many industries (ultrapure water for super critical utility boilers);
- Condenser water treatment;
- Semiconductor market for ultrapure rinse water;
- Food & beverage market for ultrapure process water;
- Pharmaceutical market for ultrapure water for injection (WFI); and
- General industrial wastewater treatment for zero liquid discharge (ZLD), and water conservation in general.

The combined markets for highly engineered desalination pump and valve products for municipal water utilities and industrial markets create a demand that is truly global in scope and intersects nearly all industrial markets.

** Note: All data on existing and future desalination capacity is derived from DesalData.com.*

About the Author

Matjaž Matošec is Research Manager at Resolute Research where he leads a dynamic team of market analysts. Resolute Research is a market research and consultancy firm providing global clients with world-class market intelligence on industrial pumps, valves and flowmeters, in the form of market reports, databases and custom research. Collectively, Resolute Research possesses decades of experience in providing consulting services to professionals working in the industrial process industries. For more information, you can contact Matjaž at m.matosec@resoluteresearch.com or visit www.resoluteresearch.com.

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The Importance of Flow Monitoring in the World of Wastewater Treatment

Wastewater treatment is not something most of the population of the United States thinks about on a daily basis. It is conducted, mostly unseen by municipalities, and goes largely unappreciated by many. However, it is a key part of everyday survival that allows humans to stay hydrated, bathe, clean dishes, launder clothing, and perform a variety of tasks that keep them alive and healthy.

By Rajen Jairam, ChemTec Equipment Company

One of the most important steps in wastewater treatment is water disinfection, a step most municipalities achieve by adding chemicals to the water. However, it is important to monitor the dosing of chemicals. To that end, flow monitors are used to control the proportions of each chemical in order to provide a uniform, safe water supply.

Why Is Water Reuse Necessary?

The earth is comprised of just over 70% water. In all, that adds up to about 332,500,000 cubic miles, or 326 million trillion gallons – a staggering amount of water that's almost unfathomable to many people. With such vast amounts of water, it's hard to comprehend the necessity for water management.

However, consider the fact that the earth's water supply is relatively unchanging – and has remained so since the earth's formation. All 326 million trillion gallons has been on the earth for all or most of the 4.5 billion years of its existence, within the water cycle. As a result, water exists in many sources, in many different stages of the water cycle – and not all of it is available for human consumption.

In fact, the vast majority of water on the earth is unavailable for human consumption. Most – about 96.5% – is located in the earth's oceans and unfit for drinking. However, even the other 3.5% of the water supply that is freshwater is still not accessible to humans due to its location in the atmosphere, deep under the earth's surface, or within glaciers and snow formations.

In the end, only 1% of the freshwater – or .007% of the earth's water – can be used by humans. With nearly 7.7 billion people on the planet using the already-limited water available, the importance of reusing water is evident. However, it is important that water utilized for household, municipal, and industrial use be treated before its release and eventual reuse.

Why Is Wastewater Treated?

Water used in households can hold any number of contaminants by the time it circles the drain and enters the sewers en route to the water treatment plant.

Humans washing their hands, bodies, or clothes and dishes release a number of biological and chemical contaminants into the water they use. Similarly, multiple industries release contaminants – often on larger scales – that have the potential to have harmful effects on many organisms in nature.

The United States uses upwards of 322 billion gallons of water per day. If every entity that used water released wastewater back into the environment without treatment, the amount of stress on the environment and its resulting damage would be catastrophic. Thus, wastewater treatment plants address the contents of wastewater before release back into the environment.

Wastewater treatment plants aim to make water safer for the animals and plants that live and use natural waters sources, including their habitats. However, the primary reason for treating water is for the removal of a variety of microorganisms. While many microorganisms are utilized in the initial treatment of the water, in order to remove solid organic waste from the system, others are not desirable after treatment.

Microorganisms harbored by unclean water can cause a wide range of human diseases. These diseases include cholera, typhoid, dysentery, and others, all of which were far more common before people learned of the dangers of bacteria in unclean water. Modern wastewater treatment plants remove bacteria in a few different ways.

How Is Wastewater Treated?

When small amounts of wastewater enter the natural environment, nature acts on its own to clean it itself, by diluting the pollutants with fresh water and enacting a series of microorganisms to feed on the contaminants. While today's vast amounts of wastewater produced by the United States simply cannot be handled by nature alone, wastewater treatment plants still utilize a process very similar to nature. Primary treatment separates particles both large and small from the bulk of the water by using filters, sedimentation tanks, and pumping raw biological solids from the water. However, it is during secondary treatment that most of the hazardous contaminants are removed.

Secondary treatment can remove up to 85% of the organic matter in wastewater by biologically activating the organic matter and sludge accumulated; helpful bacteria in this sludge can feed on the wastewater, removing harmful contaminants. Afterward, it is aerated by promoting oxygen flow to the necessary bacteria, allowing it to transform the contaminants in the wastewater to byproducts that are then filtered out of the water. Finally, the wastewater is treated with chemicals to remove any remaining harmful bacteria.

How Are Chemicals Used for Wastewater Treatment?

Industry experts estimate that around two-thirds of municipalities operating wastewater treatment plants use chlorine to disinfect the water before it is released. Others choose to use alternative chemicals such as ozone or chloramine. This process happens after the effluent water is released from the plant's sedimentation tank, and before the water is discharged into the receiving body of water, usually a river.

Due to its toxic qualities, chlorine is a highly effective, powerful chemical when it comes to the removal of harmful microorganisms. If used properly, chlorine can eliminate as many as 99% of bacteria from treated water. Before introducing the water into the environmental receiving grounds it will occupy, the wastewater is dechlorinated to reduce the harmful chemical effects of the chlorine itself.

Precise levels of chlorine must be administered in order to safely disinfect water while avoiding toxic effects on people and animals who will later consume it. In addition, stable flows across the entire treatment process are essential to completing it safely. For these reasons, ChemTec has developed a range of flow monitors for water treatment purposes.

Flow Monitors

ChemTec specializes in the design and production of flow monitors that meet water treatment industry specifications. Whether the method of chlorine delivery is liquid or gaseous, flow monitors are able to sense and respond to changes in chemical flow rates. The resulting consistent flow ensures the water continues to receive optimal levels of chemicals, as well as protects the equipment.

FS series (Non-adjustable) – able to handle water flow rates of 0.25 – 8.50 gallons per minute (GPM).

LCA series (adjustable) – able to handle water flow rates from 0.38 liters per minute (0.10 GPM) to 56.8 liters per minute (15.00 GPM).

500 BP series (adjustable) – able to handle water flow rates of 0.1 – 20.0 GPM.

Wastewater disinfection systems using flow monitors utilize a magnetic piston in the unit. The piston moves with the flow. A reed switch monitors the position of the piston indicating that flow rates remain within the acceptable levels.

When flow rates move outside the norm, the situation indicates that a problem may exist within the system. Common problems include a blocked filter or a failing pump, both of which may cause severe disruptions within the system if allowed to continue. It is crucial that such issues be identified and addressed immediately to prevent damage.

Flow monitors with custom configurations can produce an alert when a blockage or another low-flow issue is detected. The issue can be addressed immediately, preventing damage to the pumps and other components of the system. In addition, other custom configurations

can send an alert or reminder when a filter requires changing. PVC is recommended for water treatment and wastewater industry applications.

Flow monitors can provide early alerts when flow rates drift from the acceptable range. Users are able to address problems before they occur, leading to increased confidence that the system is operating at a functional level and will remain safely operating. They can rest assured that their system is monitored constantly and the water produced remains at safe levels for human and animal consumption as well as for other environmental concerns.

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About the Author

Rajen Jairam is the head mechanical engineer at ChemTec with over 28 years of experience in designing, testing, manufacturing, and assembling within the process industry. He specializes in CNC programming, thermodynamics, and fluid mechanics, with an extensive trained background as a conventional machinist. Rajen holds a degree in mechanical engineering from Florida Atlantic University.

