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MAINTENANCE TECHNOLOGY

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Mid-Atlantic Pump &
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All Pumps, All Day

Welcome to the Mid-Atlantic Pump & Process Equipment Symposium XI. We are confident that you will meet fellow professionals from a variety of industries, learn a great deal about pump assembly and function, and have a good time doing it.

Maintenance Technology editors Jane Alexander and Michelle Segrest will be joining you and participating in the various seminar sessions. I hope you'll take a moment to meet them and participate in the video interviews that they'll be doing throughout the day. They'll make you online celebrities at maintenancetechnology.com.

We also hope you'll enjoy this special issue of *Maintenance Technology*, prepared especially for symposium attendees. It includes two articles from our August Water & Wastewater Reliable Pumping supplement; a profile of Rebekah Macko, who will be instructing many of you at the symposium; and several pages from our Reliability and Maintenance Center department.

Enjoy the day and I'm confident you'll leave filled with new skills and knowledge that will improve your plant's operations. **MT**



Gary L. Parr
Editorial Director





RELIABLE
PUMPING

WATER & WASTEWATER SYSTEMS

CASE STUDY

DESIGN INFLUENCES ROTARY- GEAR PUMP MAINTENANCE

Smart-sensing technology contributes to the predictive maintenance of wastewater and other facility pumps.

BOBBIE MONTAGNO, PULSAFEEDER ENGINEERED PRODUCTS



Pumping infrastructure represents an enormous investment for large facilities.
All images courtesy of Pulsafeeder, a unit of IDEX Corp.

Pumping infrastructure represents an enormous investment for large processing facilities. In any given plant, thousands of pumps are needed to move liquids from point A to point B.

Some of the primary applications for which rotary-gear pumps are used in refineries and chemical-processing plants involve treating wastewater to be reused for cooling towers, boiler feeds, or to dilute chemicals that are required for other processes. For these applications, harsh chemicals such as bleaching

chemicals, cleaning agents, and corrosion inhibitors are dispersed on a high-volume, continuous basis. Over time, this can take a toll on the pumping equipment, establishing the need for proper maintenance programs.

THE COST OF MAINTENANCE

In most plants, annual maintenance costs for pumping infrastructure can range from 2% to 5% of the replacement value of the infrastructure. At first glance, that range seems

minimal. But the delta between 2% and 5% can equal millions of dollars (or in some cases, tens of millions) throughout the life of the plant. Total maintenance costs must also be measured beyond the physical expense of the parts, the tools, and the engineers who wield them. Maintaining pumps in a chemical plant, refinery, or wastewater facility directly affects uptime, which in turn affects the bottom line.

Pumps that run regularly, feature wear items, and handle hazardous and corrosive

WATER & WASTEWATER SYSTEMS



chemicals will inevitably require maintenance. This can be a blessing and a curse.

Plant managers who get it right, in a preventive and predictive fashion, can streamline operations and maximize uptime. Those who let maintenance slip into a reactionary or “run to fail” approach can hinder operations and create ripple effects that shorten the life expectancy of equipment.

PREDICTIVE MAINTENANCE

Predictive maintenance requires a long-term view. It involves planning, scheduling, condition monitoring, analysis, and spare-parts management. Predictive maintenance for pumps is aided by smart-sensing technology that can alert engineers to dry-run conditions, temperature changes, increases in vibration, or decreases in pressure.

Today, sensors are readily available and their value (and deployment) will continue to expand as wireless communications connect plant infrastructure to maintenance personnel using tablets and smart phones across the Industrial Internet of Things (IIoT).

Predictive maintenance can also be done without advanced communications technology. Readily available information and historical pump performance can be used to schedule the replacement of wear parts with minimal disruption to plant operations and minimal investment in sophisticated cloud-based controls.

SHORT-TERM REACTIVE MAINTENANCE

Although predictive maintenance is always the goal, sometimes reactionary maintenance becomes the reality. When budgets are cut, maintenance is often considered a quick fix to address short-term financial constraints.

Reactive maintenance provides short-term savings, until equipment fails. When a failure occurs, the response relies on the skills of the

on-site team and the availability of spare parts. If either fails to meet expectations, substantial losses can result from downtime and lost production.



Access to the inner workings of a pump is another important design feature that affects maintenance.

DESIGN IMPACT

Maintenance starts with a simple design. Some pumps are designed for a limited life, and purchasing decisions are purely based on cost. Other pump designs seek to provide reliability over a longer life, while balancing the anticipated cost of repairs. Rotary-gear pumps are often deployed to pump harsh and aggressive chemicals, so sealless designs are easier to maintain because there is no leak point for the harsh chemicals to damage the pump or surrounding equipment.

When it comes to rotary-gear pumps, the number of spare parts should always be considered. Maintaining a sufficient inventory of gears, shafts, O-rings, and liners is critical. Spare-parts kits should contain every part that a pump requires, and kits should be easy to procure (with just a single part number). If tied to a proper design, spare parts should be simple and easy to install. Some pumps feature symmetrical parts that only fit in one way,

making parts replacement mistake proof, and keeping time to repair at a minimum.

