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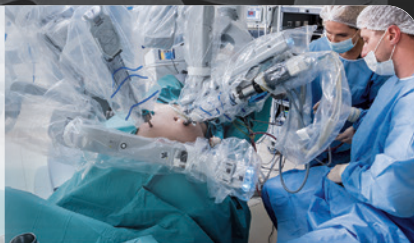
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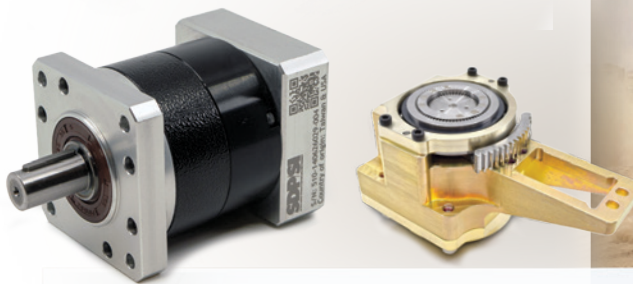
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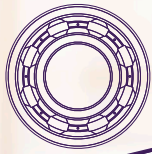


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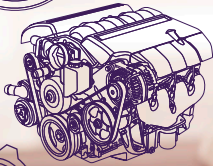
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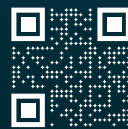
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PTE Extras

Vesconite Lantern Rings Solve Hoover Dam Hydro Plant Corrosion Issues



When engineers at Hoover Dam determined that the original cast iron lantern rings built into some of its turbines needed to be replaced, they were looking for a solution to help them overcome the corrosion issues they experienced with the cast iron. Vesconite Hilube lantern rings provided a new solution.

powertransmission.com/blogs/1-revolutions/post/9405-vesconite-lantern-rings-solve-hoover-dam-hydro-plant-corrosion-issues

Pack Expo Las Vegas 2023

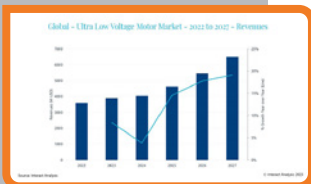
Produced by PMMI, The Association for Packaging and Processing Technologies, Pack Expo Las Vegas featured more than 2,000 exhibitors showcasing the newest innovations for more than 40 vertical markets, spanning nearly one million square feet of exhibit space. Here are some product highlights from the show.



powertransmission.com/blogs/1-revolutions/post/9421-pack-expo-2023-highlights-automation-and-material-handling-technology

Interact Analysis Examines Ultra-Low Voltage Motors Market

New research by market intelligence firm Interact Analysis shows that the ultra-low voltage motors market is experiencing a period of growth. By 2027 the market will be worth almost \$6.5 billion driven by demand from battery driven applications and a need for greater flexibility in manufacturing and logistics processes. The increased use of mobile robots is having a huge impact on the market for ultra-low voltage motors and, as a result of this, the supplier landscape will change significantly.



powertransmission.com/blogs/1-revolutions/post/9428-interact-analysis-examines-ultra-low-voltage-motors-market