Hybrid Bearings Enhance Performance of Dry-Start Vertical Pumps

This equipment exploits the elasticity of synthetic rubber and ensures stable bearing behavior

After 30 years of research, an engineering team in Japan has developed a hybrid-type submersible bearing that prevents burnouts during vertical pump dry-starts, exploits the elasticity of the synthetic rubber to level the pressure during typical operation, and ensures stable bearing behavior by conferring vibration control while supporting the rotating shafts. Using polytetrafluoroethylene (PTFE) strips as slide members and synthetic soft rubber for cushioning between the slide elements and metal shell (or the base plates), the hybrid bearing can be used for dry-start operation of vertical pumps without applying lubricating water from the outside prior to pump operation.

By Fumitaka Kikkawa and Yoshimasa Kachu, Mikasa Corp. & Hiroshi Satoh, Oridea Inc.

Advantages of Adopting a Dry-Start Bearing

A wet-start vertical pump system requires that water be injected from outside the pump into shaft protection tubes at the top of the column pipes before operation. In most cases, the water is pumped up automatically after a fixed time to avoid wasting the feed water pump power or the water from the tap, which is usually called self-feed water. A dry-start pump does not require lubrication and is less prone to environmental damage from crevice corrosion in joint parts where seawater remains. As the stainless steel shafts are exposed directly to the pump main flow, pitting corrosion—prone to occur in low-flow-velocity or stagnant regions—is reduced. Shown in Figure 1.

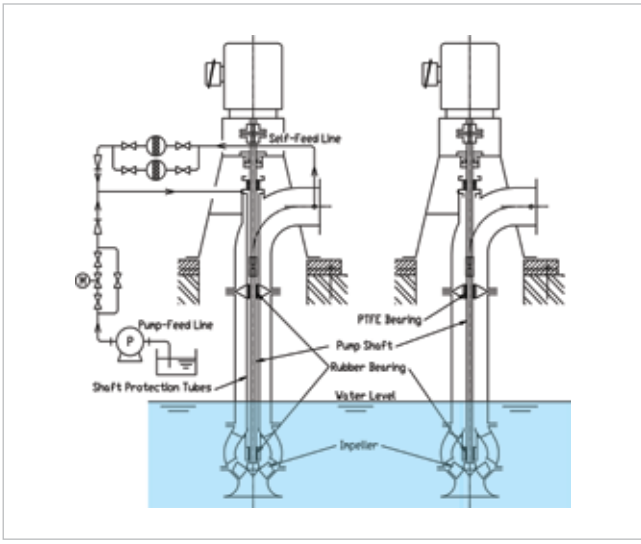


Figure 1: Vertical pumps systems: (a) wet-start, (b) dry-start.

Figure 2: PTFE/Rubber hybrid bearings for pumps.

Structure of Hybrid Bearings

Three molds have been developed to produce three types of bearings, each suitable for a different range and scale of application. These include full-molded, segmental and barrel type bearings. Bearings are basically composed of four layers: PTFE strips as slide elements, synthetic rubber for cushioning, base plates as the backing-plates and a metal shell that serves as the holder. The full-molded bearing is used almost exclusively for vertical pumps, making a simple, three-layered structure as shown in Figure 2.

Friction Coefficients

Creating submersible bearings with materials that have low friction coefficients has been a top priority for submersible bearing manufacturers. Figure 3 shows friction coefficients in tap water of different bearing materials (PTFE, polyether ether ketone [PEEK] and

polyurethane in hybrid structure with rubber) used in dry-start vertical pumps and rubber bearings used in wet-start pumps. Friction coefficients were obtained using identically structured bearings to match test conditions. The graph plots one of the outcomes obtained by changing the bearing loads from 0.25 to 1.0 mega-Pascals (MPa) at four stages. The results show that all bearing materials have excellent friction coefficients.

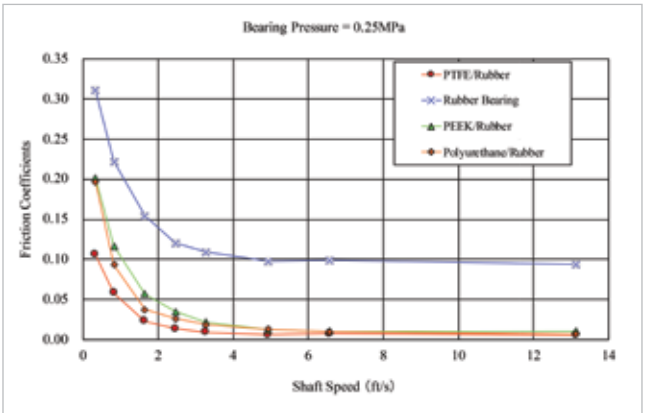


Figure 3: Relation between friction coefficient and shaft speed for various bearings.

Effects of Synthetic Rubber

Friction coefficients obtained using the two test bearings during wear resistance testing indicate that the test bearing with the persistently soft rubber layer (72 Shore A hardness) has a lower friction coefficient than the bearing with the rubber layer turned into ebonite (80 Shore D hardness). This suggests that the rubber layer may prevent sharp rises in the local pressure on the bearing conferred by the shaft deflection. The rubber seems to keep pressure low overall and limit the solid contact friction areas. The free surfaces of the rubber made by or among the PTFE strips may improve the elastic effect compared with the bearings without free surfaces facing the shaft, as with a the bearing with a monolithic ring-like structure of metal and resin[1]. The balance between the number of grooves and the size of the area in which the water film formed to lower the friction coefficients is important. If the number of grooves is increased to enhance the elasticity of the rubber, the size of the water film area will decrease and invite the larger friction coefficients and vice versa. Because the pump shafts of the vertical pumps are suspended on the center of the column pipes, the bearing load by the shaft weight is comparatively small, which is typical with vertical pumps. While this reduces the importance of self-alignment, another problem may emerge.

Adhesive & Abrasive Wear Resistance

Wear resistance related to adhesive wear and the abrasive wear of the slide members is an important factor for submerged bearings from the viewpoint of tribology. Figure 4 shows the results of an adhesive wear test on two pieces of same-sized bearings. One was the PTFE and rubber hybrid bearing, while the other contained abundant sulfur and was vulcanized to harden the rubber into ebonite with the hardness of 80 Shore D.

Figure 4 plots the coordinating friction data according to the wear amount after confirming the friction coefficients through a series of tests performed concurrently for the pure wear test and the measurement of the friction coefficients. The wear amount of the PTFE/ebonite hybrid bearing is displayed as a ratio, while the wear amount of the PTFE/rubber hybrid is assumed to be 1.0. The graph indicates that the wear of the original bearing with the soft rubber layer is about one-half of the wear amount of the bearing with a rubber layer transformed into ebonite.

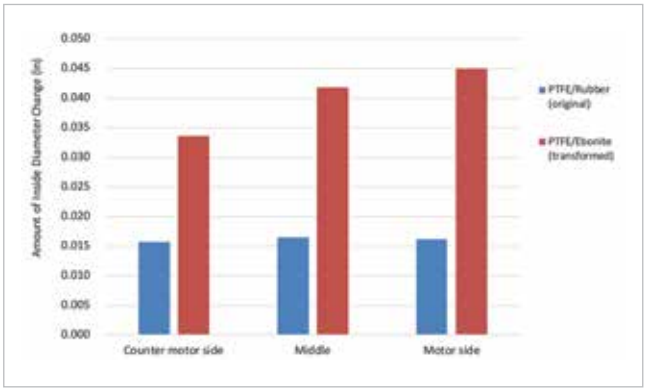


Figure 4: Test results of PTFE/Rubber hybrid bearing. (a) is figure of test bearing and (b) shows wear amount.

