The global magazine for pump users and suppliers

PUMP engineer

Special Topic: Oil & Gas

In this issue of Pump Engineer magazine:

Volume 29, April 2021

COVER STORY:

Tycon Alloy

Leading the Casting Industry and Seeking Perfection with One-Stop Solutions

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COVER STORY

Tycon Alloy: Leading the Casting Industry and Seeking Perfection with One-Stop Solutions

As of January 2021, all of Tycon Alloy's assets were successfully transferred to its new facility in Zhongshan, China. Recognizing the success of the move, Michael Lo, General Manager of Tycon Alloy, expressed how beneficial the larger production capacity and environmentally friendly facility have been for the company. Pump Engineer had the pleasure of speaking with Mr. Lo and Mr. Benny Lu, Regional Business Manager, about Tycon's coping strategy for overseas markets in the post-epidemic era and how it intends to move towards a better 2021.

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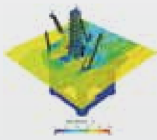
A common challenge in the industrial sector is finding a solution that works for not only the application, but also the engineering teams. Learning how to recognize when to be a leader and when to be part of a team has been a lifelong experience for David Amesty, Lead Mechanical Engineer, P. Eng.

SPECIAL TOPIC

16 **CFD Simulation for the Oil & Gas Industry**



The oil & gas industry is well known for operating in harsh environmental conditions. The engineering needed to withstand these natural forces must be structurally sound, or the risk of health and safety-related incidents can increase. Regular maintenance is not always possible in remote locations where the industry operates. Having the ability to accurately design and test components such as pumps is an essential part of the design process.

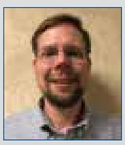
Q & A

28 **Q&A: Monitoring Seals and Sealing Systems**

Pump Engineer is proud to present Q & A | Monitoring Seals and Sealing Systems. This article will address the three primary factors to consider when establishing seal monitoring goals. In order to improve a sealing system's reliability, the data collected through monitoring a system must be converted into knowledge that will be used to meet the stated goal.

END USER INTERVIEW

34 **Understanding the Cost of Failure:** Interview with Robert Bishop, Plant Manager, Chemtrade Syracuse



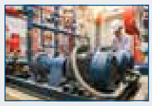
When it comes to maintaining critical equipment like pumps and valves, Chemtrade Plant Manager Robert Bishop relies on modern technologies like ultrasound, thermography, and vibration analysis to determine the cost and impact of failures, for large and small facilities.

TECHNICAL ARTICLES

24 **Conversion of NPSH-Values to Another Speed: Quadratic or Not?** | Part 1

The conversion of the head (H) of centrifugal pumps from the speed n1 to the speed n2 can be done by means of the well-known equation $H_2 / H_1 = (n_2 / n_1)^2$. *Is this equation, however, also valid for the conversion of Net Positive Suction Head (NPSH) to another speed? The use of the equation for both purposes therefore leads one to question: is it correct to use the exponent '2' in the equation* $NPSH_2 / NPSH_1 = (n_2 / n_1)^2$, *without any restrictions?*

32 **A Single Point of Centrifugal Truth:** Closing the Gap Between Operations and Maintenance Through Real-Time Performance Data



Centrifugal pumps are vital pieces of industrial equipment. While maintenance and operations departments agree that it is important to keep them up and running, each department's views on care for the application start to differ when the pumps malfunction. To mitigate the risk of hostility between operations and maintenance when an error occurs, real-time performance data can be used.

42 **Integrated Rupture Disk Assemblies for OEM Hydraulic & Pneumatic Equipment**

For over 85 years, rupture disks have served as an effective passive safety mechanism to protect against overpressure or potentially damaging vacuum conditions. The disk is designed to activate within milliseconds when a predetermined differential pressure is achieved. As equipment reliability in operation is essential for its owner, high integrity from the pressure relief technology used to protect low- and high-pressure OEM systems is crucial.

ALSO IN THIS ISSUE…

Dear readers,

As the weather begins to change and the days get longer, I am filled with a renewed enthusiasm for the many exciting possibilities of 2021. The opportunity to attend conferences and meeting points to witness industry leaders joining together to focus on expanding and improving their pump knowledge, while making progressive goals for the future of the pump industry, is something I am greatly looking forward to. It is always inspiring to see what further strides have been made in our industry! On that note, 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 oil & gas, which is this month's special topic, provides us with the opportunity to take a closer look at the systems and technologies used in tandem with industrial pumps to ensure that harsh conditions do not hinder oil and gas production. Our Special Topic article, found on page 16, provides an in-depth analysis on how computational fluid dynamics are used to simulate fluids' behaviors in a pump design. This model is used to mitigate the risk of unforeseen complications once the pumps are in operation by applying the properties and behaviors of fluids, materials, and the environment to the simulation.

In this month's Cover Story, we explore the progressive steps TYCON ALLOY is taking to support its overseas markets in the post-pandemic era, and how it intends to move towards a better 2021. With customer service at the centre of everything it does, TYCON ALLOY continually strives to strengthen its connections by offering services that range from early product development and technical support, to after-sales service and well stocked inventory. Discover the many ways that TYCON ALLOY is dedicated to expanding its footprint into new industrial sectors by providing a one-stop solution for the casting industry, on page 8.

End user Robert Bishop also provides insight on how he relies on modern technologies like ultrasound, thermography, and vibration analysis to determine the cost and impact of failures, for large and small facilities, on page 36. Our Market Report sheds light on how the Covid-19 pandemic has accelerated a trend toward a proactive strategy that uses sales leadership rather than sales leads, on page 38.

With such a wide range of pump focused technical articles and case studies, 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. 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.

Angelica Pajkovic

Editor, Pump Engineer

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Pump Engineer 2021 Special Topics

June 2021: Pump Instrumentation

August 2021: Seal-less Pump Technology

October 2021: Power Generation

December 2021: Seals & Bearings

Global Highlights

NEW PROJECT

Hamworthy to Provide 230+ Pumps for Royal Navy Frigates

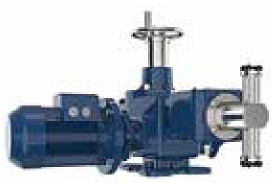
Hamworthy Pumps is to supply Babcock International Group with pump solutions for five highly specialized Type 31 military vessels. With this contract, the two companies strengthen an already close and long-standing collaboration on deliveries to the government market in the UK.

The Babcock International Group contract includes the delivery of a total of 235 pumps over a five-year period. According to the newly appointed CEO, Hans Christiaan Laheij, the Type 31 program will be an important reference in the coming years, with Hamworthy Pumps further increasing its focus on the Navy segment.

"Hamworthy Pumps has a long history as a supplier for naval projects and a significant installed base on military ships in the USA, Canada and the Netherlands," says Hans Christiaan Laheij.

DIVISION REBRAND

Seko Industrial Processes Renames Division: Exakta



Italy's Seko Group has recently renamed their Seko Industrial Processes division 'Exakta'. Based in Milan, Exakta designs, manufactures and supplies metering and process pumps for heavy-industrial processes across a number of sectors, including oil and gas, water treatment, and power generation.

Seko Group says that the rebranding is a continuation of the business's strong growth in the industrial processes sector over many years. Seko Group, which specializes in chemical dosing and control systems for cleaning and hygiene and water treatment applications, has an annual turnover of EUR €200 million and more than 1,300 employees worldwide.

NEW EDUCATIONAL RESOURCE

Hydro, Inc. Launches Hydro University

Hydro, Inc. has decided to use the extensive experience repairing, rebuilding, and optimizing pumps they gained from OEMs to teach and engage the next generation of industrial pump users. Hydro University is a new resource that provides hands-on, applicable pump knowledge to optimize industrial operations while also reducing maintenance costs.

Hydro University utilizes 3D modelling, taking students directly inside a pump to show them each element and how its performance affects efficiency, optimization, and energy savings. It will also teach best efficiency points, affinity laws' use for system changes, vibration analysis, and pump design configurations. Hydro University will offer webinars, seminars, e-learning courses, and applied knowledge. Training programs are designed for individuals seeking to expand their knowledge or skills, and for companies looking to educate/train groups of employees.

SUPPORTING VACCINE PRODUCTION

Flowserve Supplies Pumps for Pfizer's Vaccine Production

Flowserve Corp is providing pumps, valves, and seals to Pfizer to support the production of its COVID-19 vaccine. The Flowserve manufacturing facilities in Chesapeake, Virginia, USA, and Itzehoe, Germany are supplying pumps to the pharmaceutical company for their North American and European vaccine production. Through its channel partner Corrosion Fluid Products, Flowserve is also providing Pfizer with a cryogenic valve application to support its expanded COVID-19 vaccine production.

"Pfizer has been a Lifecycle Advantage customer since 1997, and now more than ever, we were pleased to be given the opportunity to let the experience and commitment of our associates support Pfizer's immediate needs as they developed and deployed a COVID-19 vaccine," said Scott Rowe, Flowserve president and CEO.

Product Developments

AllightSykes has released the Sykes Acoustic Stackable Pumpset to complement its extensive range. The new product offering has automatic priming, solids handling capability, and 316 stainless steel wear plates and impeller, enabling use for mildly corrosive fluids. The stackable frame can stack pump units two high, offering space efficiency. The design focuses on ease of use so the pump can be operated without having to open doors. Powered by a fuel-efficient Perkins 400 Series or 1100 Series engine, oil change intervals are up to 500 hours, lowering costs and making it more environmentally friendly. Safety is also key to the Pumpset, with two external emergency stop buttons, a fire extinguisher recess, and a robust design.

KNF has released an additional low pulsation pump, the FP 70, to its smooth flow series. The FP 70 combines the low pulsation from centrifugal and gear pumps with the strength of diaphragm pumps. The KNF FP 70 smooth flow pump is designed for use in applications such as medical technology, inkjet, 3D printing, and analytical instruments. It is self-priming, can run dry, handles liquid transfer gently, and is chemically resistant. The KNF FP 70 achieves a flow of up to 850 ml/min and has been developed for operations up to 2 bar (29.4 PSIG) pressure. In addition, the patented four-point-valves ensure reliable self-priming of the pump, so no additional priming pump is required.

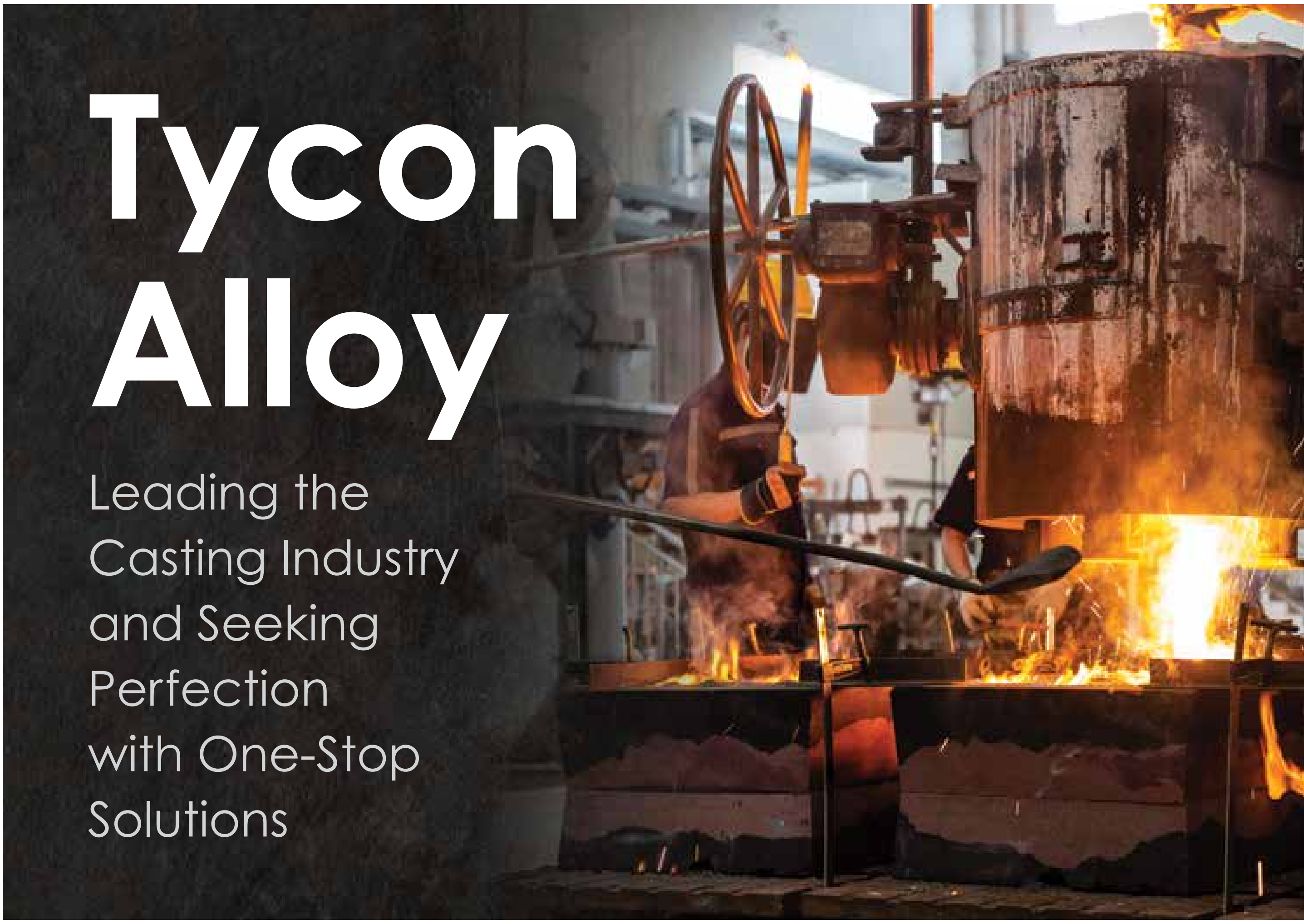
Sulzer's energy-efficient CPE (single-stage) centrifugal pump range has been granted NSF61 and NSF372 drinking water certification. The CPE pump range now conforms to the most stringent standards applied to drinking water applications. One of the most notable features of the CPE is its increased energy efficiency. The pump's energy efficiency rating greatly exceeds the requirements of the U.S. Department of Energy (DOE), resulting in long-term energy savings for customers. The CPE pump is designed to meet the process requirements for a range of applications, including clean or slightly contaminated liquids, viscous liquids, and fibrous slurries. Having now achieved NSF drinking water certification, CPE process pumps can now be used in water treatment, water supply and distribution as well as desalination applications.