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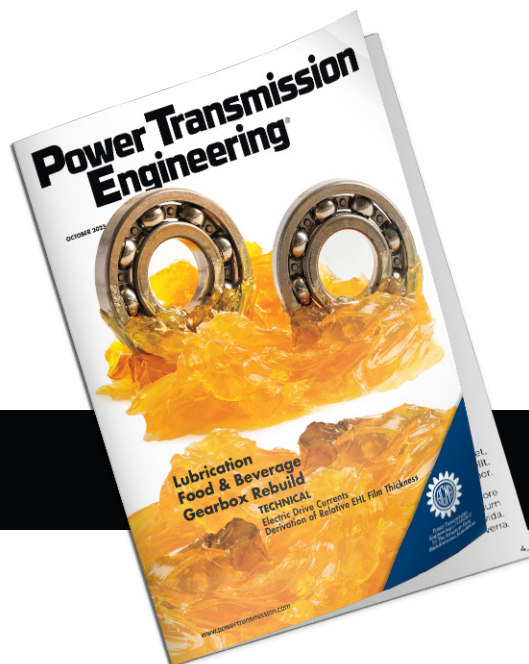
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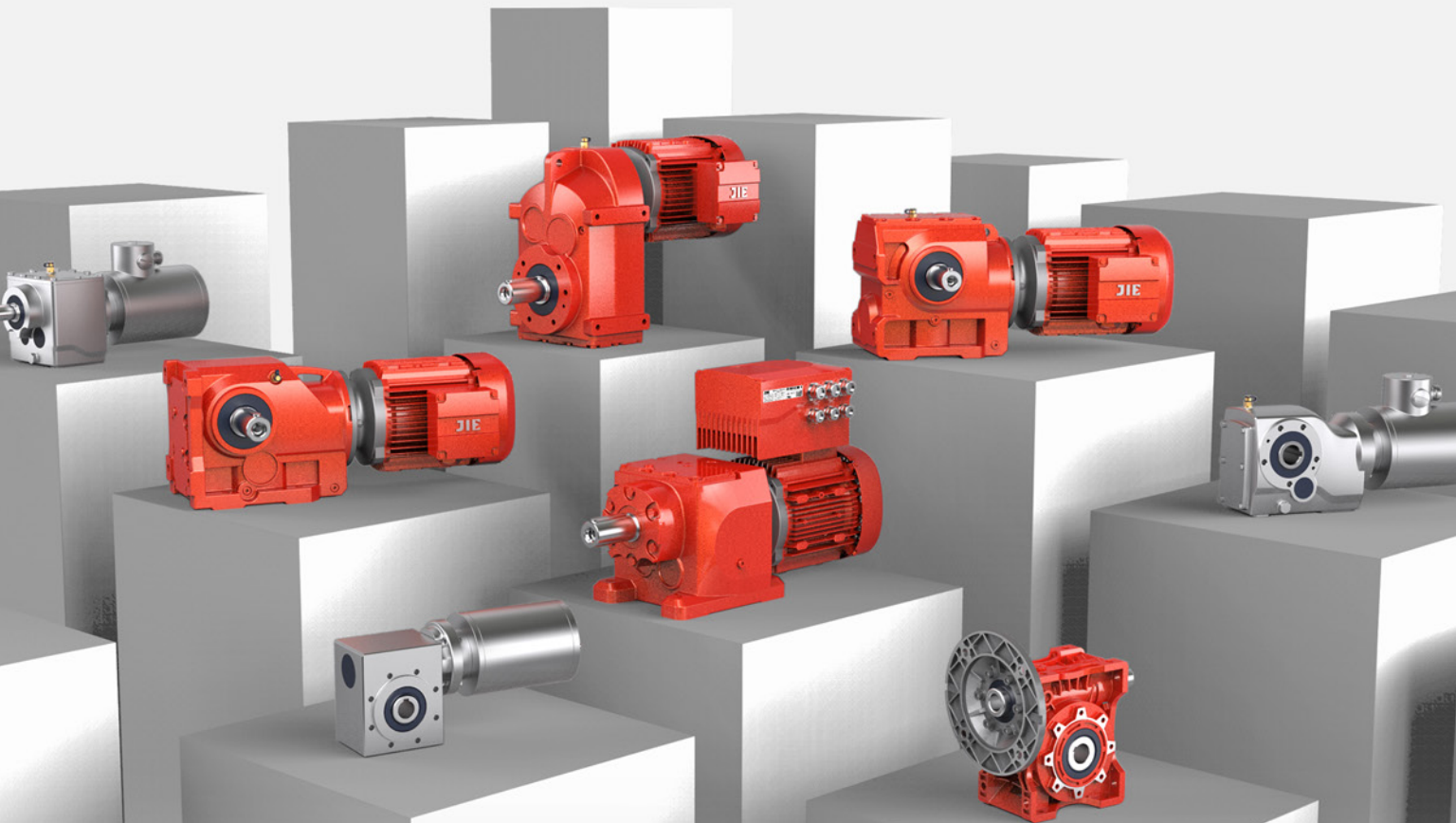
Michael Goldstein founded *Gear Technology* in 1984 and *Power Transmission Engineering* in 2007, and he served as Publisher and Editor-in-Chief from 1984 through 2019. Michael continues working with both magazines in a consulting role and can be reached via e-mail at michael@geartechnology.com.



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 - To learn more about all the ways you can reach our audience of power transmission product buyers, contact Associate Publisher Dave Friedman (friedman@agma.org).
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 - To let us know how great the magazine looks, or to tell us you have some really awesome photos of power transmission components in action (we're always on the lookout for great cover photos), contact Jess Oglesby (oglesby@agma.org).
 - If you've got something not covered by the above, your best bet is Dorothy Fiandaca, our materials coordinator. She's been with the team longer than
- anyone else, so if she doesn't know the answer, she can put you in touch with someone who does (fiandaca@agma.org)
- And if you just want to chat about cool stuff going on in the industry, I'm always up for a conversation (stott@agma.org).
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- **IN PERSON.** Come see us at Motion+Power Technology Expo (motionpowerexpo.com) October 17–19 in Detroit. Don't miss our "Ask the Expert" stage in booth #3136, where we'll be conducting live interviews with industry experts throughout the show.
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Tecnofirma

DEVELOPS MODULAR SYSTEM FOR ELECTRIC MOTOR PRODUCTION

Electric drives often need to operate under high voltages up to 800 V to provide more power and higher speeds. However, the risk of partial discharge increases at these voltages. In combination with high operating temperatures, these can locally damage the insulation and lead to machine failure. However, good impregnation ensures not only electric insulation but also copper bonding, to mechanically strengthen the electric motor, and air gap filling, to allow a better heat transfer. In turn, the more accurate the impregnation of the electrical winding, the higher the overall performance, coil insulation and voltage resistance, which has a positive effect on the service life of the drive train. For this reason, Tecnofirma S.p.A. has developed a modular impregnation system that, thanks to its design, makes it possible to achieve a much better filling of the wire packs in the stator than comparable trickling variants while consuming less resin. By tilting the component at an angle of 5 to 10 degrees, the resin reaches the cavities faster and more homogeneously. Thanks to NC-controlled impregnation axes that can be programmed in all traversable directions (x-y-z) with an accuracy of up to 0.1 mm, a high degree of reproducibility is ensured even with different component geometries.