Absorptivity of Shaft Vibration

In addition to the effect on friction coefficients, the rubber layer also affects shaft vibration control. A viscoelastic material like rubber suppresses the self-excited or sub-synchronous vibration that is caused by the strong nonlinearity of the bearing characteristics and tends to appear when loads are small, as in the case of the shafts of vertical pumps. Figure 5 shows the peak-to-peak amplitude measured on a bearing spider fixed on the middle part between the column pipes of the test pump in operation. The inside radiating spokes holding the bearing in the shaft center were replaced with rods extruded from the load cells to measure the bearing load. This pump was 6 meters long under the floor. A 200-millimeter bored vertical pseudo-pump with three bearings (upper, middle and lower) was fixed in the bearing spiders. The impeller of this

pseudo-pump was replaced by a rotating disk with the same rotating inertia to cease its pumping action. The amplitude curves shown in Figure 5 compares the three kinds of bearings (PTFE/ rubber hybrid, nitrile rubber [NBR] and cylindrical silicon carbide [SiC] bearing). Rotation speed was continuously altered throughout the test, and the loads on each bearing, as well as the vibration amplitude, were traced. Only the cylindrical SiC bearings generated a self-excited vibration accompanied by the hysteresis phenomena. The PTFE/rubber hybrid bearings ran quietly through the full range of rotational speeds. Once excessive vibration is generated with the use of SiC bearings, an abnormal noise occurs, and the loads on both upper and middle bearings can increase by as much as tenfold[2]. These phenomenas were often observed in real pumps in factory tests and in the field. Based on these findings,

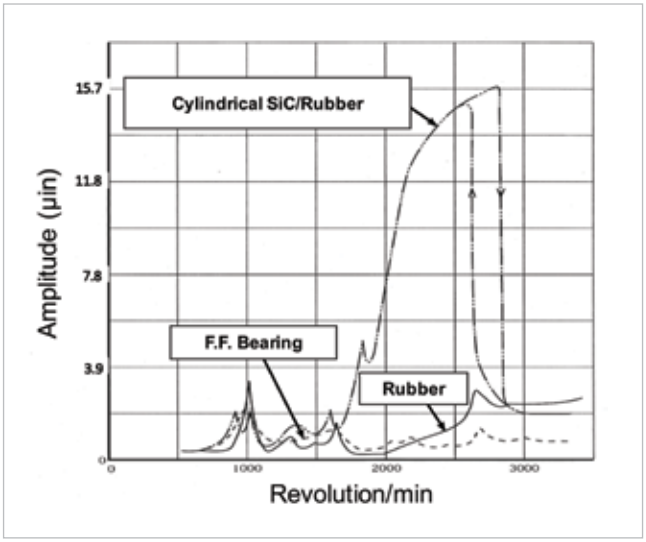


Figure 5: Vibration amplitude when used three kinds of bearings.

the rubber layer improves the damping performance of the pump system and weakens the nonlinearity of the bearing spring constant because of the viscoelastic nature of the rubber. The actions differ markedly from the actions of the monolithically structured metal/resin without rubber lining effects. Once a vibration like sub synchronous resonance is generated, pump parts, such as the shaft, might fracture. Even if the consequences are not severe, the abnormally raised bearing loads will result in extreme wear of the bearings[2].

Acceptability of Dry Runs

Figure 6 shows the threshold of the possible dry-start continuing time relative to the bearing pressure in an experimental run at a progressively higher shaft speed. The plot shows a nearly inverse relationship between the dry-run continuing time and bearing pressure. As expected, the bearing pressure remains low on the vertical pumps as long as their assemblies and alignments stay normal. The dry run can presumably be extended to a few minutes. Under the ordinary usage requirements for vertical pumps, the period of in-the-air operations using the dry start bearings at the point of pump startup is 10 seconds or less. Therefore, Figure 6 shows that almost all of the vertical pumps are capable of dry start[3].

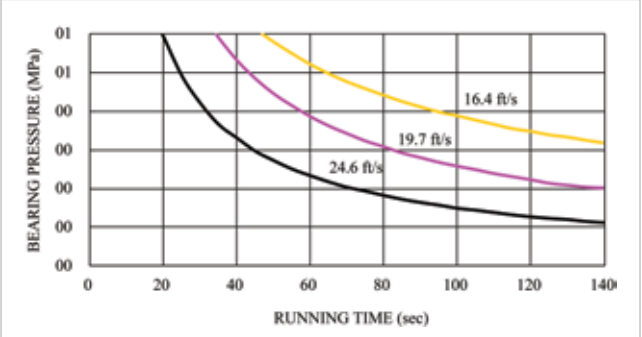


Figure 6: Dry-run continuing time at different bearing pressure and shaft speeds.

Acceptability of a Lack of Lubrication Water

A lack of lubrication water arises when some force or phenomenon intercepts the flow of replacement water to or from the bearing surroundings. Assuming a cutoff of the passage of lubricating water to and from the bearing, the test bearing was sealed in an experiment using the oil seals at both ends after immersion in water.

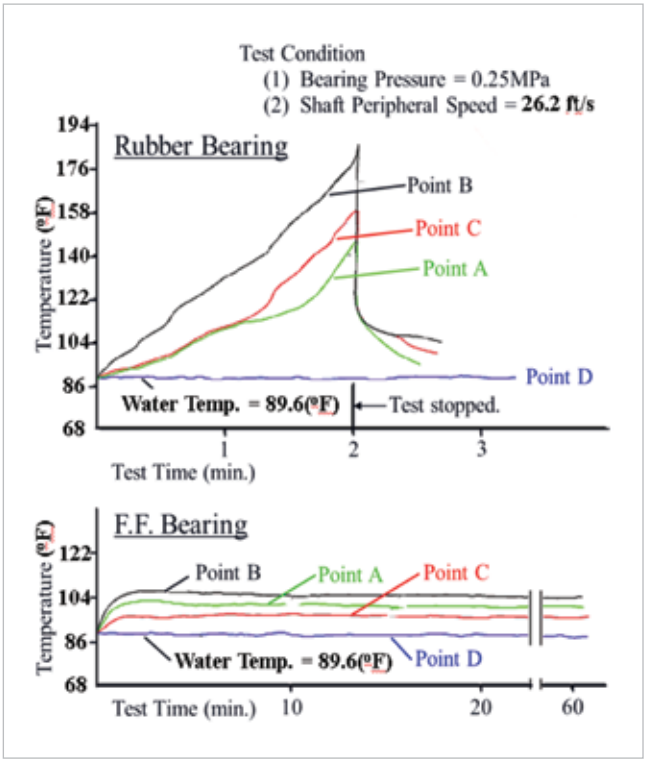
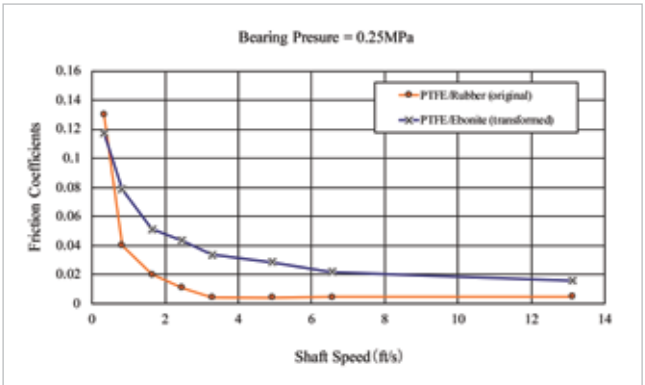
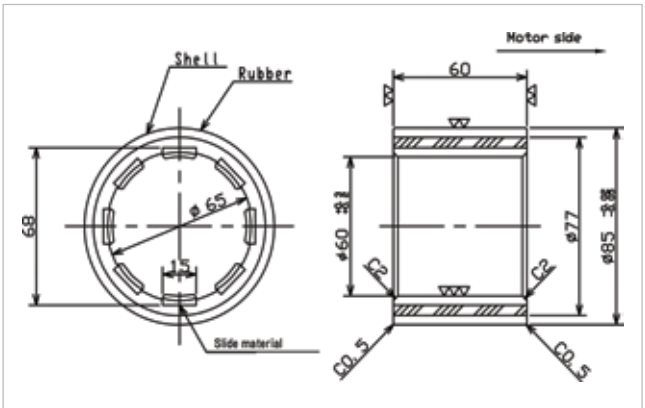


Figure 7: Temperature change when preventing feed water exchange to the bearings.