ProMinent recently expanded the performance range of its range of peristaltic metering pumps to a maximum performance of up to 65 l/h at up to 5 bar backpressure. The DFXa series has been developed for small dosing quantities and has three versions which meter 6–18 l/h (5bar), 10–30 l/h (7bar) and 22–65 l/h (5bar). The new 18 l/h variant is suitable when a few ml/h need to be dosed with high precision. The peristaltic metering pump is designed for metering outgassing, abrasive, shear-sensitive and highly viscous liquids. Tests showed that the DFXa can dispense media with viscosities of up to 200,000 mPas. At maximum feed rate, the rotor speed is 100 rpm for all types, and the wide control range of 1:3,000 allows very slow speeds, further extending the service life.

The Netzsch NOTOS Multi Screw Pumps offers a series of self-priming pumps that deliver precise, high efficiency operation. This pump range includes three models in multiple arrangements. The NOTOS design is based on the HEUD concept — High Efficiency Unique Design. The concept has resulted in a pump with precise tolerances, optimized spindle profile and optimized discharge design. The NOTOS Multi Screw Pumps offer precision, efficiency and reliability in an easy to maintain, lightweight package. It is suitable for a wide range of applications including oil and gas, marine, power generation, tank storage, and process industries. Additional upgrades are available for the NOTOS to meet the American Petroleum Institute (API) standards; in addition, a wide range of materials are available including grey cast iron and chrome-nickel steel, as well as duplex, superduplex or Hastelloy steel.

Tsurumi has expanded its LH-series of heavy-duty submersible pumps designed for high head drainage applications at construction and mining sites. With a maximum capacity of 14 m^3/min and a maximum head of 92 m, the pumps meet the needs of; open-pit and underground mining, heap leaching, and large-scale tunneling work. The new LH-D-series has 2-pole 110/185 kW motors, on which a double suction impeller is mounted to deliver reliable performance in high volume, high head applications. The main feature of these pumps is that they powerfully draw large volumes of water from both the upper and lower sides of the double suction impeller. This ultimately reduces thrust load, extends service life, and increases the stability of pumping operations.

ITT Goulds Pumps has announced the launch of its newly redesigned 3700i API 610 OH2 Pump for the oil industry. This enhances Goulds Pumps' OH2 market offering and is API 610 12 Edition Compliant. The new pump is the first OH2 pump in the industry to feature Goulds Pumps' patented filter cartridge that continuously filters contaminants from the oil and removes damaging water from the bearing oil utilizing specifically engineered moisture-absorbing materials built into the filter. The 3700i is a single-stage, radially split overhung pump and now offers new casing features, improved temperatures, i-FRAME technology, oil filtration, and is compatible with Goulds' i-ALERT solutions. Other unique features and specs of this product include: patented on-board condition monitoring with the i-ALERT®2 v3 sensor; proven channeled oil lubrication system ensures flow-through of cooled oil to thrust and radial bearings, and more.



Tycon Alloy

Leading the Casting Industry and Seeking Perfection with One-Stop Solutions

Last year, Pump Engineer had the honor of visiting Tycon Alloy's new plant in Zhongshan, China. Although Tycon had not yet completed its relocation, the facility's potential spoke for itself. As of January 2021, all of Tycon Alloy's assets were successfully transferred to the new facility and are now completely operational. Recognizing the success of the move, Michael Lo, General Manager of Tycon Alloy, expressed how beneficial the larger production capacity and environmentally friendly facility have been for the company.

Pump Engineer had the pleasure of meeting with Mr. Lo to discuss Tycon's current coping strategy for overseas markets in the post-pandemic era and how it intends to move towards a better 2021. Mr. Lo was joined by Mr. Benny Lu, Regional Sales Manager focused on Tycon's American market, who described some of the experiences he had throughout 2020.

By Xue Guanpu

Making the Best of Remote Technology

Pioneers from every industry are making efforts to develop new business models with the goal of minimizing any negative effects brought on by the pandemic. "The pandemic has reshaped the world," stated Mr. Lo, "and I believe that most people in this industry share a common hope that one day we will be able to realize business exchanges with clients through the internet."

Through video conferences and online platforms, Tycon has been able to maintain a smooth technical exchange, and share project updates with their clients, with ease. "We spoke with TUV last year concerning a new set of remote software designs for remote detection applications. One technology that stood out was a pair of built-in 3D glasses," Mr. Lo explained. "Using the 3D glasses, the authorized personnel from Tycon's quality assurance department can connect with customers,

or the third-party inspectors, through the internet. The technology then allows the Tycon employee to visually check a product's detailed information, or the process of production, by displaying what the glasses see wherever they go. It is good to see that some new technologies have emerged from the difficult times."

> *"For our customers, purchasing from Tycon is an experience; they are purchasing expertise and value rather than simply spending money on products."*
>
> **– Mr. Lu**

Remote technology brings technological upgrades not only to manufacturers, but to end users and the third-party testing agency as well. However, mutual trust is the bedrock for everything. "Without it, no improvement can be achieved for anyone. Although there was no on-site contact with our customers in 2020, we feel that we have been able to grow the connections between us," added Mr. Lo.

Customers are Friends

The casting industry, without doubt, has gone through tremendous changes since the COVID-19 outbreak. Prior to the lockdowns initiated by the COVID-19 pandemic, Mr. Lu travelled between the United States and China on a bi-monthly basis. Throughout 2020, however, he found himself grounded in the U.S. where he was able to witness the industrial sector's crisis with his own eyes. "At the start of the pandemic, foundries were basically ground to a halt with extremely low supply and demand. It was a few months before the state government announced that some core businesses could go back to work again," he recalled. Despite the inability to facilitate high levels of production, the providers of high grade engineered casting solutions took steps to ensure that they were there to support their clients, no matter what their needs were.

"At Tycon, we treat our clients as our dearest friends," stated Mr. Lu. "As I believe that friends should care for and support each other, we strive to have close communication ties with each of them." To maintain close communication with its clients, online meetings are held one to two times a week to help customers understand the stages of product production and to avoid the supply chain disruption. "In addition to technical dialogues and business talk, we also provide our clients with the comfort and care they have come to expect at Tycon," explained Mr. Lu. For example, after learning that some of its U.S. customers were short on medical supplies, including masks and hand sanitizer, Tycon immediately arranged for the delivery of the necessary supplies to be sent from China to the clients' home addresses.

To further help customers get through the difficult times, preferential policies were issued by Tycon. "We fully understand the difficulties our customers are facing in the current geopolitical climate, so we allowed for delayed payments. For those who have difficulty taking over the goods once purchased, we also offer a service

Sales team.

Pouring line.

to temporarily store the goods in our warehouse, in China, to avoid extra logistical costs," stated Mr. Lu. "Whether working with customers or colleagues, Tycon values team spirit. Although our production volume had to be reduced due to insufficient orders, not even one employee has been dismissed."

Service is Always the Core

Having achieved independence from valve or pump factories over a decade ago, Mr. Lo believes that the casting industry will continue to become a more professionalized sector. "The question that Tycon has been asking itself recently is: How should we evolve this traditional industry to face the progressive and everchanging industrial market we see today? Successful industries across the globe are not just simply selling their products. I think the services associated with product sales make up the core that we should constantly invest in."

The company always tries to understand the difficulties that its customers encounter in their production process, and works together in order to provide a highly interactive service. "In fact, customers come to you if you can always take the initiative to communicate with them because it is just a part of the service they want. The importance of service has gradually become

Machine shop.

better understood thanks to this pandemic. Customers recognize the time and effort that is put into things like custom engineered solutions, as long as they find what you offer is reasonable," stated Mr. Lo.

Tycon advocates providing solutions that range from the early product development, and input of technical support, to after-sales service, and well stocked inventory. "If any issues occur, our expert staff, in both of our domestic overseas offices, are sent to the site to mitigate the risk of any new issues and help solve the ones that have occurred. For our customers, purchasing from Tycon is an experience; they are purchasing expertise and value rather than simply spending money on products," added Mr. Lu.

Improving Anti-Risk Ability

The anti-risk capability of an enterprise is put through a severe test when it is undergoing a crisis; especially for heavy asset manufacturers.

Mr. Lo shared Tycon's experience with his peers in the casting industry: "First of all, the sustainability of cash flow is the base of everything. After the outbreak, the whole industry worried if cash flow was disrupted. For a whole year, cash flow was high on the agenda for all Tycon staff in 2020."

"Second, investment should be applied with special care and planning. Not every project should be invested with your funds, even if it is highly intelligent or promising. For a heavy-asset enterprise, any imprudent investment decision might devastate itself in difficult times. Tycon chose to invest on essential sectors; the Zhongshan project has been our largest investment in the past few years."

"Third, partnerships provide a good support for the stability and development of heavy asset companies. Tycon's strategy is putting strength on our core products and technologies while developing and coordinating with qualified peers from this industry. We can therefore share responsibilities, benefits and risks in many aspects. After all, surviving risks is all that matters."

Omega fast loop moulding line.

VA technology automated shellroom.

Embracing Opportunities Born from Crisis

Despite the hardships brought on by COVID-19, there has been no lack of opportunities emerging from the crisis. In addition to the petrochemical sector that Tycon has been devoted to for over 20 years, new opportunities from hot sectors of the casting industry have presented themselves. "Tycon always looks to embrace the future with more possibilities. We have seen a remarkable growth in health care and food & beverage industries in the U.S. market," Mr. Lu said.

"In addition to the COVID-19 outbreak, the aging population is a large contributing force affecting the growth of the health care industry. More hospitals and advanced medical equipment are demanded by the elderly. As for the food & beverage industry," he continued, "restrictions on dining out have accelerated its growth in demand, as more people are inclined to cook at home."

> *"With our new plant completed, we have the capacity, sufficient funds and manpower to support high volume production orders. Cost optimization, reliability, flexible of delivery, as well as quality stability are where our strengths are."*
>
> – Mr. Lo

As these two rising sectors demand more stringent material selection requirements than the petrochemical industry, there has been a new push for high quality solutions. "Stainless steel is the main choice of material for these applications. While stainless steel is also frequently used in the traditional oil and gas sectors, they do not require as fine a finish. The largest difference between these sectors is therefore, that health care and food applications require very smooth surfaces to ensure that there are no defects that might allow for the breeding of bacteria. Overall, they have rather strict requirements on surface treatment," Mr. Lu explained.

Tycon is excited to continue to expand its footprint in new industrial sectors and strives to embrace the challenges that come with exploring new opportunities. "Although the transition will be challenging, we are not starting from zero. We have gained first-hand experience in these new sectors before and believe we will be able to offer outstanding engineered solutions," stated Mr. Lo. "Moreover, with our new plant completed, we have the capacity, sufficient funds and manpower to support high volume production orders. Cost optimization, reliability, flexible of delivery, as well as quality stability are where our strengths are."

Final Thoughts

During his 20 years at Tycon, Mr. Lo has explored the development and future of the casting industry. He and Mr. Lu believe that the most important thing is to push this traditional industry forward by adapting to the changing environment. It is important to learn from crises such as COVID-19 and continue to put the customer first by offering high quality one-stop casting solutions.

Foundry view.

The Importance of working as a Team

An Interview with **David Amesty**, Mechanical Engineer

A common challenge in the industrial sector is finding a solution that works for not only the application, but also the engineering teams. Learning how to recognize when to be a leader and when to be part of a team has been a lifelong for David Amesty, Lead Mechanical Engineer, P. Eng.

Pump Engineer was happy to speak with David about his dedication to continuing education, his vast experience in the oil and gas industry, and the many projects he has worked on that have furthered his knowledge of various equipment and systems.

By Brittani Schroeder and Angelica Pajkovic

David began his journey into an engineering career at the Universidad Central de Venezuela. When he graduated with a Bachelor's degree in Mechanical Engineering, he ranked top three in his class. "I spent over 15 years in the oil and gas industry in Venezuela, mostly doing projects in heavy oil," said David. He also spent one year in Ecuador working for EPC projects and taking on roles in the Mechanical Lead and Project Management teams.

In 2006, David moved to Calgary, Alberta, Canada, and began a new role as a Principle Mechanical Engineer. "Since moving to Canada, I have attended a Continuing Education program in Mechanical Engineering at the University of Calgary, and am pursuing a Masters in Engineering and Management at Ohio University. I will never stop trying to improve myself and my knowledge base." When he first moved to Canada, David was primarily working in the Alberta oil sands. "After awhile, I moved to working in pipeline operations before opening my own consultancy business," he continued.

> *"I will never stop trying to improve myself and my knowledge base."*

David now acts as the Founder and Lead Mechanical Engineer of Ingenusterra Consultancy. "I do a lot of smaller projects, mostly building the systems such as: heating and ventilation, air conditioning systems, and more. I have experience with a variety of mechanical heavy equipment, heat transfer process and utility systems, pipelines and a range of design software to solve highly detailed and technical problems," he relayed.

The biggest challenge David faces in his work is facing differences of opinion. "Every different stakeholder in a project is going to have a slightly different opinion. You may propose a solution to a problem, and though it may be a good solution, it is possible that not everyone will agree with you. You need to be open-minded and find alternatives in these situations," said David. "To reach an agreement between everyone, you need to know the people you are working with, and understand where they are coming from; the internal people, the external people, the clients, the big boss, the site leads, the operators, the maintenance crew, the fabricators, etc. I would say 50% of my job is just dealing with people and being able to communicate effectively with them."

David Amesty.