An electric motor is only as good as its insulation: If the individual

windings and the cavities between the wires are insufficiently impregnated, wear is more likely, and the risk of partial discharges increases. If a phase failure occurs, for example, the windings of the two other phases must conduct more current. This results in excessive heat generation to the detriment of motor train performance. Furthermore, such partial discharges can occur over a long period of time without being noticed, leading to a creeping failure of the motor.

“Impregnation basically pursues two goals: On the one hand, the voids in the stator winding are closed by allowing the resin to penetrate by capillary action. On the other hand, the wire heads are covered at the end so that undesirable voltage contacts cannot occur,” explains Omid Armaghan, managing director of Tecnofirma Deutschland GmbH. “Here, it is important to keep the resin, which by nature tends to slip, in the desired position until the firing process is completed.” Impurities as well as air bubbles must be excluded, while at the same time perfect saturation of the die in the sheet package must be produced. This makes the process extremely complex and very demanding, especially when it comes to handling the resin. To make the process more efficient and safer in terms of insulation quality, Tecnofirma equipment experts have developed a modular system that perfectly coordinates all the relevant process parameters: Correct positioning of the nozzles,

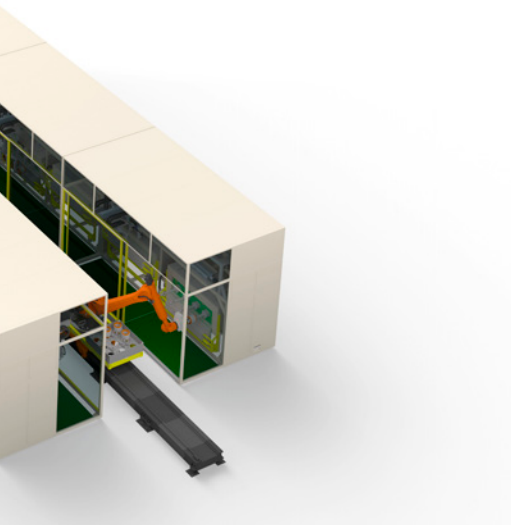
precise control of the amount of resin dispensed, optimum temperatures of both the resins and the stators, and more flexible positioning of the components via rotation speed, direction of rotation and inclination.

Scientifically Proven: Component Inclination Increases Filling Factor

The impregnation system was designed as an independent module consisting of two ovens arranged side by side. These are equipped with chucks for the stators and all the mechanics for operation, i.e., servomotors, heating, and fans. “The two ovens share an axis system on which the resin metering and the application group for the trickling process are installed,” says Armaghan, describing the setup. “We can program the axis movements down to 0.1 mm in all traversable directions (x-y-z). Precise positioning as well as monitoring of the last positions via camera ensures that the nozzles always step into the exact position.” The components are slightly tilted during impregnation, which increases the filling factor. This allows a much more homogeneous resin distribution to be achieved.

In addition, the system design increases the efficiency of the insulation process, as work can be carried out in parallel on two ovens. By combining impregnation and gelation, production volumes can be increased. In the first unit, the impregnation process takes place with the rotating chucks leaving the oven and moving forward to facilitate access to the nozzles. Meanwhile, the gelation of the previously completed





impregnation takes place in the other oven. Tecnofirma attaches great importance to constant optimal tempering of both the resin and the components. Stators are maintained at the right temperature during the entire course of the trickling application, which is particularly advantageous for long stators cores with longer impregnation time. “We are currently conducting studies in which we feed the thermal energy stored in the process exhaust air back into the system. Currently, we are using some of it to circulate heat into the curing oven,” Armaghan said. “In addition, we use a special technology in our furnaces, such as the ‘canopy’ architecture, which minimizes heat distribution—and thus optimizes energy consumption.”

Flexible Module Allows Easy Process Connection and Maintenance



Although the system was designed as a stand-alone module, it offers numerous options for connection and interlinking. For example, the system can be integrated into a powder coating process or coupled to preheating or cooling stations. In addition, a high production rate line can be created by arranging several modules side by side in parallel, with loading and unloading automated by an anthropomorphic robot on a motorized carriage. Such linkages can shorten cycle times and increase production efficiency. In addition, the system offers flexible pickup of stators so that different components can be machined depending on their diameter. “In this way, the plant is able to impregnate stators

in three different sizes without having to significantly change the process conditions,” adds Armaghan. A Data Matrix code scanner recognizes the geometry and selects the appropriate program for machining.