The bearing temperature was measured in the vicinity of the bearing surface. Figure 7 shows the temperature change of the test bearings during the experiment. Points A, B and C in the figure are temperature measurement points. Point B is at the middle of the longitudinal location of the bearings, and points A and C are at the two ends. When the inflow and outflow of lubrication water is blocked, the rubber bearings are at high risk of seizure. For hybrid bearings, the risk exists only when the bearing surfaces get wet[4].

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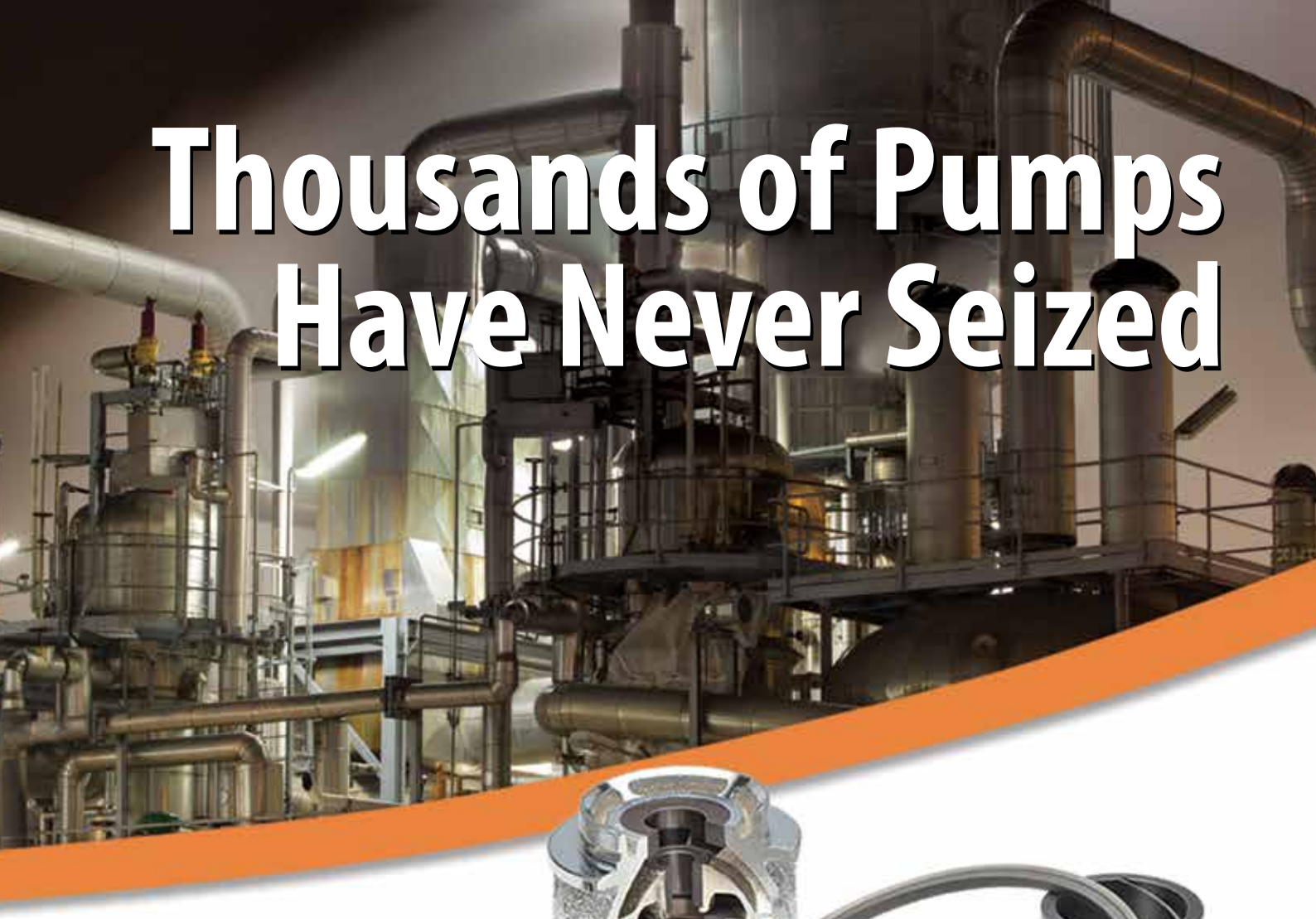

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Energy Efficient Engineering:

Interview with **Adam McMurtrey**, Industrial Sales Engineer, Midwest, ExxonMobil Fuels & Lubricants Company

When it comes to working with customers to solve lubrication and engineering problems, Adam McMurtrey relies on a lifetime of experience that goes all the way back to his childhood. For ExxonMobil's Mobil Serv program, he works closely with industries ranging from lead mines to chicken rendering plants—always with energy efficient lubrication at the forefront of every solution.

By Michelle Segrest, Contributing Editor

Adam McMurtrey.

Adam McMurtrey has a simple but effective process.

"When I go to a customer in any type of manufacturing, I tell them that I do three things," said McMurtrey, an Industrial Sales Engineer for ExxonMobil Fuels & Lubricants Company. "I use the acronym ACE. I will analyze the operation. I will try to consolidate the lubricants and greases that the company uses to help avoid contamination and to simplify its process. Then I try to enhance their operation either by extending the life of the equipment, extending mean time between failures or time between overhaul or by extending the life of the oil."

Usually, operations are already running when McMurtrey arrives at the facility. "Even if they do not use our other services, our engineering services are always available to the customers," he explained. "We support our current customers, and do not charge them for these services. We try to understand their operation and what makes it unique."

For example, one client has a plastic injection molding operation in Missouri in which they manage more than 100 pieces of old and new production equipment. "One of the things we realized early on is they have a significant amount of dirty hydraulic oil," McMurtrey said. "This causes two problems—it causes equipment failure and requires frequent oil changes or top-offs. We performed a Mobil Serv equipment study to understand the operation so we could make specific recommendations. Once we provided recommendations on filtration, ISO cleanliness, and storage and handling best practices, we helped them understand how they could reduce the amount of energy they consume over a specific period of time, in this case a year. We gave the client a proposal that saved them USD $106,000 per year from increased equipment life, increased production time, longer oil life, and reduced energy costs. It did not cost the client anything, it was just a recommendation, but they could take action on the specific changes

"When I go to a customer in any type of manufacturing, I tell them that I do three things: I will analyze the operation, I will try to consolidate the lubricants and greases that the company uses to help avoid contamination and simplify its process, and I try to enhance their operation."

we recommended for the oil cleanliness. Then we performed a total cost of ownership analysis to make sure it made sense for them to use this energy efficient hydraulic oil."

The client adopted both recommendations and now uses the energy efficient hydraulic oil for their operation. A project like this could take three to 12 months to complete.

"It did not make sense for the client immediately—why would they put an energy efficient hydraulic oil into contaminated reservoirs?" McMurtrey explained. "There are times when we make a recommendation that we believe will extend the life of the valves, and pumps, and other equipment, but it actually does not make sense for the customer to implement it. In this case, we usually give them the documentation so they understand, but then recommend that it does not make sense to move forward."

Sometimes the recommendations involve changing the operation or changing the habits of the operators to get the desired result. "That is the hardest part," he said. "For example, we may say, instead of changing the oil every month, we recommend changing it once a year. Also we need to help them realize that in some applications they are greasing the application too frequently. It can take a while for them to adjust to these new habits. If the recommendation does not make sense, we are fine with that. It is just good to look at it so you know what is possible."