Working with Valves

With over 25 years in the industry, David has earned a lot of experience with a variety of equipment and systems. "I have worked with valves quite a bit, most commonly safety valves, control valves, and block valves" he said. "Safety valves are needed to open or close in emergency situations. The control valves are more specific to the process and typically more expensive because they control the process and give a precise flow. Block valves have the capability to set flow, but are not as accurate, since the main purpose of these valves is to isolate, not to control. So, depending on the type of service, the tides change, and you need to select the right type of valve, and there are so many to choose from! Ball valves, butterfly valves, gate valves, and more."

David has come across his fair share of problems while working with the valves in his career. "I especially see problems when working with special relief valves. Since these are usually found in pressure vessels, the type of safety valve is a bigger deal," he explained. The valves used in pressure vessels must be certified by a third party to ensure they meet all standards required. "Pressure vessels are bound by certain laws and need to keep up a CRN (Canadian Registration Number) in Canada. The requirements for these vessels are very hard and need frequent inspections, especially during the designing process. Therefore, the pressure safety valves usually have very strict requirements as well – they need to be certified to the correct set pressures, and they need a stamp of approval, such as ASME. Other kinds of valves for other applications do not need as much paperwork as these valves do," said David.

Pumps and Specialty Alloys

David has also had the opportunity to work with pumps during the many projects he has been a part of. "A little later on in my career, I was asked to specify the pumps for a project I was working on. These pumps were very interesting to me; one train of pumps was being used for oil dispatch, and the second train of pumps was used for water injection. The problem we ran into with the water injection pumps was that the water had a lot of chlorides in it, and that can really affect stainless steel," said David. "Working with chlorides, we realized we needed a more specialty alloy, rather than standard stainless steel, so we ended up using duplex instead. Duplex works very well with water and chlorides, and so it worked well with the pumps as well." The water injection pump was very large, reaching up to 1,500 PSI. "Fifteen years ago, this large pump cost us close to USD $2.5 million. Nowadays, I would say it is closer to USD $3.5 million. The pump was so large that we had to build platforms around it to be able to perform any kind of maintenance."

Since then, David has worked with a wide range of pumps: centrifugal pumps, positive displacement pumps, diaphragm pumps, and pumps fabricated to API, ASTM, and vendor standards. "Centrifugal pumps

are pretty standard in the market and are present when you are working with scotch or free particle fluids. Centrifugal and screw pumps are what I have worked with most."

While working with pipelines and pipeline terminals, David has been gained experience with specialty materials as well. "I cannot consider myself a metallurgist, and I still need to work with a properly certified metallurgist on most projects, but I do know a fair share about different materials," explained David. "Stainless steel is very different to carbon steel, and stainless has its strengths and weaknesses. When you are looking at a large concentration of hydrochloride, no metal can withstand that. But when you are working in cryogenic applications, stainless steel is very well matched. Stainless might be expensive, but it has a lot of great capabilities too."

A Variety of Projects

To solve problems that may arise in a project, you need to be able to work in a team – this is what David believes completely. "You have to share your knowledge with others, and they will share their knowledge with you, and maybe you will find a brand new solution to a problem that you had not considered before. It is impossible to work in this industry and not work in a team," said David. "Sure, sometimes you want to be the winner and come up with the solution all on your own—we would all like that. But that is not how it works. There are times when you need to be a leader, but a lot of the time you also need to be a team member. There have been a lot of projects and problems that I could not have found success on if it were not for my team beside me."

"Working in the heavy oil industry, I gained experience in operations, design, and construction of upstream and downstream facilities; facilities that produce almost 200,000 barrels of heavy oil per day. We had to work in a

special type of refinery, (upgraders), for the processing of heavy oil, because it produces synthetic oil and has sulfur and coke as by-products."

"In a recent large project, I was working on pipelines for a gas processing facility. I was working with a lot of different process systems, primarily steam and acid gas. Here, the key for success was strong leadership and teamwork."

Looking Ahead

David believes that this world is a coin with two faces. On one face is the marketing industry, which encourages massive consumption. On the other face, there is a need to mind energy sources, diminish waste, and help Mother Nature.

"The fact is, we cannot be greener if we do not reduce consumption. The more we consume, the more energy is required and more eventually ends up in a landfill," stated David. "I encourage a smooth transition to more sustainable energy sources. While oil and gas will still be deemed necessary, to maintain consumption needs, I believe that if we follow the four Rs (reduce, reuse, recycle, and recover) we will be able to collectively help Mother Nature by minimizing our waste."

"As an engineer, I am committed to thinking of ways to both save energy and use it more efficiently. By doing so I am able to live life with no more then what is necessary," concluded David.

"As an engineer, I am committed to thinking of ways to both save energy and use it more efficiently. By doing so I am able to live life with no more then what is necessary."

CFD Simulation for the Oil & Gas Industry

The Oil & Gas industry is well known for operating in harsh environmental conditions. The engineering needed to withstand these natural forces must be structurally sound, or the risk of health and safety-related incidents can increase. Products and systems in the oil and gas industry must also be durable, long-lasting, and rigorously tested. Regular maintenance is not always possible in remote locations where the industry operates. Having the ability to accurately design and test components such as pumps or even large-scale structures like oil rigs is an essential part of the design process.

By Dr. Naghman Khan, Technical Writer, SimScale

Simulating Harsh Conditions

The ability to simulate a variety of situations that a pump or large structure could be exposed to, allows for designers and operators to preemptively prepare for otherwise potentially unforeseen complications. For example, consider an offshore oil rig exposed to high and unpredictable winds and structural forces regularly (Figure 1). When designing the rig and selecting suitable sites for its operation, assessing the rig's climate-induced influences is essential for quantifying the risk, mitigation measures, and design changes that must be met in order for successful and safe operation. Figure 1 shows the results of a wind analysis on the rig. The study illustrates the wind velocities and forces on the structure, as well as the floor level wind speeds that workers would be subjected to. This type of digital wind tunnel analysis can be critical for industries that operate in harsh conditions and are becoming more available to engineers through the cloud.

CFD for Pump Design

Computational fluid dynamics (CFD) is a type of engineering simulation concerning fluids' behavior and properties (liquids and gases). In CFD, a digital representation of a physical object is created using a 3D CAD model. This model is then 'simulated' in the desired environmental conditions by applying the properties and behaviors of fluids, materials, and the environment.

The primary heat transfer mechanisms of conduction, convection, and radiation are modeled along with the fundamental fluid properties such as viscosity, density, and turbulence. In essence, a digital twin of an object is created, such as a pump, and mathematically simulates its real-world performance based on a set of realistic assumptions. By varying the 3D model parameters, such as pump size and shape, it is possible to simulate a pump's performance in multiple configurations and environmental conditions. The testing can be done for multiple pump design candidates, such as different rotor sizes for a given volute, or different rotor design. An engineer will perform a simulation of a given pump design for the entire range of allowed flow rates in order to assess the performance (head) and calculate the reaction forces and moments

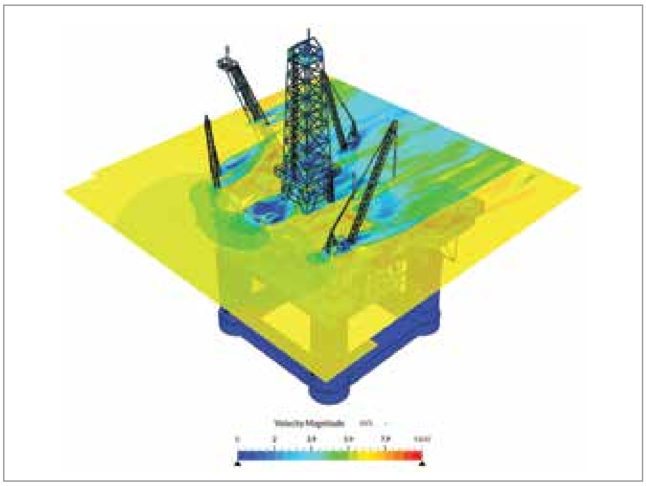


Figure 1: CFD simulation of a wind loading and comfort analysis of an oil rig. CFD is used to evaluate the structural forces on a rig, wind-induced risks, and the safety and comfort of workers.

acting on the rotor (impeller), to then choose/size the motor and the shaft bearings.

This is especially important when designing a pump for harsh conditions that do not lend themselves to being easily tested. A digital twin model can also significantly reduce physical prototyping costs as the design feedback and hence, iteration, is coming straight from the virtual prototype being simulated.

The Benefit of Simulation in the Cloud

CFD in the cloud gives engineers the ability to access simulation from anywhere, through their preferred web browser. The application is hosted and run entirely on the cloud, making it accessible and secure, eliminating the need for in-house storage solutions. One of the powerful features of simulating in the cloud is the scalable and on-demand computing power, without the need for expensive and local hardware. This means an engineer designing a pump can set up and run dozens of simulations simultaneously for each design variation, and also for different operating points and working conditions for the same pump design. A pump might have half a dozen parameters in its design that can potentially be varied to arrive at an optimal configuration. For example, pump features that can be optimized include the shape, number, and size of the pump blades, the radius of the pump itself, the inlet and outlets of the casing, and the impeller's rotational speed (RPM). Environmental variables that need testing will include the temperature, viscosity, and density of the fluid, e.g., types of crude oil, the ambient temperature, and structural and loading forces on the pump assembly. For each of these parameters, a range of input values should be simulated to gain an accurate understanding of the performance limits of a particular pump design. This testing level can only be achieved through CFD analyses with significant cloud computing resources to drive it.

Pumps in the Oil & Gas Sector

A centrifugal pump, commonly used in the oil and gas industry to pump crude oil, is simulated in CFD (Figure 2). In this simulation, crude oil with an API of 30° is used. The API is the American Institute of Petroleum's gravity metric for describing the density of oil relative to water. An API bigger than 10 means the oil will float in water. Lighter crude oils (higher API values) are generally considered more valuable as they produce more lightweight finished products in the refinery process.

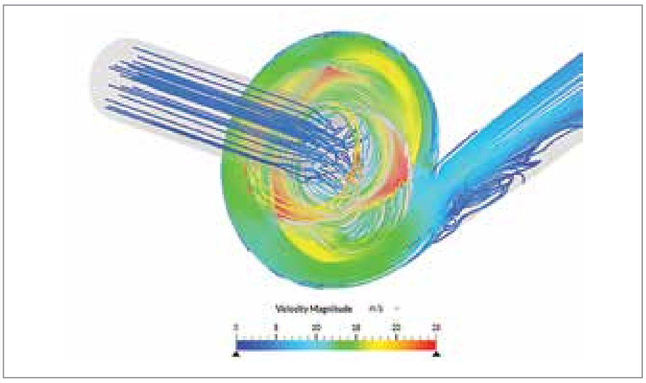


Figure 2: CFD simulation of crude oil flowing through a centrifugal pump. The streamlines show velocity, with red indicating higher speeds.

In this study, the pump is pushing a fixed flow rate of 3 m^3 of crude oil with a density of 865 kg/m^3 (actual density varies with temperature). The analysis is run at 10°C increments starting at 50°C and ending at 10°C. With each decreasing temperature step, the viscosity and density of the crude oil will rise. An engineer can use CFD to evaluate the impact of density and viscosity on pump efficiency and power requirements, especially useful for off-shore applications where the average line temperature of an oil pipeline, for example, varies seasonally. The torque calculated on the pump blades is an output of the CFD simulation and is used to calculate power. As the density of oil being pumped increases at lower temperatures, this will place an additional power load on the pump, requiring more energy to pump the same volume of oil, eventually placing more wear and tear on the pump components. If we use the run at 50°C as the baseline for comparison, the pump power required to maintain the same flow rate increases

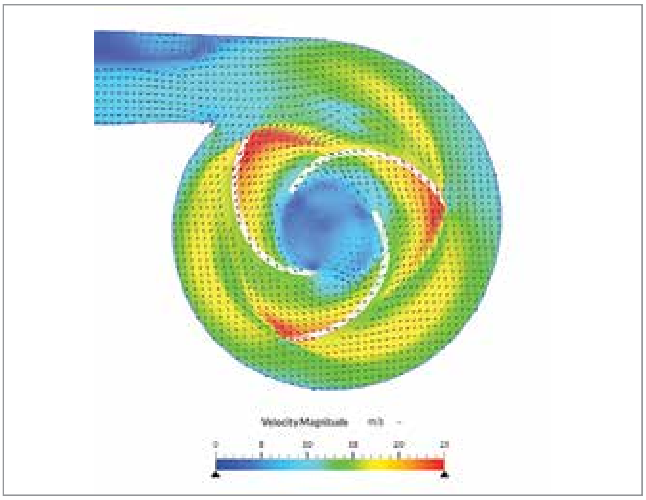


Figure 3: CFD simulation of crude oil flowing through a centrifugal pump. The image shows the velocity of oil as it is pumped. Red indicates higher speeds. The pump is running at 200 RPM.

by up to 6% when the oil temperature decreases to 10°C, as it becomes thicker (Figure 4). With increasing temperature, the viscosity of the oil decreases (high Reynolds number flow and therefore a lower friction factor to overcome). The pump is run at 200 RPM, and the flow velocities can be seen in Figure 3.

Final Thoughts

Computer simulation of components and systems is especially useful for evaluating design performance and, gives the ability to virtually analyze a wide set of operating conditions and environments. CFD on the cloud has lowered the cost and resources needed to access high fidelity engineering simulation.

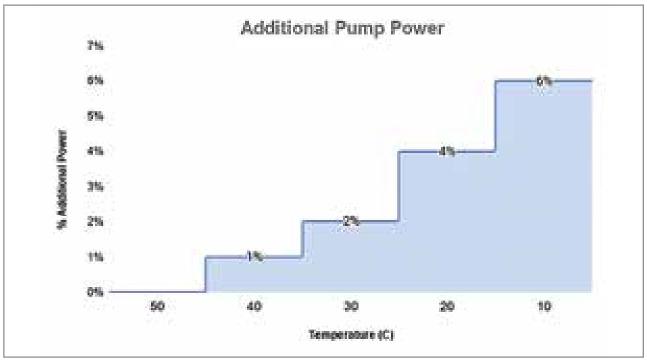


Figure 4: The additional pump power required to pump a fixed flow rate, rises with decreasing oil temperature.