Access to the inner workings of a pump is another important design feature that affects maintenance. If the pump's gears are not readily accessible, then engineers need to decouple the motor, close the valves, and remove piping at the suction and discharge ports of the pump. Pumps that feature a front pull-out design can be repaired in place. This minimizes downtime by eliminating the need to lock-out/tag-out the pump, and move it to the repair shop.

MAINTENANCE ROI

Maintenance costs for a single repair will always be insignificant, compared with the costs associated with lost production and process restarts. The true return on investment associated with maintenance should be connected to a plant's uptime. The simpler the equipment is to maintain, the faster it can be done. This gives plant operators more flexibility to schedule maintenance between shifts or whenever it is most opportunistic (or least disruptive).

Although the demographics for engineering staffs continue to change, the loss of vast experience is gradually being offset by new technology that can sense issues and alert engineers to problems before they occur. This type of sensing technology, coupled with simple designs, intuitive access, and fewer parts to maintain, forms the cornerstone of preventive-maintenance programs that keep plants up and running, and also provides management with the data it needs to make better decisions for capital budgets and long-term infrastructure improvements. **RP**

Bobbie Montagno is the aftermarket business line leader at Pulsafeeder Engineered Products, Rochester, NY. For the past 30 years, she has held leadership roles in application engineering, product management, and aftermarket. She can be reached at bmontagno@idexcorp.com.



CASE STUDY

WASTEWATER SYSTEM CUTS MAINTENANCE 87.5%

Wastewater-pumping system solves chronic clogging problems at Heathrow Airport.

MARK WILLSON, XYLEM INC.

London's Heathrow is one of Europe's busiest airports, daily serving more than 200,000 passengers with an average of 1,200 flights arriving and departing. To service all of the systems that support those people and planes, Heathrow Airport Water Services Department manages an extensive network of 120 pumping stations. As can be expected, a system of this size doesn't always operate smoothly.

Chronic clogging issues at one of the airport's wastewater pumping stations were one problem area. To solve it, department personnel agreed to install and pilot the Flygt wastewater pumping system, manufactured by Xylem Inc., Rye Brook, NY.

As well as delivering consistently clog-free pumping, the Flygt Concertor, a wastewater-pumping system with integrated intelligence, dramatically reduced energy consumption by 53% at the pumping station.

THE CHALLENGE

The Central Area Sanitation unit adjacent to Terminal 1 is a receiving station for all aircraft toilet waste and was experiencing a very tough clogging challenge. The station manages wastewater directly from aircrafts. The wastewater contains a high level of non-biological solids including various types of plastic material, wipes, disposable diapers, and clothing. This stringy material can be difficult to pump since it can easily get caught on the impeller and partially block the pump, leading to increased energy consumption



and, in worst cases, full pump blockage.

This challenging wastewater application led to regular clogging and the sump not being kept properly clean.

"We would usually have to deal with two or three clogging issues during a three-month period," said Ian Jolly, systems specialist for water, Heathrow Airport Water Services Department.

"We also used to see a shelf of fat and material deposits build up on the walls of the sump, as well as floating debris. This presented a very tough challenge to our existing wastewater pumps which we frequently had to de-clog."

INTEGRATED CLOG-FREE TECHNOLOGY

Heathrow Airport required a solution that would solve the operational costs and environmental problems caused by:

- high levels of floating debris on the surface of the wet well

- higher than normal percentages of rag/non-biological solids in the wastewater.

The Heathrow team trusted Xylem's expertise in solving these particularly challenging problems and agreed to a trial of the Flygt Concertor. "We have used a number of Flygt technologies over the years and have found the Flygt team to be very willing to listen to our needs, always eager to find a solution," Jolly said.

As a world's first, Flygt's wastewater-pumping system combines built-in sump and pipe-cleaning functionalities in a single integrated solution. It is capable of tackling sump floating debris as well as pipe sedimentation.

Furthermore, the pump-cleaning function, together with Adaptive N-hydraulics, effectively detects and solves clogging from large debris.

It is precisely the integration of intelligent functionality that makes Flygt Concertor a unique wastewater-pumping system. It provides unparalleled results and long-term positive benefits for many applications.

Since the installation of Flygt Concertor at the Heathrow Central Area Sanitation Unit in November 2015, Concertor has provided absolute clog-free operation, as well as a remarkable improvement in the wet-well environment.

"Since installing Concertor we have had absolutely no clogging and the sump remains clean with no fat build-up," Jolly said. "As well as peace of mind—which really is priceless—the cost savings are significant at approximately 87.5% of the annual costs in cleaning and servicing."

The maintenance on the system is greatly

WATER & WASTEWATER SYSTEMS



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reduced, according to Tomas Brannemo, senior vice president, President Transport, Xylem, Inc.

“Normally, you would have clogging issues, pipe blockages, and the sump itself would get floating grease,” he said. “The entire system would need to be cleaned with a vacuum truck. Concertor’s integrated intelligence has sump and pipe cleaning built inside. At regular intervals, this system automatically takes down the level, sucks up the debris, and flushes it out so that the sump is clean. It also goes through pipe cleaning cycles as well as automatically recognizing and unclogging itself if clogging should occur.”