If process parameters or machining needs do change, the flexible design provides easy access for maintenance and adjustment without having to interrupt the entire production run. The individual modules can be easily detached from the linkage,

maintained, and adapted. This is very important for many applications, as the requirements for electric motors are subject to constant change. “That’s why we made the entire system and production design open, so that expansions can be implemented more easily. The modularity of the architecture and the feasibility of numerous options mean that the systems can be adapted to changing production needs at any time,” Armaghan summarizes.

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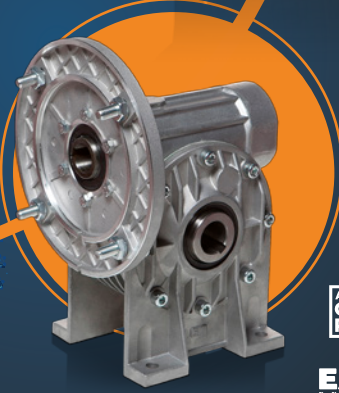
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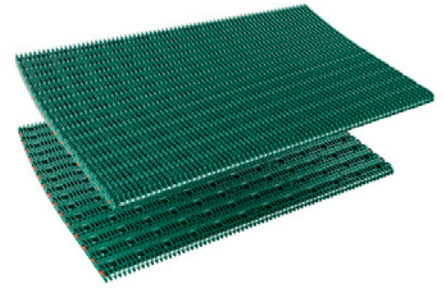
The 6997 Series is a next-generation evolution of the long-serving Rexnord 5997 Series MatTop Chain. The design of the new 6997 Series chain offers a 15 percent increase in strength over its predecessor, in addition to improved container stability at transfers for less product damage and loss. The lateral stiffness is 10 times greater than its predecessor making for less pulsation, reduced down containers and less chain deflection between wearstrips. 6997 Series chains utilize USP (Ultra-Stabilized Polypropylene) material construction, comprised of polypropylene plus stabilizing antioxidant additives, which provides superior resistance to

chemicals used in cleaning and boil-out as well as extended chain life in high-temperature environments.

The Rexnord 6997 Series MatTop Chain utilizes the same conveyor structure, sprockets, transfer combs and DTS-C as the Rexnord 5997 Series MatTop Chain for easy retrofit installations.

“Rexnord continuously develops innovative conveyor chain and chain material solutions to meet the increasing performance demands of our customers in the food and beverage industry,” said Chad Walker, director of global product management for beverage conveying. “The new Rexnord 6997 MatTop Chain embodies this mission, providing an innovation solution that combines of our industry experience, design knowledge and manufacturing expertise.”

“Rexnord continuously develops innovative conveyor solutions to meet the increasing performance demands of our customers in the food and beverage industry,” said Walker. “The new Rexnord 6997 MatTop Chain aligns with this mission, providing a 15 percent



stronger and 10 times stiffer belt versus the 5997 Series. The strength and stiffness enable improved product stability and less pulsation, increasing uptime with fewer downed containers.”

regalrexnord.com

Omni Powertrain Technologies

INTRODUCES ELECTRIC POWERTRAIN FOR SKID STEERS



Omni Powertrain Technologies announces the development of a new electric powertrain designed for the propulsion of skid steers. The new product features an Omni gearbox paired with a Magelec Propulsion axial flux motor.

The SP4000 gearbox offers peak efficiency and torque ratings of 97 percent and 4,000 Nm. The gearbox has a continuous torque rating of 2,500 Nm and a maximum input speed of 7,000 rpm.

The MP21 electric motor is a liquid-cooled axial flux motor of compact design offering high torque and power density. It is designed for battery voltages between 200 to 800 Vdc. It has an IP67/IP6K9K enclosure rating for reliability. Efficiency across the operating range is greater than 95 percent. Motors are optimized using Magelec inverters. The flexible motor design offers positional choices for mounting inverters, HV cabling, and cooling ports.

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Kollmorgen

EXPANDS PERFORMANCE AND FLEXIBILITY OF AKD2G SERVO DRIVE SERIES



Kollmorgen has announced the new AKD2G 24A drive. Designed for applications in precision multi-axis servo systems, the new single-cable optimized drive builds upon the strengths of the AKD2G portfolio including upgraded safety features, SD card backup and a graphical display with higher amperage to support more applications with higher power requirements such as conveyors and vertical lifting applications.

Compared to other drives in its class, the AKD2G 24A servo drive provides three times the continuous current rating during peak operation for up to five seconds—ideal for intermittent-use, high-power servomotors. In these peak-dependent applications, customers can potentially downsize their servo drive to this new 24A offering. Kollmorgen's Motioneering sizing and selection tool provides guidance through the process.