About the Author

Naghman is a simulation expert working at SimScale. He has a Ph.D. in simulation and modeling from the University of Nottingham and a Master's Degree from Imperial College London, UK.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TENDERS

Australia: New Sewer Trunk Main And New Inlet Pump Station

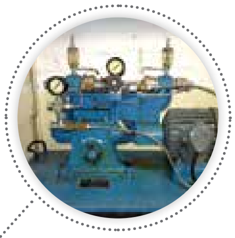
Description: *New Sewer Trunk Main And New Inlet Pump Station*
Contact point: *+61-08 8391 7200*
Time limit for receipt of tenders or requests to participate: *May 11, 2021*
Language in which tenders or requests to participate may be drawn up: *English*

Japan: 4 Pump Casings And 1 Other Item

Description: *4 Pump Casings And 1 Other Item*
Contact point: *092-418-3345*
Time limit for receipt of tenders or requests to participate: *May 10, 2021*
Language in which tenders or requests to participate may be drawn up: *English, Japanese*

China: Primary Network Backwater Booster Pump

Description: *Primary Network Backwater Booster Pump*
Contact point: *+86-010-68946709*
Time limit for receipt of tenders or requests to participate: *April 27, 2021*
Language in which tenders or requests to participate may be drawn up: *English, Chinese*



Canada-Ontario: One (1) 2022 Rescue Pumper Fire Truck

Description: *One (1) 2022 Rescue Pumper Fire Truck*
Contact point: *+1-905-468-3266*
Time limit for receipt of tenders or requests to participate: *April 23, 2021*
Language in which tenders or requests to participate may be drawn up: *English*

India: Preventive Routine Mechanical Maintenance Of Fuel Oil Pressurizing Pump

Description: *Preventive Routine Mechanical Maintenance Of Fuel Oil Pressurizing Pump*
Contact point: *+91 5446 272 201*
Time limit for receipt of tenders or requests to participate: *April 26, 2021*
Language in which tenders or requests to participate may be drawn up: *English, Hindi*

Canada – Manitoba: Request For Proposal Professional Consulting Services For Cooling Upgrades - Water Pumping Stations

Description: *Request For Proposal Professional Consulting Services For Cooling Upgrades - Water Pumping Stations*
Contact point: *204-986-3855*
Time limit for receipt of tenders or requests to participate: *April 29, 2021*
Language in which tenders or requests to participate may be drawn up: *English*

Germany: Delivery Of A Tlf 4000 Tank Pump (city Of Bassum)

Description: *Delivery Of A Tlf 4000 Tank Pump (city Of Bassum)*
Contact point: *dorau@nsgb.de, +49511/30285-78*
Time limit for receipt of tenders or requests to participate: *April 26, 2021*
Language in which tenders or requests to participate may be drawn up: *English, German*

Kuwait: Providing A Mechanical Insulation For The Condensate Heater Drainage Pump In Sabya Station Distillates

Description: *Providing A Mechanical Insulation For The Condensate Heater Drainage Pump In Sabya Station Distillates*
Contact point: *info@mew.gov.kw, +965-25371000*
Time limit for receipt of tenders or requests to participate: *April 25, 2021*
Language in which tenders or requests to participate may be drawn up: *English, Arabic*

Philippines: Modernization Of Paco Pumping Station, Paco, Manila

Description: *Modernization Of Paco Pumping Station, Paco, Manila*
Contact point: *molano.antonio_jr@dpwh.gov.ph, +63-(2)(5)304-3528*
Time limit for receipt of tenders or requests to participate: *April 21, 2021*
Language in which tenders or requests to participate may be drawn up: *English, Filipino*

To subscribe to the Projects & Tenders newsletter, please contact Josh Gillen (**j.gillen@kci-world.com**). To submit a project or tender, please contact Angelica Pajkovic **(a.pajkovic@kci-world.com).**

PROJECTS & TENDERS
For flow control industries

A New Approach to Casting Impellers Using 3D Printing

Following the need to replace a power plant's worn out impeller, experts chose to use a combination of 3D sand printing and standard sand casting to shorten lead-times and replace the damaged application. This resulted in a better understanding of the two casting approaches, and ultimately improved the pump's overall performance.

By Jérémy Mouchel and Sébastien Delamare, INOXYDA

When a power plant needed to replace a worn out impeller, on a pump provided in the 1980s for the plant's cooling system, it was faced with three main challenges:

- Getting the pump back in service in the shortest possible time,
- Remanufacturing the impeller without having the original pattern, and
- Improving the performance of the pump by reviewing the design.

Rather than following a more conventional method of replacing the impeller, a new approach was proposed to meet the challenges faced by the facility in question. The proposal was to combine the use well known aluminium bronze sand casting with 3D sand printing technology.

3D Sand Printing Technology

The use of 3D sand printing technology in foundries is now considered a mature technology and is slowly entering the industrialization phase. As opposed to direct part printing, this technology consists of printing a mold in which a selected alloy will be poured, making it adjustable to existing and recognized alloys. The technology that is used for this process is called Binder Jetting. Binder Jetting is a process in which a liquid binder is deposited on a layer of sand which has been heated beforehand to enable polymerization. The binder then bonds these areas together to form a solid part one layer at a time. The complete printing is done by successive layers of approximately 250 μm, which are carried out until the mold and core are finished. The materials commonly used in Binder Jetting are: metals, sand, and ceramics that come in a granular form.

In order to meet the replacement impeller's requirements, personal with expertise in mixing casting and experience with new 3D systems were necessary. The process of replacing the impeller involved the following sequence:

- Scanning the old impeller to create a new 3D file,

- Improve the design of the hydraulics,
- Use the new 3D file to « print » the sand mold, and
- Casting.

For this project, a large size printer which could accommodate a 970 x 555 x 460mm volume, was required. The size of the printer is a criteria of importance, as it limits the size of the components; for larger parts it is, however, always possible to proceed by sub-assemblies to reach desired volume.

The Combination of Standard Casting Methods with 3D Printing Systems

By combining the two technologies, different steps are required to achieve a successful outcome; the different steps need to coordinate with different knowledges. The following is a list of the necessary steps:

a) Designing the various 3D files

Component 3D File

The initial step consists of creating a 3D file of the component to be casted; new parts are usually readily available with 3D files. For existing components, the use of scanning technology is necessary. The designer can then decide either to touch up the model or improve it depending upon his requirements.

Mold/Core 3D File

Based on the component 3D file, a casting engineer then decides what position the part will be casted in by:

- Defining the mold parting line,
- Adding machining overstock,
- Adding extra thickness for contraction/shrinkage (a specific rate for each material), and
- Designing the running system, the risers and the chiller positions.

Without this knowledge, it is impossible to use a 3D file to print a mold. As each file is application sensitive, knowledge of which criteria is necessary for each 3D print is gained with experience.

b) Molding

Once the 3D files are finished, the sand printing of the various parts of the mold can be launched. For this specific project, the mold was created in three parts: the bottom, top and core. If standard casing technology had been used, each part would have needed a separate wooden tooling.

At this point the use of modern 3D printing technology reverts back to the more conventional casting process. Assembly of the mold needs to be handled by an experienced operator who will carefully position the various components such as coolers, isothermal sleeves and air channels before closing the mold completely.

Bottom of mold. *Core (hydraulics).*

c) Completion, machining, and controls

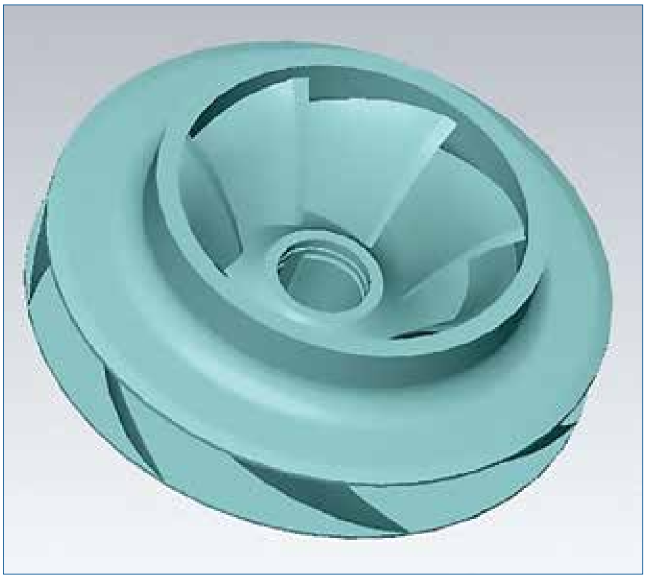
Following the completion of the mold, liquid aluminium bronze is poured. Once it has cooled the operators knocks out the part before cutting the risers and grinding the surface.

As quality is a major requirement for each parts of an application, several controls are used, including: base material conformity by chemical analysis and tensile test, dimensional control, and surface roughness

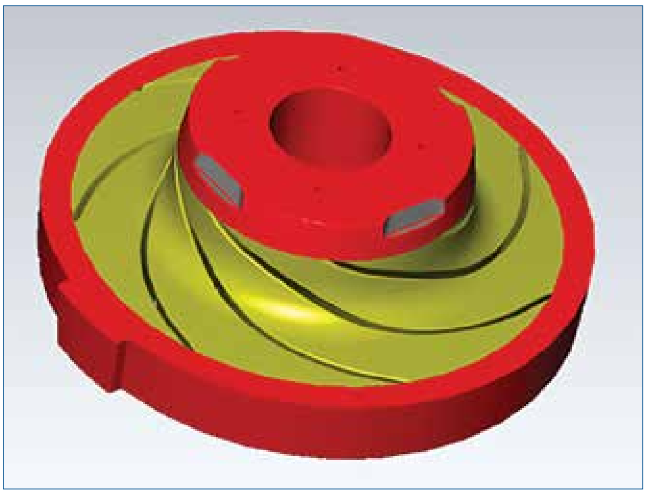
3D printing in layers.

control. The use of surface roughness control ultimately helps reduce the time spent on the grinding phase.

At this stage, the impeller is ready for final machining, including slotting and balancing. Final controls include dimensional and dye penetrant tests.



Impeller 3D file.



3D file used for printing the core.

	Lead Times	Cost	Patterns	Batch Size	Design Complexity	Storage Costs	3D Files
Standard Sand Casting	++	+++	Needed	Small & medium size	+++	+++	No
3D Sand Printing	++++	+	Not needed	Prototype & small size	++++	0	Yes
3D Sandbloc machining	+++	+	Not needed	Prototype & small size	++	0	Yes
Combined: Standard + 3D Printing	+++	++	Needed	Small & medium size for complexe parts	++++	+	Partially

INOXYDA has now led several projects combining both technologies and has gathered experience and knowledge to establish a first comparison chart of possible solutions.

Comparison and Limits of 3D Technology

The successful replacement of the impeller for this project provided a unique opportunity for a comparison between standard sand casting and 3D sand printed casting. The use of the two methods together proved to be fully complementary and resulted in reduced lead-time. The primary complications arose from having a number of trades with different backgrounds working together: Design Engineer, 3D Programmers, Molders, Founders/Melters, and Machining Operators were all required to make the project successful. In terms of the quality of the impeller, all of the criteria was reached using the 3D method; surface roughness was even improved.

As all technologies have limits that must be identified in order to find the right solution, the following issues were taken into consideration at early stages of the project:

- Batch size: 3D sand printing is, today, not competitive for simple parts where patterns exist,
- Cost of 'Risk': Cost of printing is still high. Any problem after closing the mold could lead to significant extra costs, and
- Dimensions: For large sizes the cost of the 3D printer is still significant and leads to long printing time.

Note on Using of 3D Sand Printing Technologies

Based on a number of different projects that have been carried out, INOXYDA has chosen to continue using existing pattern based sand casting for simple parts, or when patterns are already readily available. When more complex parts are required, such as in the case of multiple cores and/or for spare parts where patterns are no longer available, the 3D sand printing is preferred.

Mold fully assembled.

About the Authors

Sébastien Delamare is the Chief Operating Officer at INOXYDA. He is a Mechanical Engineer with 20 years of experience in sand casting large complex components according stringent quality requirements.

Jérémy Mouchel is a Sales Engineer at LBI Foundries. He has 15 years of experience in sand casting, including shop floor supervision and project management.

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Conversion of NPSH-Values to Another Speed: Quadratic or Not? | Part 1

The conversion of the head (H) of centrifugal pumps from the speed n_1 to the speed n_2 can be done by means of the well-known equation $H_2 / H_1 = (n_2 / n_1)^2$. This equation is however, also valid for the conversion of Net Positive Suction Head (NPSH) to another speed? The use of the equation for both purposes therefore leads one to question: is it correct to use the exponent '2' in the equation $NPSH_2 / NPSH_1 = (n_2 / n_1)^2$, without any restrictions?

By Jürgen H. Timcke

Investigation

In order to determine a conclusive answer to the question posed above, it was first necessary to understand the findings in references 1, 2 and 3. Although some explanations are offered, there is no conclusive statement that suggests that the NPSH conversion should always be quadratic.

The most effective way to achieve an answer to the question 'quadratic or not?' was therefore to evaluate the existing Q-NPSH-curves of two speeds: n_1 = 1,450 [1/min] and n_2 = 2,900 [1/min]. The goal was to use these speeds to calculate the exponents X by means of the equation $NPSH_2 = NPSH_1 (2{,}900 / 1{,}450)^X$. After completing the equation it followed that: $X = \lg (NPSH_2/NPSH_1) / \lg 2$, is always referred to the NPSH-values at Q_{opt}; this is the flow rate at the best efficiency point (BEP).