ENERGY REDUCED BY MORE THAN 50%

The system aims to deliver proven reliability at the lowest total cost of ownership and to achieve this it also, among other benefits, drastically reduces energy consumption.

In the case of the once-troublesome Central Area Sanitation Unit pumping station, energy savings have increased to 53% which, again, is a result of sophisticated software and cutting-edge components. The Energy Minimizer function automatically ensures that all the pumps run at their most efficient duty points together with:

- IE4 high-efficiency motor
- self-cleaning Adaptive N-hydraulics
- constant power functionality.

Additionally, since there is no need for ventilation, cooling, or heating of cabinets, customers benefit from substantial energy savings throughout the system’s total life cycle.

“Concertor’s compact design allowed it to fit into the existing position within the pump station, without any extra investment required to enlarge the cabinet. From an aesthetic and practical consideration the reduced panel-requirement size will be of great benefit,” Jolly said. “It was simple to install and very user friendly. Actually, the trial pump was installed by one of the airport’s water services mechanical technicians, who was not experienced in



Above. One of Heathrow’s aircraft wastewater vehicles transports sludge to the Central Area Sanitation unit. All images courtesy of Flygt, a Xylem brand.

Below. Ian Jolly, system specialist for water services at Heathrow Airport, works with the Flygt Concertor during the system trial.



the commissioning of wastewater-pumping systems and quickly gained confidence with the ease of installation and operation.” RP

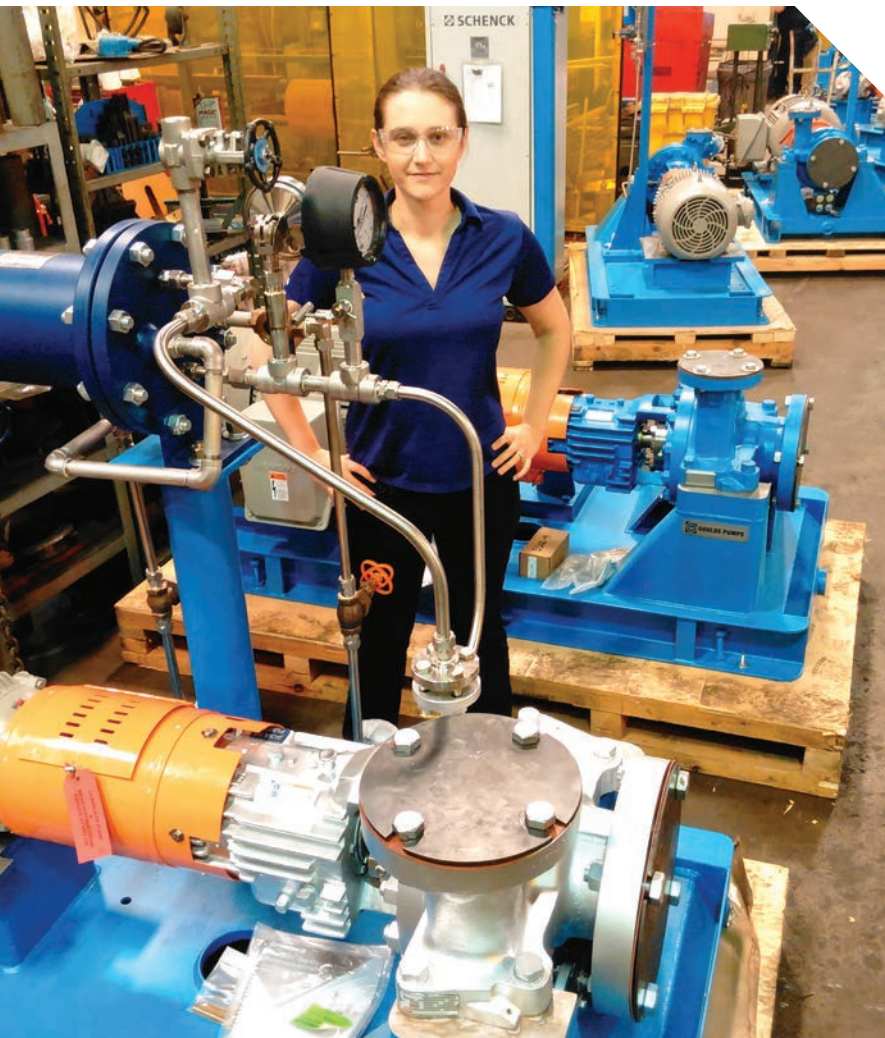
Mark Willson is a field sales engineer for Xylem managing infrastructure accounts in the South East region of the UK, with responsibility for Xylem product sales into Thames

Water and Heathrow Airport accounts. Willson has more than 15 years of experience in the water-treatment sector. Prior to joining Xylem, he worked in the water-treatment and petrochemical sectors, and with Ford Motor Co. as a project engineer. He holds a BEng degree in mechanical engineering and a teaching degree.