The new AKD2G 24A servo drive provides configurable options including safety level, I/O, feedback, and fieldbus. It supports a secondary brake through a standard X4 connector and allows for faster Smart Feedback Adapter (SFA) wiring with a standard X5 connector.

"The AKD2G 24A delivers higher amperage for more applications," said James Davison, Senior VP/GM at Kollmorgen. "This high level of flexibility and performance potential means customers aren't forced to mix and match drives. Simply put, the expanded AKD2G servo drive family now gives customers more power and control with less complexity."

kollmorgen.com

Sumitomo Machinery Corporation of America

UNVEILS NEW LINE OF SERVO GEARBOXES

Sumitomo Machinery Corporation of America (SMA) has launched a line of Servo Gearboxes. These new additions to the product portfolio encompass the Servo Cyclo, Servo Hyponic, and Servo Bevel BuddyBox 4.

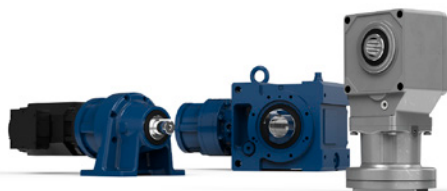
"We are thrilled to introduce our Advanced line of servo gearboxes. They are a true testament to our pursuit of excellence and innovation for the automation needs of our customers," said Eric Schoonover, motion control manager at SMA. "We are combining our decades of robotic and motion control experience with our trusted and robust power transmission products to produce servo-ready industrial gearboxes."

Highlights Include

The Servo Cyclo provides quiet, shock-resistant performance and utilizes our unique cycloidal disc mechanism for durability and long service life. It comes in two series: Standard-Backlash and Low-Backlash.

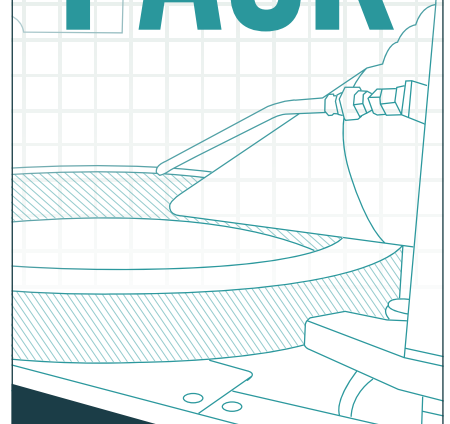
The Servo Hyponic offers high efficiency (up to 93 percent) and low maintenance, making it an ideal choice for those seeking compact, versatile solutions. Its modular design allows for various gearhead and motor combinations.

The Servo Bevel BuddyBox 4 is known for its hardened steel components and heavy-duty, fortified, grease purgeable system that provides a robust solution capable of withstanding the most demanding applications. Its design includes tandem dual lip seals to prevent leaks and contaminants.