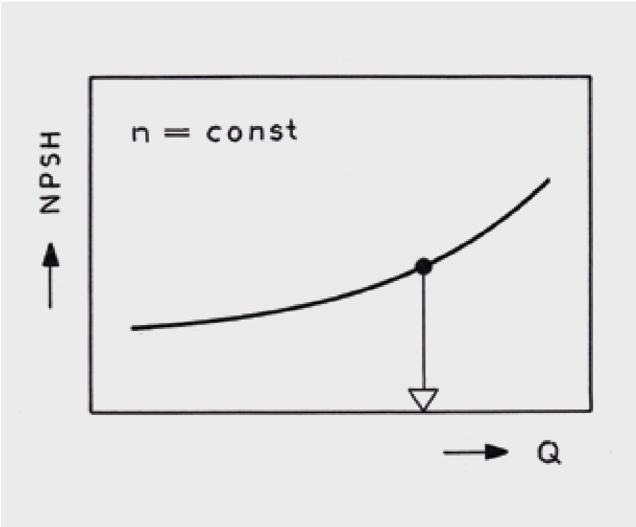


Figure 1: Q-NPSH-curve, white triangle: Q_{opt}. Black point: NPSH at Q_{opt}.

NPSH is not a measured, but a calculated value based on four influence quantities as shown in the equation $NPSH = A - H_V - H_S + c_s^2 / 2g$ (A = atmospheric pressure, H_V = vapor pressure, H_S = suction head and $c_s^2 / 2g$ = velocity head, all in metres). Figure 1 shows the tendency of a Q-NPSH-curve.

'H_S' is also not a measured but a determined value, dependent on the cavitation criterion. It is important to note that, "without specifying a cavitation criterion (i.e. the permitted extent of cavitation), a statement on the required NPSH of a pump is (in principle) meaningless."[8]

A widely used cavitation criterion is '3% head drop.' The head drop of 3% does not refer to 3% of the Q-H-curve. It instead refers to the 3% of the H_S-H-curve at various, but always constant, flow rates (see Figure 2). The valid equation for the calculation of NPSH with the cavitation criterion '3% head drop' is therefore: $NPSH3\% = A - H_V - H_S3\% + c_s^2 / 2g$.

For simplification reasons, 'NPSH3%' can be denoted as '$NPSH_3$'. "The symbol 'NPSH' can therefore be found in the pump characteristics on many manufacturers without an explicit specification that it is actually the $NPSH_3$."[8]

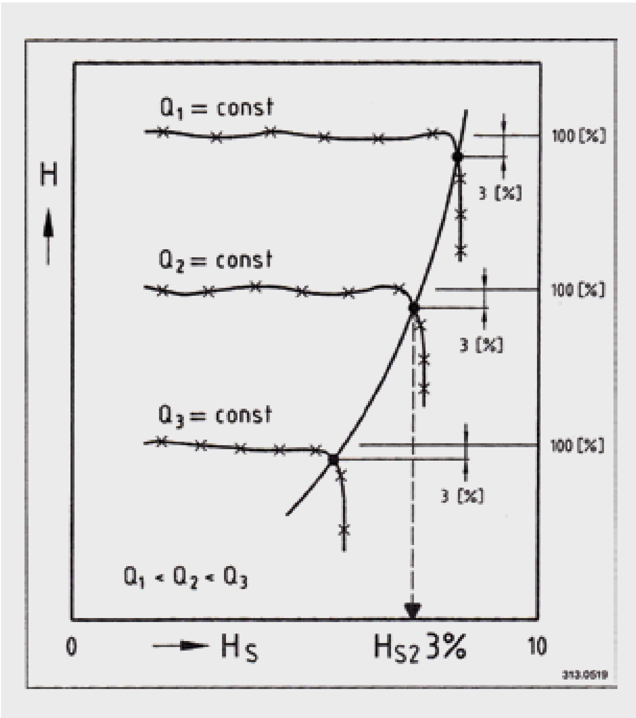


Figure 2: Determination of the $H_S3\%$ - values for the calculation of NPSH3% (x = Measuring points).[11]

Investigated Ranges

An investigation was conducted on ranges of single stage volute casing pumps with axial inlet and radial discharge branch in center line up, to assess how various manufacturers will produce a standard model.

Following ranges have been investigated (the number in brackets indicates how many of each type of pump were investigated):

- Water pumps which were developed before the water pumps standardization (1)
- Water pumps in accordance with EN 733 standards (6)
- Chemical pumps in accordance with ISO 2858 standards (1)
- Process pumps in accordance with API 610 standards (1)

	Investigated ranges (Type of pumps)	Manu-facturer		Number of the sizes
1	Water pumps (Not standardized)	1	A	12
2	Standardized water pumps according to EN 733			20
		2	B	20
		3	C1	12
			C2	20
		4	D	20
		5	E	20
		6	F	20
3	Chemical standard pumps according to ISO 2858	7	G	30
4	Process pumps according to API 610	8	H	27
Total number of the sizes				201
Number of the Q-NPSH-curves to evaluate				402

Figure 3: Investigated ranges and their manufacturers.

	Size	Manufacturer 3		6	1	2	4	5
		C1	C2	F	A	B	D	E
1	32-125		o ▲					
2	32-160	o	o ▲	o	o	o	o	o
3	32-200		o ▲					
4	40-125	—	o ▲	o				
5	40-160		o		o	o	o	o
6	40-200	o	o ▲	o ▲				
7	40-250		o	o				
8	50-125	—						
9	50-160		o	o	o	o	o	o
10	50-200	o						
11	50-250							
12	65-125	—	o					
13	65-160		o ▲	o	o	o	o	o
14	65-200	o	o					
15	65-250	—						
16	80-160	—	o					
17	80-200		o ▲	o	o	o	o	o
18	80-250	o	o					
19	100-200	o	o ▲	o	o	o	o	o
20	100-250	—	o					

Figure 4: Investigated sizes of water standard pumps, black triangle: $NPSH_{1450}$ > $NPSH_{2900}$ (9 sizes). To maintain the neutrality of the manufacturers they have been labled in arbitrary sequence with A - B - C - D - E - F - G - H. The manufacturer C offers various characteristic curves, and consequently also various Q-NPSH-curves, for different sizes of pumps.

Overall, 201 pump sizes were investigated, see Figure 3. The evaluation was made for the two speeds: n = 1,450 [1/min] and n = 2,900 [1/min]. A total of 402 Q-NPSH-curves were therefore used as the basis to determine the NPSH-values for the calculation of the exponents X. Figure 4 shows the investigated standard water pump sizes. Only the sizes that can operate with both n = 1,450 [1/min] and n = 2,900 [1/min], in accordance with the standard, were presented in the chart. Additional sizes, as offered by some manufacturers, were not taken into account.

Manufacturer-dependent pump sizes marked with a black triangle in Figure 4, demonstrate a higher NPSH value at n = 1,450 [1/min] then when n = 2,900 [1/min]. This conclusion is neither theoretically nor practically possible. These sizes were therefore not used in the calculation of the exponents X. Consequently, Figure 11 shows the frequency-distribution of only 192 calculated exponents X, and not 201, as the number of the investigated sizes.

Calculation of the Exponent X

The index 'opt' always means 'BEP' (Best Efficiency Point).

Case 1:

$Q_{opt2900} = 2Q_{opt1450}$ (respectively $Q_{opt1450} = 0.5Q_{opt2900}$)

The NPSH-values at BEP from the Q-NPSH-curves can be used to calculate the exponent X, see Figure 5. The procedure of the calculation is self-explaining and therefore additional explanations are not required. The result of the calculations shows that the values of the exponent X are the same.

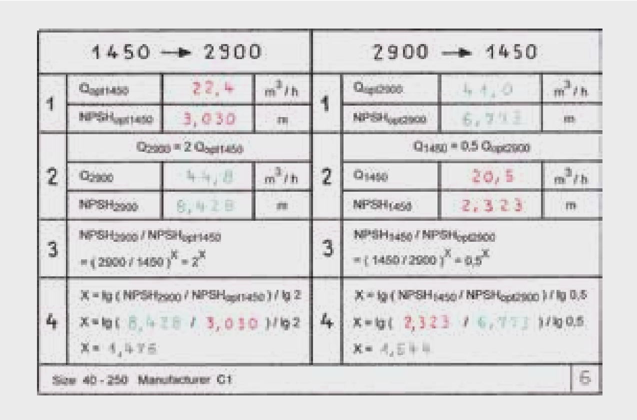
1450 → 2900				2900 → 1450			
1	$Q_{opt1450}$	77,25	m³/h	1	$Q_{opt2900}$	154,5	m³/h
	$NPSH_{opt1450}$	1,745	m		$NPSH_{opt2900}$	4,965	m
2	$Q_{2900} = 2\ Q_{opt1450}$			2	$Q_{1450} = 0.5\ Q_{opt2900}$		
	Q_{2900}	154,5	m³/h		Q_{1450}	77,25	m³/h
	$NPSH_{2900}$	4,965	m		$NPSH_{1450}$	1,745	m
3	$NPSH_{2900} / NPSH_{opt1450} = (2900 / 1450)^X = 2^X$			3	$NPSH_{1450} / NPSH_{opt2900} = (1450 / 2900)^X = 0.5^X$		
4	X = lg ($NPSH_{2900} / NPSH_{opt1450}$) / lg 2 X = lg (4,965 / 1,745) / lg 2 X = 1,509			4	X = lg ($NPSH_{1450} / NPSH_{opt2900}$) / lg 0.5 X = lg (1,745 / 4,965) / lg 0.5 X = 1,509		
Size 100 - 65 - 315 Manufacturer G							5

Figure 5: Generally valid calculation of the exponent X if $Q_{opt2900}$ = 2 $Q_{opt1450}$. For example chemical standard pump according to ISO 2858, size 100 - 65 - 315, manufacturer G, '1' = Values from the Q-NPSH-curves.

Case 2:

$Q_{opt2900} \neq 2Q_{opt1450}$ (respectively $Q_{opt1450} \neq 0.5Q_{opt2900}$)

As there are Q_{opt}-differences in some of the manufacturers Q-NPSH-curves, the calculation of the exponents X can lead to different X-values, see Figure 6.



1450 → 2900				2900 → 1450			
1	$Q_{opt1450}$	22,4	m³/h	1	$Q_{opt2900}$	44,0	m³/h
	$NPSH_{opt1450}$	3,030	m		$NPSH_{opt2900}$	6,773	m
2	$Q_{2900} = 2\ Q_{opt1450}$			2	$Q_{1450} = 0.5\ Q_{opt2900}$		
	Q_{2900}	44,8	m³/h		Q_{1450}	20,5	m³/h
	$NPSH_{2900}$	8,428	m		$NPSH_{1450}$	2,323	m
3	$NPSH_{2900} / NPSH_{opt1450} = (2900 / 1450)^X = 2^X$			3	$NPSH_{1450} / NPSH_{opt2900} = (1450 / 2900)^X = 0.5^X$		
4	$X = lg(NPSH_{2900} / NPSH_{opt1450}) / lg\ 2$ X = lg(8,428 / 3,030)/lg2 X = 1,476			4	$X = lg(NPSH_{1450} / NPSH_{opt2900}) / lg\ 0.5$ X = lg(2,323 / 6,773)/lg 0.5 X = 1,544		
Size 40 - 250 Manufacturer C1							6

Figure 6: Generally valid calculation of the exponent X if $Q_{opt2900} \neq 2\ Q_{opt1450}$. For example, water standard pump according to EN 733, size 40 - 250, manufacturer C1, '1' = Values from the Q-NPSH-curves.

The result of the calculations show different values of the exponent X. As different X-values cannot be used for a meaningful evaluation, the arithmetical mean values (index M) for the concerning Q-values, and their appertaining NPSH-values, must be calculated.

To read Part 2 of this article look to the June 2021 issue of Pump Engineer.

**** See references in Part 2 of the article.***

About the Author

Dipl.-Ing. Jürgen H. Timcke studied mechanical engineering at the University of Applied Sciences in Karlsruhe. He has 40 years' experience in the field of centrifugal pumps and has gained a thorough understanding of the pump industry. In the last 30 years, he has been a Manager of the Development, Design and Testing at a number of international and well-known pump companies. In addition to his professional activities he was also a regular lecturer at the University of Applied Sciences in Konstanz. As an expert in his field he was elected a member of the AMERICAN SOCIETY OF NAVAL ENGINEERS. Other articles by Timcke can be found at: www.juergen-h-timcke.ch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Q&A | Monitoring Seals & Sealing Systems

Pump Engineer is proud to present Q & A | Monitoring Seals and Sealing Systems. This article will address the three primary factors to consider when establishing seal monitoring goals. In order to improve a sealing system's reliability, the data collected through monitoring a system must be converted into knowledge that will be used to meet the stated goal. Readers are encouraged to ask questions for consideration in the future.

By Michael Huebner, Flowserve Corporation

Q **I need to improve the mechanical seal reliability in my plant. What are the options for monitoring seals and sealing systems?**

A It is always beneficial to set a goal to improve the performance of the equipment in a plant. It is, however, also important to consider if the proposed solution will achieve that goal. Monitoring a system, by itself, is not likely to result in any improvements. To achieve the desired improvements, the appropriate monitoring options need to be identified, the collected data needs to be understand, an action plan needs to be developed and executed, and follow up must be conducted to confirm the results.

For mechanical seals, there are three main areas that should be considered when establishing monitoring goals: the environment, the piping plan, and the seal itself.

Pump and Seal Environment

A mechanical seal's performance is directly affected by the environment in a pump's seal chamber. End users are almost always aware of the application conditions for a centrifugal pump, since this is defined by the process conditions in the plant. Even with this awareness, there is often a surprisingly small amount of real time data available on the seal.

When end users are asked about pump application conditions, they often refer to pump datasheets. The issue with this process is that the information may be inaccurate or obsolete, or may be shown as a range (e.g., normal/minimum/maximum). Some conditions, such as the pump's discharge pressure, may be measured but others, such as the pump's suction pressure, are seldom monitored. Due diligence is therefore necessary, to be aware of the pump's operating conditions.

Although the conditions in the seal chamber are related to the pump suction and discharge, the seal chamber is rarely monitored directly. There are very few installations where the end user directly measures the seal chamber pressure or temperature.