Getting It Done Right

Engineer uses methodical process and attention to detail in her professional and personal life.

Michelle Segrest
Contributing Editor



This pump, built to API 610 (11th ed) with a modified Plan 23 seal arrangement, is for hot water service at a chemical plant.

REBEKAH MACKO APPROACHES every task with one simple philosophy in mind: It's more important to get it done right than to get it done right now. Her father taught her this lesson early in life. An organic geochemist, his approach to all things revolved around a methodical process, the success of which he passed down to his daughter.

"I can remember spending a lot of late nights in the lab with my Dad," Macko said. "In fact, he likes to tell the story that he took me to the lab before taking me home from the hospital when I was born. We would take apart something, and he would show me how it works. I was always encouraged to look at the world around me, appreciate science, and look at the details of things. When I was really young, I thought I wanted to be a biologist and work with bugs or work in the rainforest."

As she grew older, around the age of 10, Macko began to realize she had an aptitude for understanding the mechanics of machines. "Science was really romantic and fascinating to me," she said. "I thought it was so amazing what people could do with all these creative tools and instruments. This is when I really began to think about being an engineer."

The interest stuck. The 33-year-old mother of a six-month-old son, Lance, has been a senior fluid-systems engineer with Geiger Pump & Equipment in Aston, PA, for eight years. Every day, she applies the lessons learned from early experiences in the lab with her father.

"I remember one time replacing the coil on a gas chromatograph," she explained. "It's a pretty simple operation with a big narrow coil of wire. I had seen the machine a bunch of times, but I didn't know what was inside, or how it worked, or even what it did. My dad explained what the parts were, and what was behind the 'secret door.' I loved learning how it works and how it tells us useful things. Now, I always want to know what every little mechanism is and the parts behind it. It's fascinating to me to realize that someone figured all this out. Nothing just happens. There are many different components, and pieces, and parts needed to put together every puzzle."

A day in the life

Macko uses her curiosity and mechanical gifts every day with Geiger. As the team leader of the packaged-systems group, she does everything from taking customer calls to troubleshooting problems and testing equipment under construction. She also works with the quality-assurance program and spearheaded the company's successful effort to achieve ISO9001 certification.

"Rebekah is a pleasure to have at Geiger," said the company's president, Henry Peck. "Rebekah is a champion for keeping our systems group on task in delivering the highest-quality products and services. When our team has an engineering challenge, whether technical or logistical,



Geiger's Rebekah Macko and Craig Fuller discuss the details of an API 610 pump.

Rebekah's Best Advice For R&M Professionals

- Pass on your knowledge. Don't discourage "dumb" questions.
- Spend time with equipment as much as possible. Go see the problem whenever possible.
- Value and respect your team.
- Challenge yourself to connect theoretical models to real-world applications. "Road feel" from experience and math shouldn't be at odds with each other.
- Communicate technical concepts in a straightforward manner.

Rebekah is a go-to for helping to find a solution. She is a role-model employee for our favorite Geiger values—continuous improvement and collaborating as a team.”

Geiger's overall base business is in industrial pump distribution, parts, assembly, and repair. Many years ago the company (then Smith-Koch), responding to market demands for the increased quality and simplified logistics of factory-assembled fluid-handling systems, started building packaged fuel-oil systems. In more recent years, its packaged systems business has expanded into custom-engineered products, building increasingly complex systems specifically to meet customer needs. This requires careful attention to individual engineering requirements. Macko's main responsibility is to ensure the company meets customer requirements

and delivers a complete packaged working system.

She uses her instinctive and genetic methodical system to coordinate these efforts for her seven-member team. Her process begins by compiling as much information as possible.

“For example, a customer may be replacing a particular bad actor or looking to optimize a piece of pumping equipment,” Macko explained. “Sometimes people will send a grainy chart or a blurry picture, and this can actually be helpful, but you need a firm footing. Information is the key. Then, I look at the details of what has been done before and try to decide if this is the way we want to continue. I'm of the younger generation of engineers, so this gives me the freedom to make new suggestions, or to try a new tech-

nology. For example, personnel may be controlling the pump with pressure, but perhaps they should be using a different variable, like level or viscosity, in their control scheme.”

The next step is selecting the right equipment for the job.

“People love to oversize their pumps,” Macko said. “They feel more comfortable with a fudge factor. There is always uncertainty in the real world, but with enough information you can pick the right fudge factor, and that can make all the difference. Sometimes it takes courage to try something new, but I'm a firm believer in designing your system with an investment in some flexibility. You just need a solid Plan B. Every plant is unique, and every installation is unique. If the information you begin with is correct, then newer technology like variable-speed drives and proper implementation can help a lot.”

Macko has put this theory to action in real-world scenarios. “I remember

Rebekah's Credentials

- B.S. Mechanical Engineering (Virginia Tech), E.I.T.
- Pump applications and troubleshooting
- Process and mechanical design for packaged fluid-handling systems, electrical and controls system integration
- Pump control optimization
- Creation and implementation of a quality management (ISO9001) system.

once a customer really oversized a pump,” she said. “Because they oversized on flow, their pump had less hydraulic coverage than expected. It was dead-heading all the time, wrecking seals, and the obvious, but expensive, solution was to replace the pump. Fortunately, the pump had a VSD designed for use with centrifugal pumps. We looked at the

features already in the drive and came up with a different control scheme using the existing equipment to correct what was going on. The existing equipment could be used because we had built some flexibility into the system. We corrected the problem without having to replace the pump.”