Since the 1970s, ExxonMobil has pioneered used oil analysis and continued to refine predictive maintenance technology through breakthrough innovation. Mobil Serv Lubricant Analysis provided accessibility and convenience and timely, accurate in-service analysis. The state-of-the-art laboratories process more than one million samples every year. The data and recommendations delivered help customers be more productive and efficient, avoiding costly unscheduled downtime while enhancing safety and environmental care.

Background

McMurtrey grew up in Colorado with three brothers and a sister, who is now a civil engineer. The 33-year-old has been working in the field for eight years, but got his early training from his father, also an engineer.

"Growing up in Colorado was a very rich experience," he said. "I did not always appreciate it at the time. I felt like my Dad was trying to ruin my childhood a little bit because on Saturdays I wanted to play sports and watch cartoons. Instead, my father bought some mountain property and he would take us boys up there, and we would try to build something. We built a zipline and a cabin. One year for Christmas my mother got my father a bulldozer. It took us a while to get it started but once we did, we started pushing some dirt up the hill and the tracks came off the bulldozer. It took us four hours to get it back on track, but we learned to work with tools. We learned how things work. We worked through winters, and we worked through summers—this really made me interested in understanding how things worked—and in particular, how things do not work and how to avoid having things stop working. I spent a lot of time with frozen fingers trying to get something to work so I could go home and have a nice warm meal."

"Growing up in Colorado was a very rich experience. I did not always appreciate it at the time. I felt like my Dad was trying to ruin my childhood a little bit because on Saturdays I wanted to play sports and watch cartoons. Instead, my father bought some mountain property and he would take us boys up there, and we would try to build something."

McMurtrey graduated from Brigham Young University with a chemical engineering degree.

He worked in the construction industry for Dow Chemical—working with construction crews and architects for five years in New York and Washington, D.C., trying to build energy efficient buildings. During that time, he became a LEED green associate—an industry designation signifying that you understand how to make things energy efficient and about environmental design. "It was always important to me to understand the mechanics of how things work, but it was also important to me to understand the processes and how make things work not just one time, but every time," he said.

It was this passion for energy efficiency and sustainability that drove McMurtrey to his current position with ExxonMobil.

"I think I was always interested in making things better—and energy efficiency fits right into that," he said. "This is a big energy provider company. What we are finding here is that, particularly with hydraulic pumps, we are able to reduce the energy consumption that pumps need to do their job in all applications— including mining, construction, general manufacturing, and plastics manufacturing. We are finding that we are able to reduce

the amount of energy that pumps consume to do their job. In some instances, we can help customers get incentives through company efficiency programs."

Training

McMurtrey said that one of his favorite parts of the job is to train. "Training is a broad term," he said. "I really enjoy training because we get into things like behavior change and the actual technical details of the whys. Why do we need to do this? Why does this work? Once people understand how this applies to their own life, it then makes sense in the work environment. If someone is training me on how to do something, I generally think about whether this makes sense for my car or other pieces of machinery I use in everyday life. Then they can drop back and apply it in a way that makes sense."

McMurtrey's team uses a combination of training resources including general instruction and facility walk throughs.

"It is important to walk around and have discussions about the specifics of why and how," he said. "As we have these types of discussions, it seems there are a lot more questions. We have content to present, of course, but we do not usually have a formal slide presentation. Sometimes it happens organically. People bring up issues they are dealing with because we just happen to be in front of them. They may say, is there anything you guys can do about this, and we can dive into their specific issue. The training does not always start specifically. We may not have all the answers going in, but the training in its basic form is built in such a way that it allows us to open up to specific issues."

McMurtrey utilizes distributors who help with onboarding and implementing. He collaborates with his senior lubrication engineer to consult on issues like gear inspections and engineering studies.

Extending Equipment Life

McMurtrey said his group has a methodology for extending the life of pumps, valves, and other equipment across all industries.

"We recently were inspecting an operation that makes rail cars," he said. "We can look at it in a real way to show ways to extend the equipment life, its uptime, and its reliability. Each situation is different so there is not a cover-all method. Sometimes the solution is through our products. Sometimes it is through storage and handling, or the cleanliness of the oil that contributes to that."

An energy efficiency example is from a 2.5-year study on a plastic injection molding operation and an axial piston pump that was able to achieve more than 3%

energy efficiency. This was measured by a third party engineering team for a customer in a real application, working with the Wisconsin Focus on Energy Program.

Reflecting again on his childhood experiences and the wisdom gleaned from his father, McMurtrey remembered one of the lessons learned. "One problem my father always had was that every month a pump would fail," he said. "It is very dry up there. We put a pump in a well that was 600 feet deep so we could have water. After only six months, it failed. It was powered by a solar array. Even at home we had a sun room with a waterfall. It just seemed like any pump my father touched would fail. I learned even then that any time I buy a pump, I am going to buy the best pump. I learned to just go for quality. Do it right and at the right time."

Advice and Tips

McMurtrey offers advice for other end users. "My area of expertise is around lubrication so first and foremost, it is important to keep the oil clean," he said. "We teach customers to be independent. We do not want them to have to rely on us. We want them to be competitive against other manufacturers across the globe. One tip is to filter the oil. Another is keeping it clean and dry. This extends the life of the equipment and the oil significantly. This is the reality—I am basically helping my customers buy less of what I sell. This is good because it helps them to be competitive and sustainable as a business. I do not just want to sell them product, I want them to improve their operation."

The Universe of Different Oils is Huge

"There are motor oils for passenger vehicles and oils for highway trucks," he explained. "There are food grade oils that you can actually consume. There are oils for all applications. There are hundreds of types of oil products across all types of manufacturing. There are gear oils, and crank case oils for engines, and R&O oils, hydraulic oils, compressor oils and turbine oils for power generating stations. Oil is designed for very specific applications."

McMurtrey said this is why the consolidation piece of his job is so important.

"A customer may have 10 different products on hand," he explained. "Some is used every day, and some is used twice a year. We can take our understanding of how these oils and lubricants were designed and understand the specific type of application and what the OEM is recommending to make an engineering recommendation to perhaps consolidate down to three greases and a few lubricants."

McMurtrey and his Mobil Serv team are forming a marriage between the equipment, the oils, and the application. Mobil Serv is the engineering service brand. "We try to help any manufacturer advance their ambitions toward mobility, productivity and sustainability. We cover many applications, but we are really good at general manufacturing, all things mining and construction, plastics manufacturing, food-related production, petrochemicals, passenger and commercial vehicles, aerospace, rubbers and tires."

McMurtrey's father is still building things in the foothills of Colorado. "He is still working with tractors and growing vegetables," he said. "I think he is proud of two things—one is that he instilled in all of us a desire to work hard, and put in long days—sunshine or not. Anytime I go to visit he asks if I want to plant a tree or work on the farm. There is always a drive to be in touch with nature and to keep our hands dirty. That is part of his essence and he instilled in us to not be afraid to get dirty and make things work better. It is always rewarding if I can make sense of what I do. It is the engineering gene."