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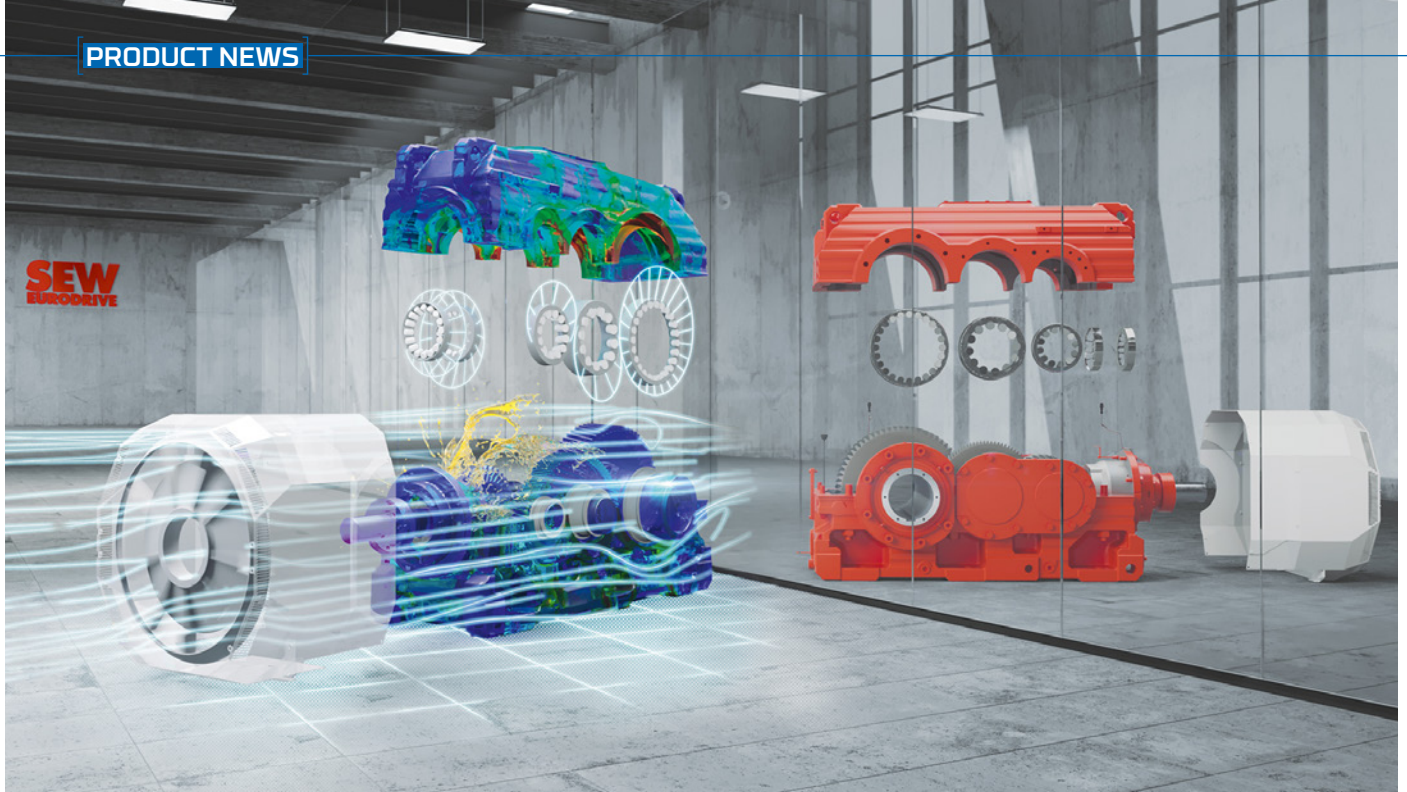
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Digital data models and the latest calculation methods lay the foundations for a further improvement in the performance of Generation X.e. SEW-Eurodrive continuously factors the findings of field/test stand trials and simulations into its own calculations, thereby improving their accuracy and reliability. The mechanical and thermal design of the X.e series was once again precisely evaluated on this basis. In conjunction with the component optimizations already implemented in the past, this results in even higher thermal limit ratings, a much longer bearing service life, and higher nominal torques. Moreover, larger application angles are now permissible with the maximum overhung load.

One potential result of these optimizations for users is a smaller gear unit size. Besides reducing the oil volume, energy consumption and total cost of ownership (TCO), this also means these users' own designs are lighter and take up less space. Particularly in the case of drives that are subject to high loads, mechanical safety—and

thus the potential for preventing damage—is also further improved. What's more, a lower oil-bath temperature and a higher bearing service life mean less frequent maintenance during operation.

With 23 finely graduated sizes, Generation X.e helical and bevel-helical gear units cover a torque range of 7.2 to 500 kNm.

sew-eurodrive.com

Digital Metrology Solutions

TRACEBOSS PLUS SOFTWARE COMBINES SURFACE ROUGHNESS AND CROSSHATCH MEASUREMENT AND ANALYSIS

Digital Metrology Solutions, provider of measurement software, consulting, and training, has introduced *TraceBoss+* (*TraceBoss Plus*) software, integrating surface texture and crosshatch measurement in a single package.

"Last year Digital Metrology's *TraceBoss* software changed how people see, save, and understand data from surface roughness gages," said Mark Malburg, president of Digital Metrology. "Since then, we've had many requests to add crosshatch

measurement to the software, as well as the ability to view torn and folded metal, a key indicator of how a honing process is running. *TraceBoss+* adds both of these functions, as well as introducing new tools to analyze, save, store, export, and output all of these results together. This complete toolset greatly helps anyone working with engine components to see their data and explore their surfaces."

TraceBoss+ software interfaces with most portable surface roughness gages. A user can take a measurement, view the results and graphics full screen, save data, and reload it for comparison and statistical process control. It reports most common roughness parameters, showing at a glance whether a surface passes or fails user-provided limits.

The built-in crosshatch functionality lets a user acquire an image of surface texture from any USB equipped microscope. Simple tools make it nearly instantaneous to obtain the crosshatch angle, while zoom and pan functions let an operator navigate through high resolution image data to review the cleanliness and consistency of honing processes.

Perhaps most importantly, the crosshatch angle information is added to the parameter results, so the data and image can be output along with surface



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roughness data in a single file. All of the data can also be printed in a concise, easy-to-share report.

“When we released *TraceBoss*, we knew we’d given surface roughness gage users a powerful tool for understanding surface texture,” said Malburg. “Now, *TraceBoss+* goes many steps further, putting surface roughness, angle, and quality analysis in one easy interface.”

digitalmetrology.com/solution/tracebossplus

Freudenberg Sealing Technologies

LAUNCH SAFETY COMPONENTS FOR BATTERIES

In lithium-ion batteries, higher energy density increases the risk of thermal runaway. As a preventive measure, Freudenberg Sealing Technologies has developed thermal barriers that help to slow down thermal runaway by increasing resistance to propagation. The new 3D thermal barriers can be used at various positions within the battery and have already proven reliable in their initial series productions.