Every two years, Geiger hosts the Mid-Atlantic Pump & Process Equipment Symposium. On Oct. 6, 2016, Macko will be one of the instructors for the 11th biennial event. The day-long symposium allows attendees to participate in seminars and hands-on classes led by a team of experts. It is the largest and most comprehensive training event in the industry.

Combine field work with paperwork

Before working with Geiger, Macko worked in the public-works department for the City of Charlottesville, VA. She inspected catch basins and mapped stormwater systems, literally working in the middle of the highway. This experience helped her understand the connection between the theory and the field.

“It’s so important to have a feeling for how things work, and this is developed through experience—taking the pump apart, putting it back together, getting to know the machines, feeling how they work,” she explained. “But there is engineering and math behind every piece of it. And the two agree. The two go together. If they don’t, you need to adjust one or the other.”

Like solving a puzzle each day, finding creative solutions is a driving force for Macko. “It’s a matter of looking at resources available beyond just the pump,” she said. “It’s important to look at the whole system, use some pump math and graphing, and then put together the theory. I also find a lot of value in going to the site, meeting with the customer, putting my hands on the equipment. This takes extra time, but it’s worth it. And it goes back to getting all the information you possibly can. You can’t always do this from the other end of a telephone.”

Once she has as much information as possible, the real work begins. “When I have all the information, then I can

Rebekah’s Top 5 Tips

1. Invest in quality and proper installation of equipment.
2. Don’t oversize pumps just for the sake of oversizing. Specify for flexibility instead.
3. Work closely with vendors who can provide strong technical expertise.
4. Follow manufacturer’s storage instructions for parts and spare equipment.
5. Always install an inlet pressure gauge on pumps and pressure-regulating equipment, in addition to the downstream gauge.



Rebekah Macko has been a senior systems engineer with Geiger Pump & Equipment in Aston, PA, for eight years.

break down the problem into testable hypotheses,” she said. “We can determine answers to questions like, ‘What, beyond the obvious, could be contributing to the issue?’ and ‘What do we know about recent changes in the system?’ Nothing is in isolation.

“Then I think about it and try to reframe the question. If it’s something that’s really stumping me, I try to describe it in three ways—with words, with diagrams, and with math. The hardest, the way that makes me think most closely about the problem, is usually in the math. I may go back to my textbook and think about the principles at work. Or I may draw a diagram and discuss it with someone with a different knowledge base than me. I try to get a different angle, and think about it in a granular way so I can process it differently. I come up with lists of possible causes and try to figure out how to test each one.”

Essence of the person

Even when she is not working, Macko’s engineering side creeps in. “It’s just who I am,” she said. “And I wear the ‘nerd’ sign like a badge of honor.”

For example, in her ceramics class, while the other students were creating pots and bowls, Macko enjoyed making pinhole cameras. “For me, pottery is a nice marriage of engineering, planning, and creativity,” she said. “You draw things, sketch them out, and make plans. I would make the pinhole cameras out of

clay, throwing the body of the camera on the potter’s wheel, make a lid, and plan for the pinhole, shutter, and holder for film to adjust for focal length. Exposing polaroid film through the pinhole you can get all kinds of wild images. This is how an engineer does pottery, I guess. I always had the best measuring tools. Others would say, ‘I really love the visceral feel of the clay,’ and there I was with my protractor.”

Determined in personal and professional challenges, Macko draws inspiration from the famous Marge Piercy poem, “To Be of Use,” which describes the importance of putting your shoulder into your work and getting things done right. “We are not doing philosophy here,” Macko said. “We have to get it right. We can’t take short cuts, because if we make mistakes, it will be seen. I believe that if you are going to do something, do it right. This philosophy rolls into my everyday life and with everything I do. My son doesn’t have to become an engineer, but I hope he grows up to be determined and creative and enthusiastic about the world around him. I hope that he can always find something interesting in everything in his corner of the world.” **MT**

Michelle Segrest has been a professional journalist for 27 years. If you know of a maintenance and/or reliability expert who is making a difference at their facility, email her at michelle@navigatecontent.com.

If high vibration in your rotating machines is resonance instead of mass unbalance, these solutions will likely fix the problem.

Got Resonance? Here Are Remedies



ACCORDING TO RON ESHLEMAN, technical director of training at the Vibration Institute, Oak Brook, IL, “Excessive vibration is now more likely to be diagnosed as resonance than mass unbalance, especially in equipment driven by variable-frequency drives (VFD) with a wide speed range.”

Resonance occurs in a system when the frequency of a vibratory force (forcing frequency) is at or near a natural frequency. Vibration levels at resonance are controlled through damping. Vibration amplification is determined by the proximity of the forcing frequency to natural frequency.