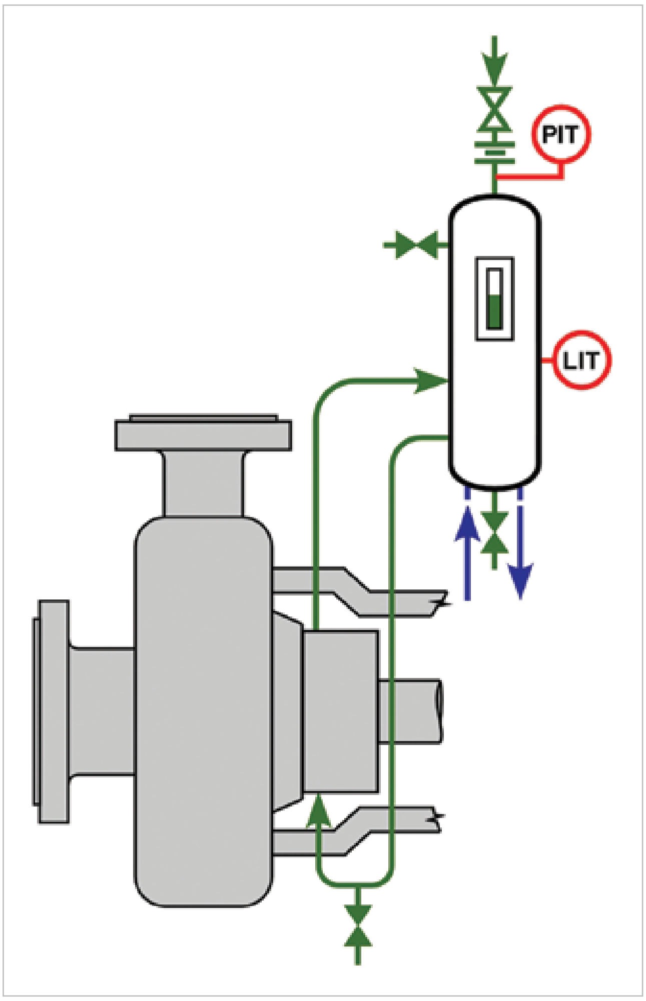


Figure 1: Example of piping plan instrumentation.

Piping Plan Performance

Mechanical seal piping plans perform a variety of functions which impact the seal's performance. These functions include: modifying the environment around the mechanical seal (e.g., cleaning, cooling, and flushing), providing an alternative sealing fluid, and collecting and disposing of process leakage. The API 682 standard therefore lists 32 piping plans that can be implemented to perform specific functions intended to

Figure 2: Seal OEM inspecting seal in the field.

improve seal performance. While it is easy to select a piping plan, it is often difficult to confirm that the piping plans is actually performing all of its required functions while the pump is in operation. To address this concern, API 682 suggests using specified instrumentation to monitor the performance of the plan's functions.

In the current edition of the API 682 standard, many of the previously specified switches and alarms have been replaced with transmitters that can improve data collection and real time awareness of a specific parameter. In an effort to maintain a balance between the opportunity cost of additional instrumentation and the functionality of the plan, the standard limits itself to suggesting the bare minimum amount of instrumentation. There can often be significant advantages to providing additional instrumentation for some applications but it is always important to maintain a balance between complexity and simplicity, completeness and adequacy, and cost and value.

Mechanical Seal Performance

There are a number of parameters, such as seal face temperature, face torque, and film thickness, which can provide valuable insights into a seal's operation. Even the direct measurement of seal leakage (liquid or vapor) can be insightful when monitoring performance. Since all of this data is collected in the seal OEM's research and development labs, end users often question: how difficult could it be to introduce these capabilities into the field and monitor the seal directly?

Very difficult, it turns out, as many of these measurements are intrusive to the seal and process. The instrumentation and sensors that are suitable in a lab environment may not be suitable in the field. When mechanical seals are developed and tested in the lab, they may be designed to meet the instrumentation and data collection requirements rather than specific seal chamber requirements. In addition, the operating conditions themselves (e.g., extreme temperatures, high pressures, aggressive process fluids, etc.) may make direct measurements impossible.

The ability to directly monitor seal performance is therefore a current focus for many seal OEMs. There are a number of different approaches being explored throughout the industry relative to collection methods, monitored parameters, and data interpretation. There are high expectations to see significant benefits as industry gains more experience with these products.

Value of Monitoring

The question that arises, when discussing the benefit of monitoring any seal parameter is, 'what value does it have to the end user?'

To better understand what types of information are most valuable to the end user, a simplified hierarchy of information relevancy has been established:

Data: numbers or observations from a known source and of a known accuracy;

Information: data which has been put into the proper context and is understandable to the user; and

Knowledge: the ability to interpret the significance of the information and act on it in a way to affect a change.

**The hierarchy depicts the information from the least valuable, at the top, to the most valuable, at the bottom.*

There are not many end users who want more data. Control rooms are full of monitors and instrumentation bringing in a stream of data 24 hours per day. Data historians store unimaginable amounts of data from virtually every part of an operation. Yet, this data has very limited value. Some value is added when the data becomes information and an operator understands what the monitors or gage are showing. The real value of monitoring comes in when the information is converted into knowledge and actions.

This hierarchy does not intend to imply that data is not useful. On the contrary; data is the basis for every decision and creates the foundation for higher levels of understanding. Historical data provides a rich source of understanding for what is normal and abnormal. It allows one to go back and understand the conditions at a previous point in time and the relationships between different parameters. Real-time data allows one to understand current conditions and provides the ability to control ongoing processes. The comments above only point out that data has limited value unless it can be understood and acted on.

The most exciting use of data is to use it for predictive or prognostic purposes. There has been a recent focus on improved maintenance strategies, such as predictive based maintenance. This type of maintenance allows the end user to schedule future maintenance based on current data. This however is only the start of possibilities for using data. In some instances, data can be interpreted and modelled to allow changes in current parameters to prevent failures or maximize the time until the equipment's end of life.

Define Real Goals

The process of defining monitoring options for seals and systems starts with defining the goals for said monitoring. There may be some data collection which simply serves to ensure compliance to a specific requirement; this is not necessarily adding value but it may be required. I would challenge the end user to consider using this data in more creative ways to actually add value to the monitoring process.

In the original question, the stated goal was to improve seal reliability. Additional monitoring may be required to meet this objective, but the user should not confuse monitoring with improvement. The equipment OEM and end user will need to work together to define the specific goal, understand the mechanisms which are creating the gap between current and future performance, define the required data necessary to achieve the goals, and create the infrastructure to ensure that current and future decisions are made correctly. In other words, the end user must have the knowledge to be successful.

Some of these steps may sound complex and onerous but this will not necessarily be the case. It is true that improvement requires a competent assessment and dedication to make a change. The effort to achieve the improvement does not, however, fall onto a single person or organization. Equipment OEMs have great insights into their equipment and have invested significantly into processes and applications to help create these improvements. Most recently, these capabilities are being incorporated into monitoring packages where the OEM provides the data collection strategy and interpretation, processes the data through complex modelling algorithms, and presents the end user with options for actions which will improve the equipment performance.

Conclusions

The real goal is not to monitor additional points and collect more data. No end user will benefit from data alone. Monitoring must be conducted to not only understand the current operation of the equipment, but to generate the knowledge needed to achieve the stated goals. If the real objective is to improve the reliability of a system, there needs be a broader approach to ensure that the data is converted into knowledge.

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.

A Single Point of Centrifugal Truth:

Closing the Gap Between Operations and Maintenance Through Real-Time Performance Data

Centrifugal pumps are vital pieces of industrial equipment. While maintenance and operations departments agree that it is important to keep them up and running, each department's views on care for the application start to differ when the pumps malfunction. From operations' point of view, maintenance is responsible for keeping the assets in optimal condition. From maintenance's point of view (assuming the company has purchased high-quality pumps), many potential issues are a direct result of the manner in which the application is used. This dynamic can turn into a blame game that quickly sours the atmosphere.

By Derek Benner, Maintenance Consultant, Samotics

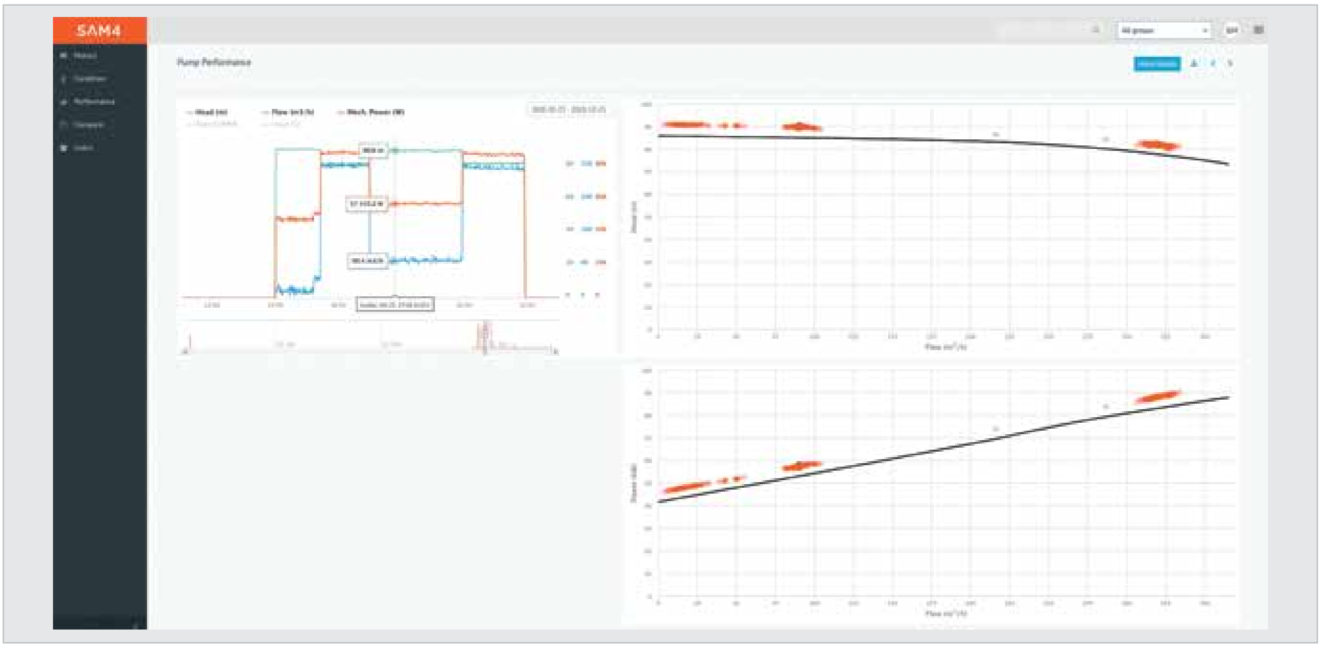


Figure 1: SAM4's pump performance dashboard. The data for each metric (head, flow, power, etc.) is plotted against time at the top left, for comparison. Head vs. flow is plotted in the top right graph, power vs. flow in the bottom. The black curve in these two graphs is the pump's designed operation at the current speed; the red dots are its actual operation at this speed over the selected time period.

Timely Data Can End the Blame Game

What is needed is a way to put operations and maintenance back on the same team: a neutral source of timely data that the two departments can use together, to solve and prevent centrifugal pump breakdowns. With the same real-time data available to everyone, the patterns behind recurring breakdowns can be identified, and there would be no need to search for a human source of error.

High-Frequency Current and Voltage Data

A data-driven tool, such as a system to remotely monitor the health of centrifugal pumps and other rotating equipment in real time, can be beneficial. A system such as SAM4 can use learning algorithms to analyze high-frequency current and voltage data in order to accurately predict upcoming machine failures. Simple metrics like running time, energy use, and starts/stops are part of the main dashboard for every asset the system monitors. The use of current and voltage data (rather than vibration, temperature, or other physical signals) enables the system to provide complex metrics that help companies save energy, improve performance, and extend machine life. One of these metrics is a real-time pump performance curve.

A Real-Time Pump Performance Curve

The pump performance curve is based on the affinity laws, which relate a pump's shaft speed and power consumption to its head and flow. Shaft speed and

power consumption, in turn, are directly related to the instantaneous current and voltage drawn by the pump's motor. As a result, the system can automatically plot a pump's operation relative to its best efficiency point in real time, using the data it is already collecting to monitor for developing damage. Figure 1 shows how a pump's real-time performance is plotted against its designed operation.

The calculations used to plot this curve are brand-independent; they can be made for any pump, as long as the pump owner provides the motor's rated efficiency and RPM, and the suitable pump and power reference curves.

The Real-Time Pump Curve in Action

Figure 2 shows an eight-hour view of the performance data for a centrifugal pump that moves oil from a storage tank to a tank truck. At the top left of the graph, the pump's startup time, each of its three loading sessions, and the pump's operation between sessions are clearly depicted.

In the graphs depicted on the right side of Figure 2, the gathered information is plotted on the pump curve, with the best efficiency point (BEP) marked by the black triangle. Each cluster of red dots reflects the pump's actual operation in one of those three states: startup, loading, and waiting. Through these graphs, the pump owner can see precisely when the pump is operating well, and when it is operating poorly. This data instantly communicates two valuable pieces of information: the pump's very off-BEP operation (top graph), and its power consumption (bottom graph).

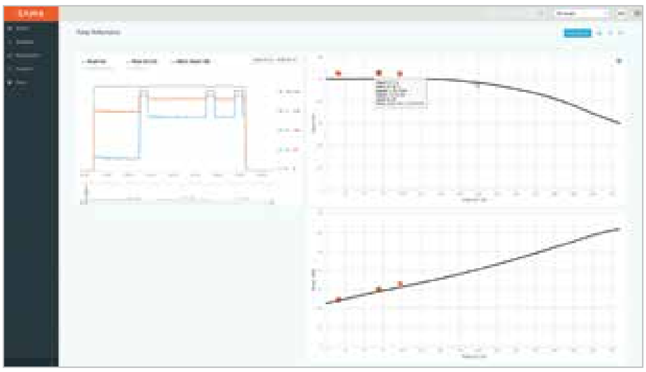


Figure 2: The real-time performance dashboard for an oil transfer pump, showing the data for the user's chosen time frame (here an eight-hour period).