Well over 100 million electric cars are expected to be on roads worldwide by 2030. To make electromobility more efficient in the future, many manufacturers are working on achieving higher ranges and shorter charging times. That is why high-performance batteries are one of the priorities in this development. But in lithium-ion batteries, higher energy density increases the risk of thermal runaway. For that technical environment, Freudenberg Sealing Technologies has developed thermal barriers. These slow down or

even stop thermal runaway by increasing thermal propagation resistance.

“What is completely new is that the thermal barriers are now also available in customized, flexible 3D geometries, which makes it possible to use them in various positions within the battery and allows for integration of additional components,” says Andrew Espinoza, global vice president technology of the oil seals powertrain and driveline division at Freudenberg Sealing Technologies.

Thermal runaway, which is the ignition or explosion of a battery cell caused by a self-reinforcing heating process, is a significant safety problem. It can be caused by a range of internal and external factors, such as overcharging, excessive discharging, damage, or heating of the battery. Thermal runaway releases not only flames and hot gases but also electrically conductive particles. These in turn can cause thermal propagation in adjacent cells and lead to short circuits in the electrical system. Thermal barriers act as protective layers that slow down or even prevent the heat and flames from spreading in the battery, which significantly increases safety.

Entirely New Possibilities

Beyond the existing 2D barriers, such as flat mats and thermal blankets, the 3D variant opens entirely new possibilities. Customer-specific, 3D geometries can be produced in a variety of high and low volume manufacturing processes, such as injection molding and continuous extrusion. Profile seals, module separators and covers, including those for bus bars, cooling lines or electrical components are a few of the products currently being produced. Another advantage: The manufactured, complex 3D geom-

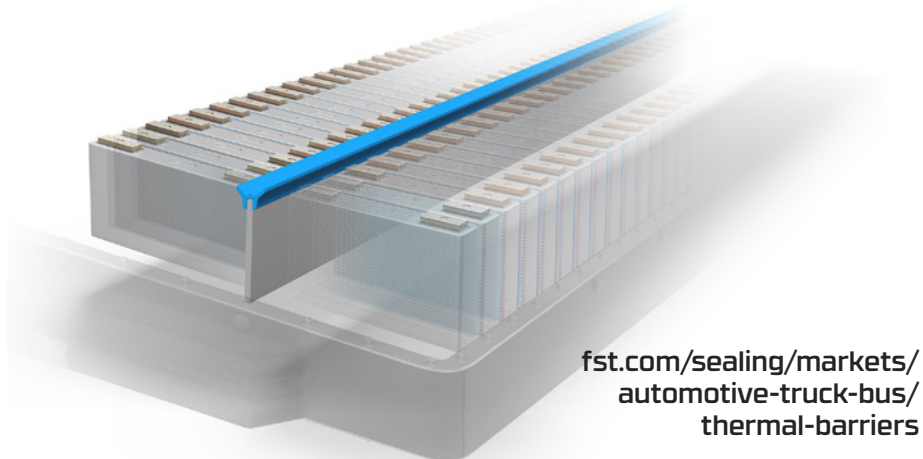
tries are lightweight and have minimal impact on the battery’s overall weight.

Specifically for these applications, materials experts at Freudenberg Sealing Technologies have developed heat-resistant, electrical, and thermal insulating materials. Testing of these materials has been completed in-house, proving that they can safely withstand temperatures of up to 1,200 °C. It is their special composition that makes these compounded polymers so extremely heat-resistant. It also makes them resistant to particle impacts, such as those that occur when cells are vented. The 3D thermal barriers utilize elastomer solutions, whether in solid form or as a foam, as well as plastic components such as Quantix Ultra, which enables complex geometries.

Extensive Testing

“The 3D thermal barriers and the utilized materials have gone through extensive testing that exceeds the required standards. They have proven their outstanding performance and reliability on bench tests as well as battery system testing. The products meet the highest quality standards, are certified pursuant to UL 94 V-0 and are already being used successfully in initial series production for the automotive industry,” says Espinoza.

With their 3D thermal barriers, Freudenberg Sealing Technologies has rolled out an innovative product that increases the safety of electric cars and lowers the risk of thermal propagation in future battery systems. As a partner of the automotive industry, Freudenberg merges market-specific know-how with unique expertise in materials, technology, and development, thus playing a leading role in the development of electromobility.



fst.com/sealing/markets/automotive-truck-bus/thermal-barriers

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- Heavy-duty, tacky, red, extreme pressure (EP) petroleum-based gear oils.
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Credit: Callan Marine Ltd, Scott Pena Photography.