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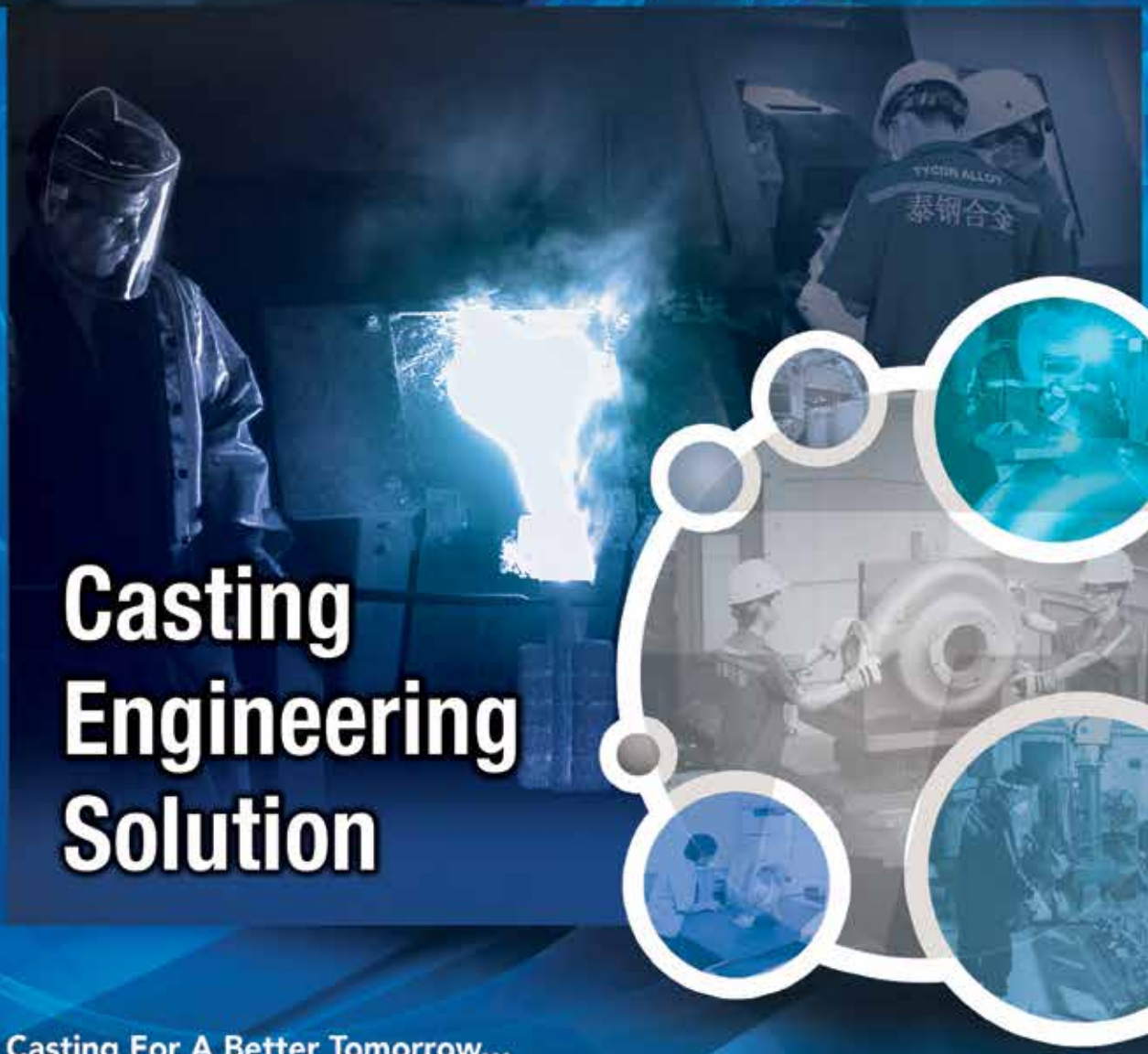

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Single Stage Volute Casing Pump:

Pressure Head Losses and Resistance Coefficients

A pump working as a turbine was comparatively investigated to determine the cause of the pressure head losses in four separate cases. This case study was not conducted with the intent of further contributing to the theme of 'Pump as a Turbine', as this topic is already extensively treated in other relevant technical literature. Instead, this study focuses on the results of measurements carried-out based on a particular order. The scope of the measurements, and their presented evaluations, are meant to be informative usable results for practice.

By Jürgen H. Timcke

The Test Subject

The test subject for this case study was a single stage volute casing pump with axial inlet and radial delivery branch, size 125-100- 200. It had a baseplate, a coupling and an asynchronous standard motor, size 180L, type B3, P = 37 [kW], n_{SYN} = 3000 [1/min].

*Note: the designation of the pump size "125-100-200' corresponds to the well-known international valid standard "ISO 2858":

125 = Nominal width of the suction branch

100 = Nominal width of the delivery branch

200 = Impeller nominal diameter

(Numerical values are in millimeters).

The purpose of the study was to determine the pressure head loss between the suction branch and delivery branch as well as the loss between the delivery branch and the suction branch. This was tested at both the turnable and not turnable runner, to see if the flow rate (Q1) of the feeding pump (P1) would flow alternatingly in normal or reverse direction through the second pump (P2), as seen in Figure 2. The particular output speeds for both the flow-through directions were also measured during the study.

Figure 1a shows the characteristic curves of size 125-100-200 while Figure 1b shows the section drawing of a single stage volute casing pump as used as "P2' for the investigation. Figure 2 depicts the test set-up for normal and reverse flow direction, with reference to P2.

Definition

For the purpose of this study a 'runner' will be designated as the rotor of P2 and rotor of the motor, both connected with a coupling. The 'runner' will be distinguished as 'turnable' in one case and 'not turnable' in the other, by means of corresponding mechanical locked measures.

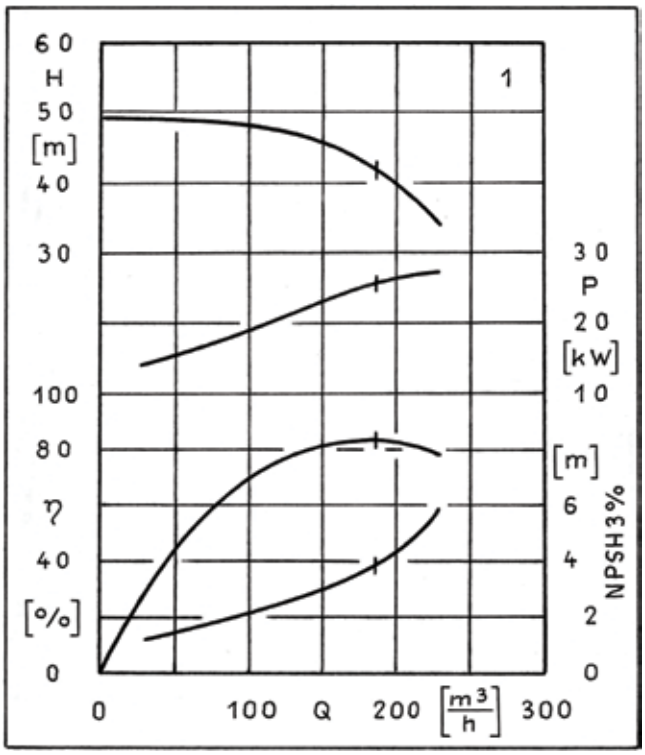

Figure 1a: *Characteristic curves of the size 125-100-200 (P2 in figure 2), n = 2900 [1/min], n_q = 40,1 [1/min].*

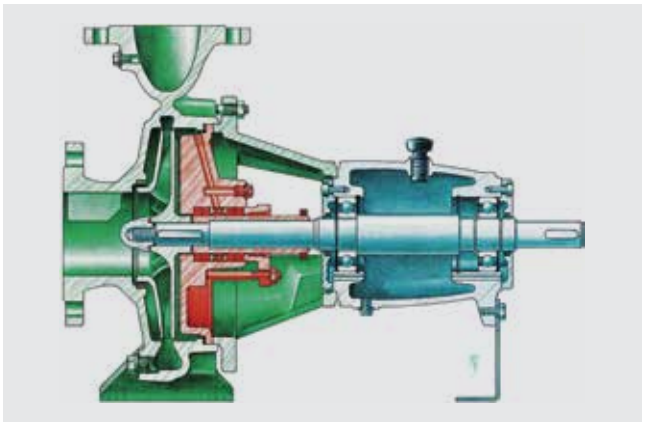

Figure 1b: *Chemical standard pump according to ISO 2858, (RÜTSCHI PUMPS Ltd. Brugg/Switzerland). The different colours on the drawing above are allocated to the three assemblies:Green = assembly "volute casing", Red = assembly "shaft sealing" and Blue = assembly "bearing".*

Abbreviations

For simplification, the following abbreviations will be used throughout the text:

- Single stage volute casing pump: P = general, P1 = feeding pump, P2 = pump to investigate
- Flow rate of the feeding pump P1: Q1
- Turbine: T
- Pump branches: S = suction branch, D = delivery branch
- Flow direction: S-D = normal, D-S = reverse
- Measuring points: E = at the inlet, A = at the outlet
- Pressure head at the pump branches: HDE = at the inlet, HDA = at the outlet
- Pressure head loss: HDV = general
  - HDV_{S-D} = from the suction branch to the delivery branch
  - HDV_{D-S} = from the delivery branch to the suction branch
- Output speed: n (with corresponding index)
- Resistance coefficient: ξ

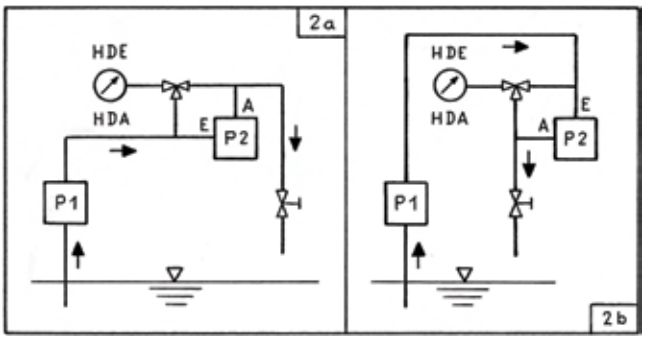

Figure 2: *Simplified presentation of the test set-up: P1 = feeding pump, P2 = pump 125-100-200; flow directions, referred to P2, figure 2a: normal (S-D), figure 2b: reverse (D-S).*

Reasons for Pressure Head Losses

When considering the typical causes of pressure head loss in a pump that is flowed through by the flow rate of a feeding pump, the following, independent of the size, should be taken into account:

- The n_q - dependent design of the impeller meridian profile
- The shape of the impeller vanes

In this study, P2 has a so-called Francis-impeller with seven three-dimensional vanes with the leading edges moved forward into the impeller eye, and an outlet diameter/inlet diameter equal to 1,56.

In normal pump operation, the back-flow from the impeller outlet to the impeller inlet must be as small as possible. Therefore, between the impeller and the volute casing radial throttling, there exists gaps on both sides. (In the referenced literature, the throttling gaps are sometimes designated as 'sealing gaps', but this is not correct: the back-flow has to be 'throttled' and not 'sealed'!).

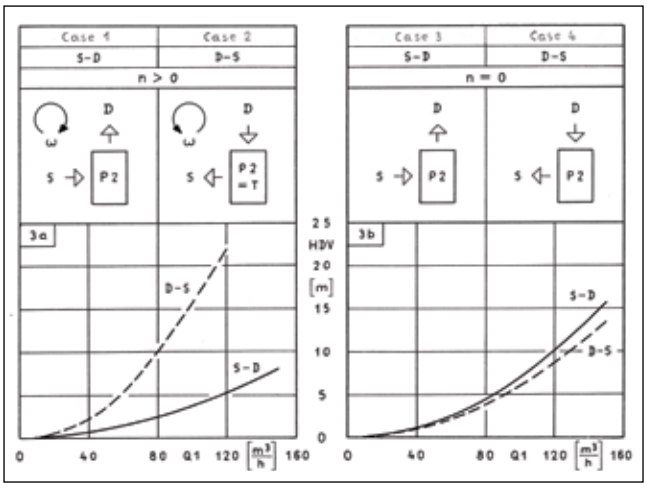

Figure 3: *Pressure head losses HDV dependent on the flow rate Q1 of the feeding pump P1, flowing through pump P2 at normal (full lines) and reverse (broken lines) flow direction, figure 3a: runner turnable, figure 3b: runner not turnable.*

Although still relevant, the design of the impeller sidewall gaps and the shape of the cross section of the volute and the diffuser, have less influence on HDV.

Pressure Head Losses HDV

The measured values of HDE and HDA are used to calculate the pressure head loss:

HDV = HDE - HDA

Better overall views of this process are depicted in Figures 3, 4 and 5. The calculated HDV-values, (Figure 3 and Figure 4) and the values of the measured output speeds n, (Figure 5) are not marked with symbols.

For pressure head losses the following is generally valid: $HDV = \xi c^2/2g$, c = flow velocity at the outlet of the flowed-through component which causes the pressure losses. This is true in the present case with the pump P2. ξ is the resistance coefficient, dependent on the component designing; this is the shape of the surfaces which comes into contact with the liquid.

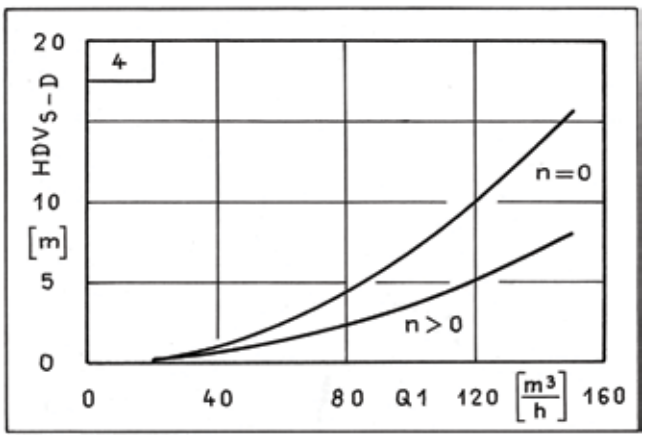

Figure 4: *Comparison of the pressure head losses HDV_{S-D} at turnable runner (n > 0) and not turnable runner (n = 0) at normal flow direction S-D.*

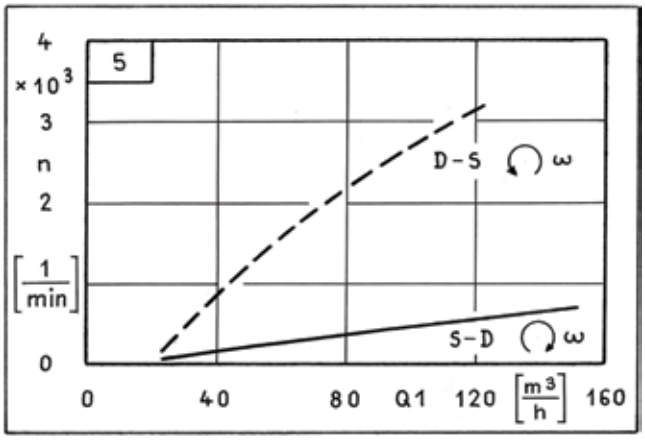

Figure 5: Output speeds n_{S-D} and n_{D-S} dependent on the flow rate Q1 of the feeding pump P1, flowing through pump P2 at normal (full line) and reverse (broken line [P2 works as turbine]) flow direction.

In the above mentioned equation, the flow velocity c is squared. Consequently, the tendency of the curve HDV = f(Q1) is to be parabolic. When the afore mentioned curves were checked, they showed extremely little deviations from the mathematically exact parable shapes. This confirms that the numerical HDV-values are meaningful without any restrictions.

Determination of the Pressure Head Losses HDV

The following four cases were investigated:

< Case 1: runner turnable, flow direction S-D

< Case 2: runner turnable, flow direction D-S

< Case 3: runner not turnable, flow direction S-D

< Case 4: runner not turnable, flow direction D-S

Results

Figure 3a shows the curves HDV = f(Q1), designated as 'HDV-curves', for Case 1 and Case 2. Figure 3b depicts the curves for Case 3 and Case 4.

Figure 3a, also depicts the HDV_{D-S} - curve of P2 working as a turbine. This curve is very steep and hence it follows, in accordance with HDV = HDE - HDA, that the HDV-values are very high. The high values are caused by the overwhelming part of the pressure head, HDE, being transferred into 'turbine power'. Therefore, in one case the HDA is very little and in the other case the output speed n_{D-S} is very high, see Figure 5.