While there are several ways to deal with resonance, situations differ. It’s important to select solutions based on specific applications. Dr. Eshleman offered the following advice.

—Jane Alexander, Managing Editor



These days, excessive vibration is more likely to be diagnosed as resonance than mass unbalance, especially in equipment driven by VFDs with a wide speed range.

Analysis

When high vibration is noted in rotating machinery, the analyst should conduct a thorough vibration analysis before applying commonly used resonance fixes. After all, excessive vibration could result from one or a combination of the following non-resonance situations:

- pedestals, foundations, or structures
- loose or missing bolts, broken welds, soft foot, or mismatched parts
- excessive vibratory force
- lack of damping.

To confirm the state of resonance in machinery, the analyst must verify the location of the system’s natural frequencies with a simple impact test, operating deflection shape, or modal test. The modal test will typically yield the most information.

Solutions

Reducing resonant-equipment vibration

levels can involve any of the following actions, or a combination thereof:

- raising or lowering the natural frequency to distance it from the forcing frequency
- adding damping
- attaching an absorber.

Raising the natural frequency is generally the preferred solution—but in variable-speed machines, it may be impossible to raise it adequately. Normally, 15% separation of frequencies is desired.

Raising the natural frequency (f_n) involves increasing the stiffness (K) or reducing the mass (M). For a simple system:

$$f_n = 1/2\pi [K/M]^{1/2}$$

Note that raising the natural frequency can be a daunting task, given that this frequency is proportional to the

square root of the stiffness divided by the mass. Many stiffeners increase mass, which works against the solution.

Lowering the natural frequency involves more system flexibility, or less mass that acts as structural support.

Damping removes energy from the system, but is difficult to implement. It can be added by using elastomeric elements or fluid dampers—when they conveniently fit into the design. Effective damping, however, involves relative motion.

Elastomeric coatings and pads typically don’t have sufficient energy-absorbing ability to reduce low-frequency high vibration.

Absorbers work well with machines in which speed varies only slightly. The ratio of the absorber mass to the machine size determines the speed variability permitted, while remaining within vibration limits. **MT**



To learn more about dealing with resonance and other vibration issues, contact Dr. Eshleman at reshleman@vi-institute.org, or visit the Vibration Institute at vi-institute.org.



Maintain Your Pumps on Schedule

TIMING IS EVERYTHING, especially when it comes to pump maintenance. Not only will a well-maintained pump last longer, it will require fewer repairs over the course of its lifetime.

Keep in mind, rigorously following OEM-specified maintenance schedules and procedures for pumping systems is crucial to the reliability, safety, and efficiency of your plant's fluid-handling processes. The best—and most logical—place to find this information is the “Instruction and Operation Manual” (IOM) for the equipment in question.

Although you will, of course, want to refer to and follow OEM-specified schedules for the particular pumping systems at your site, the one outlined here is a good example. It's taken from the preventive-maintenance section of the applications guide for the 3196 i-Frame series from ITT Goulds Pumps, Seneca Falls, NY (gouldspumps.com). These ANSI units are typically used to handle hazardous fluids in challenging chemical-plant environments.

This straightforward schedule and the procedures associated with it, however, are not merely suggested or recommended. According to the company, adherence to the preventive-maintenance section of its applications guide is required to maintain the applicable ATEX classification of the equipment.

—Jane Alexander, Managing Editor

Rigorously following OEM-specified maintenance schedules and procedures for pumping systems is crucial to the reliability, safety, and efficiency of your plant's fluid-handling processes.

Routine maintenance

- Lubricate bearings.
- Inspect the seal.

Routine inspections

- Check level and condition of oil through sight glass on bearing frame.
- Check for unusual noise, vibration, and bearing temperatures.
- Check pump and piping for leaks.
- Analyze vibration.
- Inspect discharge pressure.
- Inspect temperature.
- Check seal chamber and stuffing box for leaks.
- Ensure there are no leaks from the mechanical seal.
- Adjust or replace stuffing-box packing if you notice excessive leaking.

Three-month inspections

- Check that foundation and hold-down bolts are tight.
- Check packing, if the pump has been left idle, and replace as required.
- Change oil every three months (2,000 operating hours) at minimum.
- Change oil more often if there are adverse atmospheric or other conditions that might contaminate or break down the oil.
- Check shaft alignment and realign as required.

Annual inspections

Check the pump's capacity, pressure, and power. If pump performance doesn't satisfy your process requirements, and if the process requirements haven't changed, the pump should be disassembled and inspected, and worn parts should be replaced. Otherwise, a system inspection should be done.