From this data, both the maintenance and operations departments can make informed decisions on how to improve the pump's efficiency. Looking at this pump's operating points, it becomes clear that it is too large for its chosen task. If it continues to operate at this speed, seals and bearings will begin to break down more often and the pump will ultimately wear out faster. A solution might be to install a smaller pump. Alternatively, the operations department could add in a VFD to maintain greater pump capacity during different operational requirements. Either way, maintenance and operations are able to use hard data to understand the true source of this pump's problems, and to find the best solution together.

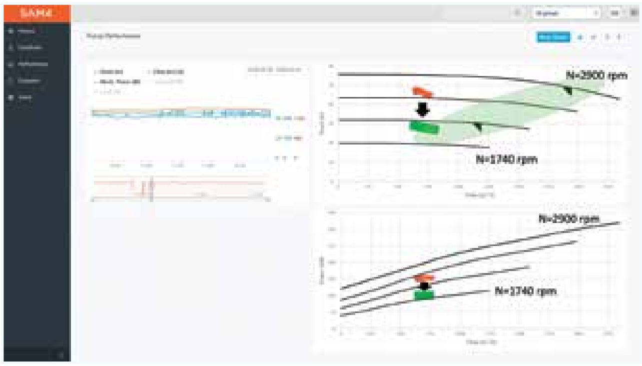
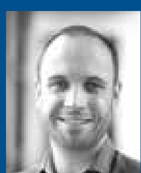


Figure 3: Using the pump performance dashboard, the pump owner found several pumps like this one that could be run at a lower speed (after making the necessary process changes), thereby moving operation closer to BEP and lowering power consumption. Further improvement would require replacing the pump (the pump is oversized).

Data-Driven Insight to Feed Productive Discussion

The ability to plot a pump's real-time operation against its performance curve is helpful to both operations and maintenance. It shows them what the pump is actually doing, giving both departments a clear understanding of how the pump is being used and how it performs. Similar pumps can be compared; are they really being operated in the same way? It is a single point of truth that allows these departments to have a genuine, blame-free discussion on how to keep their pumps running in the most efficient and effective way.



About the Author

Derek Benner is a maintenance consultant at Samotics with 16 years of experience in corrective, preventive, and condition-based maintenance. After earning a BS in mechanical engineering, Derek wrote his MBA thesis on how new industrial technologies will affect operations and maintenance organizations.

Understanding the Cost of Failure:

Interview with **Robert Bishop**, Plant Manager, Chemtrade Syracuse

When it comes to maintaining critical equipment like pumps and valves, Chemtrade Plant Manager Robert Bishop relies on modern technologies like ultrasound, thermography, and vibration analysis to determine the cost and impact of failures, for large and small facilities.

By Michelle Segrest, Contributing Editor

Determining the cost of failure for critical plant equipment is an art that Bishop has learned through decades of experience working at both large and small facilities. The Plant Manager for Chemtrade Syracuse, a division of the international chemical production company that produces sodium nitrite as a food preservative, uses modern technologies and a robust maintenance system to make key decisions about plant reliability and it all starts with collecting data and understanding the system.

Bishop has worked at huge facilities like Bristol-Myers-Squibb and now runs a plant of roughly three dozen people. "Some people think bigger means more opportunity," he said. "I once walked away from a large company where everyone had a very narrow responsibility. I like to do a lot of different things, so working at a smaller site is a strategic thing for me. I enjoy having a smaller site where we all wear a lot of hats. My earlier belief of 'bigger is better' was the wrong direction for me."

After years of varied experience, Bishop has learned that a basic balanced maintenance philosophy is the most effective approach to maintaining the integrity of an application.

"For things that move, like a pump, it is best to collect data about its performance while it is in use," Bishop recommended. "If you are talking about a valve that does not get moved very often, the amount of data and the type of data you can collect may be limited. Depending on the application, it may be acceptable to have some leakage from a valve.

"I once walked away from a large company where everyone had a very narrow responsibility. I like to do a lot of different things, so working at a smaller site is a strategic thing for me. I enjoy having a smaller site where we all wear a lot of hats."

Robert Bishop.

However the application still needs to be monitored and can be checked with ultrasound. If there is a temperature difference in the process stream, then it may be a good idea to use thermography to confirm that a valve is holding."

The cost of maintaining pumps, and other plant equipment, should strike a balance with the economic benefits. Although an effort should be made to maintain a pump to prevent failures, this process can often be quite costly. "In reality, we have to understand what the cost of the failure is, and how much are we willing to spend to prevent a failure from occurring," explained Bishop. "Sometimes, the best thing is to do nothing and wait for it to fail. If when a pump fails it is not going to hurt anyone, and it will not have a negative impact on the environment, then a run-to-fail approach can be appropriate. In these instances it is important to have the correct replacements to turn it around quickly, so that the cost and gain balance can be maintained." Using technology to determine whether to repair an application or let it run to fail, can make a significant difference in making the best decision.

Using Technology

Having a system that collects the vibration, thermography or ultrasound data, or working with vendors who offer these services, can greatly benefit an operators understanding of the health of a system. With this understanding an operator is better able to determine the life span of an application and decide what preventative maintenance is suitable.

"I took a class with someone who worked at a glass manufacturing site and their next scheduled outage was 40 years out. That is not something I am used to. I think this is rare," said Bishop. "In a facility, such as the glass manufacturing plant, there are a number of mechanical redundancies. In the facilities I have worked in, an outage is typically planed every 10 to 15 years. Most of the places where I have worked were not that critical, so we did not require full redundancy on all mechanical parts. If you know a failure is imminent and if the failure is acceptable, then you have to determine the cost? This is all assuming no one will get hurt and there will be no environmental concerns."

Once the cost of failure is determined, a plant can decide to either replace the equipment, or study the data along the way to build an understanding of the health of the machines.

"A lot of our pumps and valves fall on either end of the maintenance spectrum," Bishop explained. "You end up with some that are duty fit and will run for decades without any issues, while others are either installed in bad situations or are not the correct application for the system making their lifespan shorter; these require a different maintenance approaches." One way to cover the spectrum is by having a good predictive program that looks at vibration on a regular basis.

In larger systems, it is also important to take oil samples and pay attention to the information of the oil analysis. In small systems it is often more about monitoring the use or some sort of frequency. "If the levels are correct, be sure to maintain the system in a clean environment, and see if there are any external leaks," stated Bishop. It is important to make sure pumps and their associated gearboxes are contributing to the overall success of the organization."

People, Culture, and Change

A passion for people and equipment has given Bishop the opportunity to find jobs that focus on a balance of reliability and systems improvement. "I enjoy dealing with the equipment side of things, but I also love to deal with people," he said. "I realized early on that this is part of who I need to be professionally."

With a degree in mechanical engineering from the University of Rochester (New York) and a Master's of Science in bioengineering from Syracuse University, Bishop had many career options. He worked in validation for 12 years and then had to make a decision to either be a lifer or diversify.

"I knew that if I did not do something soon, the decision would be made for me," he said. "The opportunity came for a role with a major pharmaceutical company, so I took the leap. That job allowed me to balance my technical skills with strong management skills and I was able to launch and implement many successful reliability programs. I enjoy having an opportunity to enhance and improve systems. No matter where you are on the continuum there is opportunity to improve. Technology is always changing. I love researching solutions to problems, evaluating the best path forward, and implementing improvements. Reliability has an endless supply of opportunity."

"No matter where you are on the continuum there is opportunity to improve. Technology is always changing. I love researching solutions to problems, evaluating the best path forward, and implementing improvements. Reliability has an endless supply of opportunity."

With an overall reliability philosophy to create robust systems, educate a team, and then get out of the way and let them be successful, Bishop believes that actions are more powerful than ideas. "People are more important than knowledge. I try to remind myself that it is great to have a lot of ideas, but if we do not actually do anything, we are never going to go anywhere. You cannot just drag your feet forever. You can force people to do what you want, but if you do not invest in the people and acknowledge that they are the ones that make things happen, you're not going to see that benefit for the long run."

Some of Bishop's favorite roles is mentoring others to reach their goals and solving day-to-day issues. He drives root-cause analysis, launches new systems, and has been involved in upgrades to CMMS systems. One of his most successful best-maintenance practices is reporting by exception. "I do not need to know when everything is going well. I need to know when things are not going as planned so I can communicate to the larger organization," Bishop said. "I try to look for what is not supposed to be there. For example, when you look at the integrity of the data in our CMMS system, you can create all the reports you want, but sometimes, it is beneficial to go look for things you do not expect to find. I do not expect to find a blank priority field. But if I write a query for that and pull up all work orders that have blank priority fields I can ask 'Why?'"

Reliability Programs That Make a Difference

Throughout his career, Bishop has driven many successful reliability programs. He implemented one for paperless work orders that saved the company 120,000 pages of paper/year and also saved four full-time equivalent (FTE) efforts. In this particular case he was also able to repurpose employee's positions and no one lost their job. The program made valuable data available in real time while improving the quality of work.

He also drove a year-long PM-optimization program and implemented a lubrication-enhancement program that allowed closed systems, consolidated lubricants, and visual-management improvements. The lubrication program focused on a site that has been around since 1943. It was originally a facility that produced penicillin during WWII and had undergone a number of evolutions through the decades. Many of the lubricants on site were not needed. In fact, some of the drums of oil were 10 to12 years old. "There were lubricants with slow turn, and it just was not ideal," Bishop recalled. "We did not know where everything went. A maintenance technician, who was with the company for 30 years, had a cheat sheet and knew which oil went in which gearbox. It worked great, but it was not a very robust system. I put together a team that analyzed where everything was being used, and then we brought in one of our vendors who helped us consolidate." The program allowed the site to downgrade from 46 lubricants to just eight oils and four greases.

"We closed up the systems provided by the manufacturer on our gearboxes and level indicators. In most cases we used a sight-glass tube," Bishop explained. "We closed the systems on the larger ones and installed Quick Connect so we could use a filter cart. We installed sample ports with dip tubes, and we started doing oil sampling near the location in was to be used. We started the oil-sampling program to drive increased reliability."

The program included taking steps to do things through visual management. Now, gearboxes have a tag that indicates what is inside. It also identifies the viscosity and the manufacturer, and the same tag is on the oil container that is brought out to the field. An identical tag is on the oil-filtration skid. It took about a year to transform into a closed system so that no moisture or particles find their way into the gearboxes. "It was definitely worth the effort," Bishop said. "We now have one of the best lubrication programs that I have ever seen. Nothing is perfect, but we now have a very robust system."

Challenges with Implementing Changes

Bishop said he has always enjoyed change and the positive impact it can have on reliability systems. But sometimes it is difficult to convince others that change is a good thing.

"The biggest challenge is convincing people that improving systems and reducing workload will not result in reduced headcount," Bishop said. "I point to my track record, and it speaks for itself. My goal is never to get rid of people. The people I work with know they can trust me."

Bishop relies on tools such as a Best In Class (BIC) weekly meeting where all crew supervisors get together with a common goal to continuously improve and help each other. They use other tools such as ARMED software, which can identify key performance indicators and reliability data such as a top-10 bad-actor list. Bishop also uses his experience in the field of equipment qualification and validation—experience that has provided him with a robust understanding of documentation, quality systems, and equipment.

> *"The biggest challenge is convincing people that improving systems and reducing workload will not result in reduced headcount. I point to my track record, and it speaks for itself. My goal is never to get rid of people. The people I work with know they can trust me."*

The greatest tool that Bishop uses is his ability to connect people with culture and change. "I always want to improve," he said. "I always appreciate the people involved, and I know what it takes to change culture. It is not always easy, but it is always possible. It does not have to be a huge project but we must always strive to improve."

Advice for Young End Users

Bishop has some advice for young end users entering the workforce. "Pick one thing and get it right," he advised. "If you want to improve your maintenance system do not try to do it all at once. For example, if you have had problems with pumps in the past and you are trying to improve that, start with one type of pump, or one application or once piece of equipment and get it right. Once you get it right, roll it out into the bigger picture. Whatever it is you are trying to accomplish, just make sure to get it right before moving on."

From Pump Sales Leads to Leadership

Over the last decade pump companies have progressively moved away from a reactive sales strategy based on third party sales leads. Instead, the Covid-19 pandemic has accelerated a trend toward a proactive strategy that uses sales leadership rather than sales leads.[1]

By Robert McIlvaine, President & Founder, The McIlvaine Company

Push and Pull Approach

When interacting with a perspective client there are two sales approaches that can be pursued. The first is a 'pull' approach; this is a strategy that aims to get the customers to come to the product. The second is a 'push' approach, in which a firm attempts to take its products to consumers. It can be argued that it is far better for a prospective client to want to know how your pump will solve his/her problem (pull), than having to ask a prospect for his/her time to listen to your product pitch and then see if he has any current needs (push).

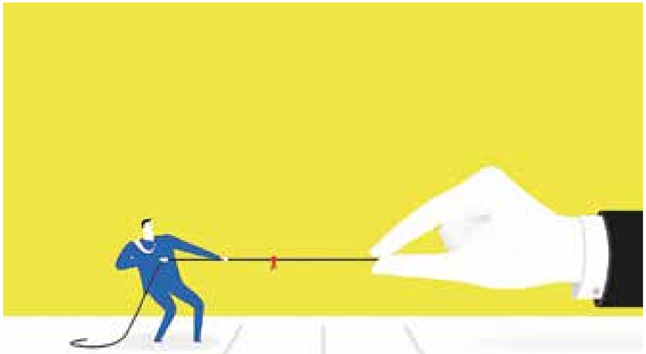
As third party sales leads are also supplied to competitors, their intrinsic values diminishes. It is therefore equally daunting to follow a third party sales lead and find that the prospect has already tentatively selected a competitor's product. Furthermore, in the ever changing digital environment, sales activity has accelerated to the point that by the time a sales lead can be pursued, it is often too late.