6 Case	Runner	Flow direction	Output speed n	Resistance coefficient ξ	
				Arithmetical mean value	Rounded
1	turnable	S-D	> 0	6,06	6,1
2		D-S		56,75	56,8
3	not turnable	S-D	0	11,08	11,1
4		D-S		23,72	23,7

Figure 6: Resistance coefficients ξ.

To label the process as 'pressure head loss' and impose a negative connotation on the word loss is therefore an inaccurate depiction of what is taking place.

Figure 3b shows that the HDV_{S-D} - curve for Case 3 has a little steeper tendency when compared to the curve in Case 4. The reason is not only the different flow directions (S-D compared with D-S), but also the kind of the flow itself inside P2:

< In direction S-D (case 3) it is a decelerated flow which results in higher losses (centrifugal pump!)

< In direction D-S (case 4) it is an accelerated flow which results in less losses (turbine!)

These connections are well-known from the fluid mechanics and are valid for both cases: runner 'turnable' and 'not turnable'.

If comparing the HDV_{S-D} - curves of Case 1 to Case 3, as seen in Figure 4, it becomes apparent that the HDV_{S-D} - curve of Case 1 is nearly half as small again than that of Case 3. This can be explained as follows:

- Turning with n_{S-D} causes the impeller to produce a certain pressure head, which rises with the increase of Q1 and, consequently, increases the output speed n_{S-D}, see Figure 5.
- This results in greater HDA-Values at the turnable runner than the values which occur at the not turnable runner. Consequently the HDV-values will be smaller.

Resistance Coefficients ξ

For all four investigated cases, and for each of the calculated HDV-values and their appertaining flow velocity at the outlet, c = f(Q1), the velocity head $c^2/2g$ was calculated. Using these two values the resistance coefficient $\xi = 2gHDV/c^2$ was also determined.

For each case and its appertaining ξ -values the arithmetical mean value was calculated. In Figure 6 these values are presented as well as those which are rounded up or down to the first decimal place.

Summary

The results show which pressure head losses originates a single stage volute casing pump, installed as 'resistance in different states' in a pipeline system which will be flowed-through in an alternate direction.

The numerical values, of course, are valid only for the investigated pump P2, but the tendencies of the HDV-curves and those of the output speeds can be considered as generally valid.

The results of Case 1 and Case 3 would be of special interest for the layout engineer, as well as for the work engineers in the plant (in practice referred to the second of two pumps operating in series):

< Case 1: runner turnable, flow direction S-D

(situation in practice: breakdown of the driving motor)

< Case 3: runner not turnable, flow direction S-D (situation in practice: pump rotor blocked, driving motor switched off)

Finally, some comments on the resistance coefficient ξ of Cases 1 and 3, see Figure 6.

While the HDV- and the c-values depend directly on the flow rate Q1, they do not for the resistance coefficient ξ. The coefficient for each of the investigated cases, i.e. the state of the flowed-through pump P2, is a constant quantity. For example, each armature of the same design has a constant resistance coefficient ξ for each size.

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About the Author

Dipl.-Ing. Jürgen H. Timcke studied mechanical engineering at the University of applied sciences in Karlsruhe. Based on his degree dissertation he decided to start his professional activities in the field of centrifugal pumps. He has 40 years experience in his field and during this period of time he was the last 30 years manager of the departments development, design and testing at the international well-known pump companies RÜTSCHI, ALLWEILER and SULZER. Apart from his professional activities he was for 10 years lecturer at the University of applied sciences in Konstanz. Other articles by Timcke can be found at: www.juergen-h-timcke.ch

As an expert in his field he was elected a member of the AMERICAN SOCIETY OF NAVAL ENGINEERS.

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PUMP ACCESSORIES

Pekos Valves S.L.U
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pekos@pekos.es
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fax:+45 98 17 5499
desmi@desmi.com
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FLUX - GERAETE GMBH
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Export@flux-pumpen.de
www.flux-pumpen.com

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www.torishima.co.jp

PUMP PACKING

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SPARE PARTS

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AUGUST 2019

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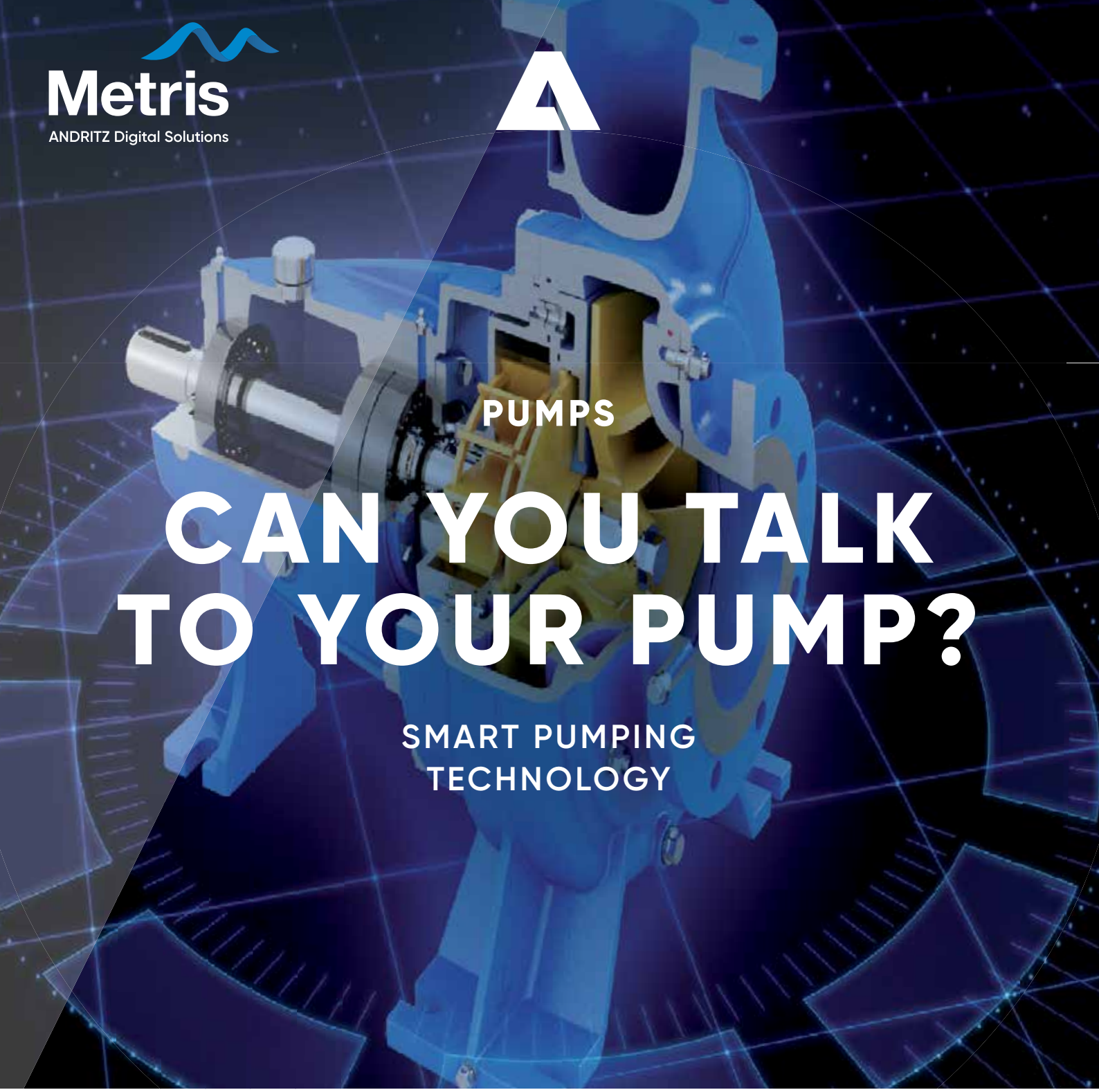

PUMPS

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