Inspection intervals

Shorten inspection intervals appropriately, if the pumped fluid is abrasive or corrosive, or if the environment is classified as potentially explosive. **MT**

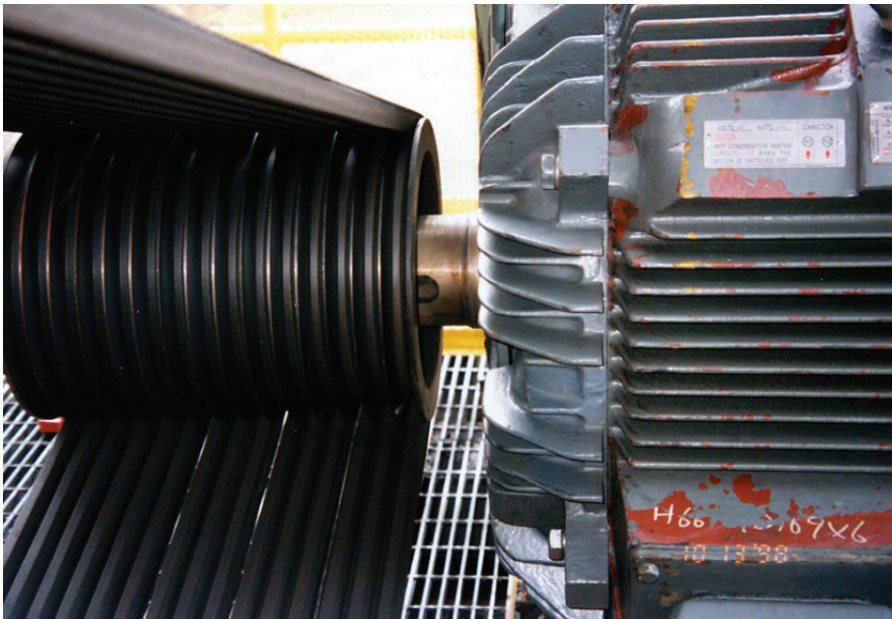


For more information on a variety of pump issues and procedures, visit gouldspumps.com.

My Motor Failed. Now What?

Mike Howell
 Electrical Apparatus Service
 Association (EASA)

PROCESS DOWNTIME is expensive—even more so when it's unexpected. So, when an electric motor fails, we tend to pull, repair, or replace it, and move on as quickly as possible. In doing so, however, we may miss an opportunity to capture basic information that could help improve the reliability of the application. With a little planning, these data can be gathered with no delay in startup.



This sleeve bearing motor, with a drive-end bearing failure and bent shaft, arrived at a service center without its sheave, and with very little information. Bearing wear was presumed to be the cause of failure. After the motor was returned to service with a new shaft and new sleeve bearings, it failed in less than an hour. A simple photo of the motor following the initial failure would have correctly identified the cause—excessive overhung load for the sleeve bearing—and a motor with rolling-element bearings could have been installed to prevent a second failure.

Collect initial data.

Develop a simple, standard procedure that a “trained” operator can use to jot down or check off some basic information about the process at the time of failure. In special applications or cases of chronic failure, photos could be extremely helpful.

Don't destroy two motors.

Startup procedures vary widely, depending on factors such as application and equipment size. Have appropriate measures in place so that, following a failure, you can rule out problems with the power supply or starting equipment before attempting to start a replacement motor.

Help your service center.

Sometimes, the cause of failure seems so obvious that, with too little information, we jump to the wrong conclusion. Furthermore, we may only discover our error when the repaired motor or its replacement quickly fails. The more application and failure details that you can share with service-center personnel, the easier it will be for them to help identify and eliminate the actual problem and provide a reliable repair for the application.

With most applications, much of the documentation can be done long before a failure occurs. Such details can make all the difference when the service center performs causal analysis. Examples of data that can be recorded in advance include:

- Complete motor nameplate information
- Power supply information: sinewave/non-sinewave power (ASD/VFD), known transients, voltage variation, voltage unbalance, starting method
- Environment: indoors/outdoors, ambient temperature, humidity, contamination
- Mounting and coupling: direct coupled, belt drive, integral mounted, overhung load, mounted vertically
- Application information: pump, blower, conveyor, crusher, inertia/starting torque requirements, acceleration time, duty cycle, typical loading.

Once a failure occurs, combine this general information about the application with specifics about the failure event, including any available photos. This approach will get your service center off to a good start in accurately determining the cause of your motor's failure and preventing a second incident. **MT**



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Handle Bearings With Care



Handling practices are an important factor in a bearing's ability to live up to its full potential.

MODERN ROLLING CONTACT bearings, when installed and lubricated properly, can outlast the machines in which they function. In practice, though, less than 10% of all rolling-element bearings reach their full design life. As for the others, 30% of premature failures can be attributed to incorrect installation or damage done during (or prior to) installation.

Jason Tranter, founder and managing director of Mobius Institute, has been involved with machine-vibration analysis, condition monitoring, and reliability improvement since 1984. He offers these important reminders for anyone who handles bearings.



Mobius Institute (Melbourne, Australia, and Bainbridge Island, WA) is a worldwide provider of a variety of reliability-improvement, vibration-analysis, and precision-maintenance training and certification services. For more information on the company and its upcoming International Machine Vibration Analysis Conference (IMVAC), in Orlando, visit mobiusinstitute.com.

Handling and installation damage

Use care when handling and assembling bearings so their rolling elements, race surfaces, and edges aren't damaged. Gouges in the raceway or battered and distorted rolling elements will raise metal around the damaged area. This condition causes localized spalling as rolling elements pass over these areas.