Collaborative Approach

Rather than following the third party sales leads or (push) approach, a collaboration sales strategy can be employed. This strategy is based on information sharing at the local sales level as well as on a national or global level, and employs a pull approach. By inviting customers to more fully participate in the sales process, one can improve relationships and, in turn, drive sales forward. No matter what industry or sector suppliers are engaged in, they will fit into one of the collaborator classification categories seen in Table 1.

Collaborator Classification	Ramifications
Sister division	The ideal group for collaboration
Unrelated products	Good if customers are the same
Complementary products	Very good from several perspectives
Supplier	Lots of leverage but minor downsides
OEM customer	Problems with alienation of other OEMS

Table 1.



Push versus pull marketing.

Many companies with sales representatives and distributors have already begun collaborating with each other. The primary issue with this practice is that the coordination is being done by the representatives and not by the companies. As the knowledge of the processes within a customer's operation is significant to the success of a sale, products suppliers can strengthen their knowledge by sharing with of each other. The parameters of the relationship are as follows:

- Sharing with suppliers is good but only to the extent the supplier is willing to jeopardize the relationship with his other customers.
- Sharing sales activity with OEM customers is ideal except to the extent it could harm relationships with other OEMS.

Collaborating with suppliers of complimentary products also has a number of additional advantages.

Collaboration with Complimentary Products

Every industrial pump that is found in a facility, or on a project site requires a number of complimentary parts. For example, many pumps must be connected with other pumps, and require the use of several valves to operate. Stainless steel is also commonly used as one of the materials of construction, and is frequently found throughout the entire pumping system. It therefore stands to reason that involving all of the applications required to make a process work from the get-go will result in a better costumer experience and ultimately drive the sale of each element.

Consider, for example, that a pump company is interested in High Pressure Acid Leach (HPAL) and

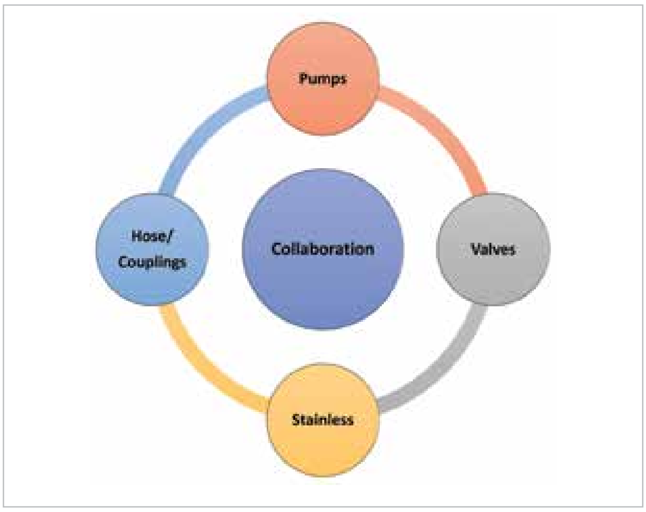


Table 2.

autoclave operations in mining. If it is known that a particular valve company is coordinating an autoclave user's conference, there would be a great incentive for the pump company to collaborate with that valve supplier. With a cross product collaboration established each company can then begin to build trust and long-term relationships with customers by offering the support they need every step of the way.

Final Thoughts

Due to the ever evolving integration and use of the Industrial Internet of Things (IIOT), companies have the opportunity to not only share information on potential purchasers, but to collaborate on specific projects by approaching the client with solutions to their challenges. As a society that is moving towards the Industrial Internet of Wisdom (IIoW), connecting in an organized way, with key suppliers of complimentary products will be paramount to leading a sale, rather than following a lead.

Reference

1. *Pumps: World Market published by the McIlvaine Company*

About the Author

Robert McIlvaine is the President and Founder of The McIlvaine Company, which publishes reports across worldwide pump and valve markets. He was a pollution control company executive prior to 1974, when he founded The McIlvaine Company. He oversees a staff of 30 people in the USA and China.

Industrial Valves: Master Class

Imagine someone learning what a car is, how it works and what its parts are. That is good, useful knowledge, but it is not nearly enough to own a vehicle: traffic legislation, insurance, and financing options are just some of the most obvious topics a person must know for that purpose. That is because a car by itself means very little; to go places with it you need to consider the car as part of a system.

A similar situation happens with industrial valves. One might know what a ball valve is, floating versus trunnion, single piston effect versus double piston effect, but if said individual was asked to procure a vale, he/she is liable to make some great mistakes that will result in poor valve performance or a safety incident. Every manufacturer or distributor has anecdotes of people calling and asking quotes for valves when they clearly have very little understanding of the application.

In today's market, companies face a double challenge when it comes to valve training. First, the only thing about valves that most technicians know when they leave college or university is that a valve is two triangles facing each other in a line. The lucky companies have some kind of mentorship program where an experienced professional teaches the ins-and-outs of the business: models, standards, supplementary requirements, manufacturer qualification, inspection, and several other critical topics to understand valves as part of a complex system of science, legislation, and market. The unlucky companies, the ones without an in-house expert or without the capability of introducing a mentorship program, face the second challenge. The stark reality that the majority of valve training available worldwide is either incomplete or provided by some actor in the process that has no interest in giving an impartial view of the subject. In short, that leaves the students with an incomplete or distorted view of valves.

To address this gap, Valve World has come up with the first comprehensive educational approach for valves: the Industrial Valves course. This course is comprised of two eight-hours modules and was designed to introduce attendees from any background to the complete lifecycle of a valve: specification, manufacturing, procuring, installation, maintenance, and refurbishing. Table 1 presents the complete list of content for both modules.

The topics selected are the result of extensive research of the current training landscape and the presentations done during the several editions of the Valve World and Valve World Americas. At the Valve World Americas conference, SMEs from major companies expose the recurrent problems that lack of knowledge on valves has

caused. For example, it is unconceivable that someone working with valves today lack a basic understanding of what fugitive emissions are, how they relate with valves, and the consequences of failing to comply with legislation. Yet they sometimes do.

Valve World is confident that the Industrial Valve course Modules I and II bring a much-needed approach to valve training. Prepared in a language easily accessible both to the layperson and to the more experienced professional, the course makes use of an abundance of examples taken from the real world. No matter what side of the valve business you are on, the Industrial Valves course is a sure way to distinguish yourself in the field and advance your career.

Table 1 – Topics covered in Modules I and II

MODULE I	MODULE II
Introduction	Recap of valve types and how they work
Valve Definition	Control valves
Standards	Specification
Valve Theory	Manufacturing
Ball Valves	Supplier Qualification
Butterfly Valves	Procurement
Gate Valves	Design Validation & Prototype Testing
Globe Valves	Supplementary Requirements
Check Valves	Fire-Type Testing
Actuation	Fugitive Emissions
Selection	Maintenance
Installation	Refurbishment
	Inspection
	Shipping & Handling
	Safety

Integrated Rupture Disk Assemblies for OEM Hydraulic & Pneumatic Equipment

For more than 85 years, rupture disks have served as an effective passive safety mechanism to protect against overpressure or potentially damaging vacuum conditions. The disk, which is a one-time-use membrane made of various metals, including exotic alloys, is designed to activate within milliseconds when a pre-determined differential pressure is achieved. As equipment reliability in operation is essential for its owner, high integrity from the pressure relief technology used to protect low- and high-pressure OEM systems is crucial.

By Jeff Elliott

In an effort to ensure high integrity pressure relief technology, OEMs are increasingly turning to integrated rupture disk assemblies with all components combined by the manufacturer. As opposed to loose rupture disk and holder devices that leave much to chance, these assemblies are being tailored to the application, can be miniaturized, and utilize a wide range of standard and exotic materials. This approach ensures the rupture disk device performs as expected, and ultimately enhance equipment safety, reliability, and longevity while simplifying installation and replacement.

Separate Components Versus Integrated Assemblies

Traditionally, rupture disks are standalone components that are combined with the manufacturer's separate holder device at the point of use. The user's installation of the application contribute significantly to the function of the rupture disk device. There is a delicate balance between the rupture disk membrane, its supporting holder, and the flanged, threaded, or other fastening arrangement used to locate the safety device on the protected equipment. If installed improperly, the rupture disk may not burst at the expected set pressure. For this reason, an integrated rupture disk assembly is often a more reliable application.

The no assembly required, integrated units are commonly certified as devices that perform at the desired set pressure. Consisting of a rupture disk and the housing, a disk assembly's one-piece design allows for easier installation and quick removal, when activated. The rupture disk and holder are combined by: welding, bolting, tube stub, adhesive bonding, or crimping, based on the application conditions

Clamped, threaded, torqued application interfaces. OEMs utilize threading and several other connection types to attach the rupture disk assembly to the application.

and leak tightness requirements. It is also custom engineered to work with the user's desired interface for the pressurized equipment. The devices are typically threaded, flanged, or configured for industry specific connections such as: CF/KF/Biotech/VCR couplings.

Integrated assemblies also prevent personnel from utilizing unsafe or jury-rigged solutions to replace an activated rupture disk. The physical characteristics of increasingly miniaturized rupture disks, as small as 1/8", can make it challenging for personnel to pick up the disk and place it into a separate holder.

Hydraulic and Pneumatic Applications Benefit

An integrated assembly is ideal for numerous hydraulic, pneumatic and other low, medium and high-pressure applications including: pumps, piston & bladder accumulators, engines, pressure vessels and piping.

For example, the oil and gas industry utilizes rupture disks on triplex pumps for many field applications such as oil extraction and well servicing operations. Triplex pumps are positive-displacement pumps configured with three plungers. Commonly referred to as ‘mud pumps,’ the devices can typically handle a wide range of fluid types, including: corrosive fluids, abrasive fluids, and slurries containing relatively large particulates. The pressures the pump must endure depends on the depth of the drilling hole and the resistance of flushing fluid, as well as the nature of the conveying drilling fluid. Typically, application specific hydraulic operating pressures are in the 5,000 to 20,000 psi range. “A three-plunger pump is continuously cycling, so the disk must be able to withstand high pressures with 1,000,000 pressure cycles or more,” explained Geof Brazier, Managing Director of BS&B Safety Systems Custom Engineered Products Division.

In most industries that depend on hydraulic systems to store energy and smooth out pulsations, standard system components, like accumulators, require rupture disks. By definition, accumulators hold hydraulic fluid under pressure. If the pressure spikes too high, there is a risk that without a rupture disk the system, or even accumulator, could experience a catastrophic failure.

BS&S miniature rupture disk technology. The physical characteristics of increasingly miniaturized rupture disks as small as 1/8” can make it challenging for personnel to pick up a disk and place it into a separate holder.

Both medical devices and fire rescue breathing equipment also depend on integrated application specific rupture disk solutions for critical life safety reliability. Medical devices in particular must often be very compact and low profile. In aerospace, tailoring integrated rupture disk applications for use with lightweight, compact materials, like titanium and aluminum, is also important, since it takes more energy to get heavier vehicles off the ground.

Integrated rupture disk assembly. With the availability of integrated, miniaturized rupture disk solutions tailored to the application in a variety of standard and exotic materials, OEMs can significantly enhance equipment safety, compliance, and reliability even in extreme work conditions.

Integrated Assemblies - Rupture Disk Design

According to Brazier, the most important design considerations for rupture disk devices are: having the correct operating pressure, knowing the temperature information, and being aware of the expected service life; this is often expressed as the number of cycles the device is expected to endure during its lifetime. Since pressure and cycling varies depending on the application, each requires a specific engineering solution. “Coming up with a good, high reliability, cost-effective, and application specific solution for an OEM involves selecting the right disk technology, the correct interface (weld, screw threads, compression fittings, single machined part) and the right options, as dictated by the codes and standards.” As user material selection can also determine the longevity of rupture disks, the devices can be manufactured from a range of metals and alloys such as: stainless steel, nickel, Monel, Inconel, and Hastelloy.

For some industries, it can be important for rupture disks to have a miniaturized reverse buckling capability in both standard and exotic materials. In almost all cases, ‘reverse buckling’ rupture disks are utilized because they outperform the alternatives with respect to service life. “Where economics is the driver, reverse buckling disks are typically made from materials such as nickel, aluminum, and stainless steel. Where aggressive conditions are required, more exotic materials like Monel, Inconel, Hastelloy, Titanium and even Tantalum can be used,” said Brazier. In almost all cases, 'reverse buckling' rupture disks are utilized because they outperform the alternatives with respect to service life.

Reverse Buckling Disks

In a reverse buckling design, the dome of the rupture disk is inverted toward the pressure source. Burst pressure is accurately controlled by a combination of material properties and the shape of the domed structure. By loading the reverse buckling disk in compression, it can resist operating pressures up to 95% of minimum burst pressure, even under pressure cycling or pulsating conditions. The result is greater longevity, accuracy, and reliability over time.

While the process industry has relied on reverse buckling disks for decades, new advancements in the technology have made it possible for OEMs to obtain miniature disks. With companies, such as BS&B, creating disks with as small as 1/8" burst diameter, more applications can rely on the disks for equipment safety. Small nominal size rupture disks are sensitive to the detailed characteristics of the orifice through which they burst. This requires strict control of normal variations in the disk holder. "With small size pressure relief devices, the influence of every feature of both the rupture disk and its holder is amplified," explained Brazier. "With the correct design of the holder and the correct rupture disk selection, a user will avoid premature failure."

Closing Remarks

While OEMs have long relied on rupture disks in their hydraulic and pneumatic equipment, high-pressure, high-cycling environments have been particularly challenging. Fortunately, with the availability of integrated, miniaturized rupture disk solutions tailored to the application in a variety of standard and exotic materials, OEMs can significantly enhance equipment safety, compliance, and reliability even in extreme work conditions.

About the Author

Jeff Elliott is a Torrance, California-based technical writer. He has researched and written about industrial technologies and issues for the past 15 years. For more information on this topic, contact BS&B Safety at sales@bsbsystems.com.

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