Damaged bearing cages or retainers

Careless handling and use of incorrect tools during installation may damage cages or retainers (typically constructed of mild steel, brass, or bronze) and shorten the bearing's life.

High spots and fitting practices

Carelessness or damage when driving outer races out of housings can cause burrs or high spots in the outer-race seats. If a tool damages the housing-seat surface, it can leave raised areas that transfer through the outer-race rolling surface, causing stress and shorter operating life.

Excessive preload or overload

Excessive preload can generate heat and cause damage similar to inadequate lubrication.

Excessive end-play

This situation results in a very small load zone and excessive looseness between the rollers and races outside the load zone. In turn, the rollers become unseated and skid and skew as they move in and out of the load zone. The problem is common with non-drive-end bearings, especially on vertical machines, and even more so with cylindrical roller bearings.

Misalignment and inaccurate seat, shoulder machining

The seats and shoulders supporting the bearing must be within specified limits set by the bearing manufacturer. When misaligned, the load on the bearing won't be distributed along the rolling elements and races as intended, but concentrated on only a portion of the rollers or balls and races.

Improper fit in housings or shafts

The bearing race where the rotating load exists should be applied with a press fit. The stationary race would normally be applied with a light or loose fit. Where the shaft rotates, the inner race should normally be applied with a press fit and the outer race may be applied with a split fit or even a loose fit.

Impact and high static-load damage

Improper mounting practices and/or extremely high operational impact or static loads may lead to brinelling. When mounting a bearing on a shaft with a tight inner race fit, pushing the outer race will exert an excessive thrust load and bring the rolling elements into sharp contact with the race, causing brinell.

Electric current arcing

Arcing inside a bearing happens when an electric current passes through the component between the races and rolling elements. Each time the current is broken while passing between the ball or roller and race, a pit is produced on both surfaces. Eventually fluting develops.

According to Tranter, since premature bearing failure can result from issues other than improper handling, it's important to always consult your bearing OEM and/or supplier for product-specific best practices. **MT**

—Jane Alexander, Managing Editor

If It's Leaking, Think Before Tightening

Your natural inclination to stop a leak could lead to greater problems.

Henri Azibert
Technical Director
Fluid Sealing Association

WHENEVER A PIECE of equipment is leaking, our natural inclination is to tighten whatever can be tightened. Applying more compression on the sealing element is typically assumed to be the solution. The expectation is that the tighter the fastener and the greater the clamping force, the higher the level of sealing performance. Unfortunately, this is not necessarily the case and, quite often, will make matters worse—much worse. Given the fact that safety should always be a primary concern, working on pressure-containing equipment requires careful thinking before any remediation is considered and implemented.



Headquartered in Wayne, PA, the Fluid Sealing Association (FSA) is an international trade association of companies involved in the production and marketing of a wide range of fluid-sealing devices targeted mainly at industrial applications. Founded in 1933, the association continues to be recognized as, among other things, the primary source of technical information in the fluid-sealing area. For more information, visit fluidsealing.com. For more information on technical topics, email henri@fluidsealing.com.



Applying more compression on the sealing element is typically assumed to be the right solution to a leak.

Flanges

Flanges sealed with a gasket should have been tightened with a torque wrench according to the manufacturer's specifications. The gasket compression loading must take into consideration, among other factors, the process pressure, process temperature, and the gasket material and style. This assumes using new bolts and an appropriate lubricant to achieve an accurate clamping stress from the torque level.

In case of a problem, tightening the bolts will often make conditions deteriorate. The gasket could be crushed and damaged. An elastomeric gasket could be extruded. The flange could become deformed. Further tightening will only exacerbate the leakage.

Compression packing

Personnel are expected to adjust compression packing on pumps to achieve desired leakage levels. While adjustments to reduce leakage are standard procedures, they should only be minor. If improvements aren't quickly realized, you may have a significant problem on your hands. Extrusion, excessive sleeve wear, chemical attack, radial motion, and other factors can't be remedied by increased compression. In those cases, increased tightening will aggravate the wear process.

Similar considerations apply to valve packing. Leakage levels are expected to be minimal. If those levels become excessive, only very small, incremental adjustments should be made—after first verifying that the originally specified torque levels are present on the gland packing bolts.

Mechanical seals

Mechanical seals typically aren't subject to adjustments to reduce leakage. That said, there are some cases where tightening comes into play.

When the stationary seal ring is of a design that can be clamped, the clamping action can easily create distortion. A few millionths of an inch out of flatness will result in a leak. Any increased tightening of the gland bolts will worsen the condition.

Even when the seal ring isn't clamped, it is often axially supported inside a gland plate. Deflection of the gland plate can be transmitted to the stationary seal face. In these cases, the only way to eliminate the leakage is to loosen the bolts.

The solution begins by confirming the specified torque requirements for the equipment—and verifying, with a torque wrench, whether those specifications had been met. If you don't have time to research the situation, consider the possible implications of the leakage and what is most likely causing it. When it comes to leakage, your motto should be "Think twice, adjust once." **MT**

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