Next-Generation Lubricants for Marine Applications

The shipping sector's regulatory requirements stipulate all ships must manage their pollution

Aaron Fagan, Senior Editor

In today's world, environmental considerations are paramount across every industry. From manufacturing to maritime, the quest for sustainable solutions has given rise to the development of environmentally friendly lubricants. Among these, Environmentally Considerate Lubricants (ECL) and Environmentally Acceptable Lubricants (EALs) have gained prominence for their positive impact on both equipment performance and the planet. Let's delve into the differences and advantages of these lubricant classifications.

Environmentally Considerate Lubricants (ECLs)

ECL, as the name suggests, signifies lubricants formulated with a consciousness towards the environment. However, the term lacks a standardized definition and doesn't come under the oversight of scientific bodies or governmental approvals. This leaves a certain level of ambiguity, making it essential for users to exercise due diligence when choosing ECLs. Although the specifics might vary from one product to another, the general idea behind ECLs is to reduce the ecological footprint associated with lubrication.

While ECLs offer flexibility and innovation in formulation, their undefined nature can pose challenges. Without a clear guideline, users might find it harder to assess the true environmental impact and performance benefits of these lubricants. This brings us to the more regulated alternative—environmentally acceptable lubricants (EALs).

Environmentally Acceptable Lubricants (EALs)

EALs are a well-defined category of lubricants designed with a focus on biodegradability, minimal harm to aquatic ecosystems, and nonbioaccumulative properties. These lubricants are specifically crafted to ensure that they do not persist in the environment, reducing potential damage to marine life and water bodies.

One of the standout features of EALs is their mandatory use in U.S. waters since 2013. EALs are required for equipment with oil-to-sea interfaces, such as marine vessels unless technical infeasibility can be demonstrated. This proactive stance has not only fostered eco-consciousness but also fueled research and development in lubricant technology.

While ECLs offer flexibility, EALs provide a regulated framework for protecting the environment and enhancing equipment performance. The clear definition and mandated usage of EALs make them a reliable choice for industries striving to balance functionality with ecological responsibility.

Key Environmental Regulations

Vessel owners have come to understand the impact their equipment has on the environment and are seeking to reduce their environmental (carbon dioxide and oil pollution) footprint.

Legislation drove the transition to EALs. In U.S. waters, the EPA's Vessel General Permit (VGP) 2013 was replaced by the Vessel Incidental Discharge Act (VIDA) in 2020; and for Arctic regions, the Polar Code covers environmental protection matters.

Both technical and sustainability requirements for lubricants are constantly increasing. As a result, environmental requirements and the conditions imposed by manufacturers are also becoming increasingly specific.

VIDA is essentially an updating of VGP in terms of establishing a framework for the regulation of incidental discharges to the normal operation of vessels sailing in US waters, by providing clarity on terminology. For example, specifically stating that certain deck machinery will require EALs.

Panolin Margear Designed for Dredging Gearboxes

Dredging must be carried out with extreme safety and sensitivity to the environment, so the use of safe, sustainable,

Advantages of EALs Over ECLs

- 1. Environmental Accountability:** EALs are backed by a clear definition and regulatory framework, making their environmental benefits more transparent and dependable.
- 2. Ecosystem Protection:** EALs's biodegradability and nonbioaccumulative properties contribute to the protection of aquatic ecosystems. Their use aligns with global efforts to reduce pollution and maintain biodiversity.
- 3. Regulatory Compliance:** Mandatory usage of EALs in certain regions ensures that industries are actively contributing to environmental protection.
- 4. Enhanced Performance:** EALs are developed to match or surpass the performance of conventional lubricants, dispelling the notion that eco-friendly options compromise functionality.
- 5. Innovation Incentive:** Regulatory demands for EALs have spurred lubricant manufacturers to innovate and develop high-performing, sustainable products.



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and environmentally friendly lubricants is important. Panolin Margear allows customers to show a reduction in carbon dioxide emissions over the lifetime of the lubricant compared to the recommended replacement time of mineral-based oil. Panolin can readily provide vessel owners with data showing how Panolin lubricants can contribute towards their carbon dioxide reduction goals.

In the dredging industry, the use of reliable environmentally friendly lubricants is extremely important. Margear has been developed to provide excellent lubricant performance in dredging equipment and to ensure the applications are both operational and compliant with VIDA.

Based on fully saturated synthetic esters with additives carefully chosen to perform specific functions in marine applications, Margear has been specifically formulated for gear systems to withstand the extreme conditions regularly seen in marine operations.

Margear performance factors include:

- High thermal stability
- Shear stability
- Hydrolytic stability
- Excellent oxidation stability
- Outstanding wear protection
- Extreme corrosion protection

The above factors are extremely important for lubricants within the dredging industry. Furthermore, in an industry where vessels are utilized all year round in extreme environments, the need for functioning equipment is imperative. Margear offers customers economic benefits due to the extremely long oil-change intervals resulting in reduced downtime and maintenance costs.

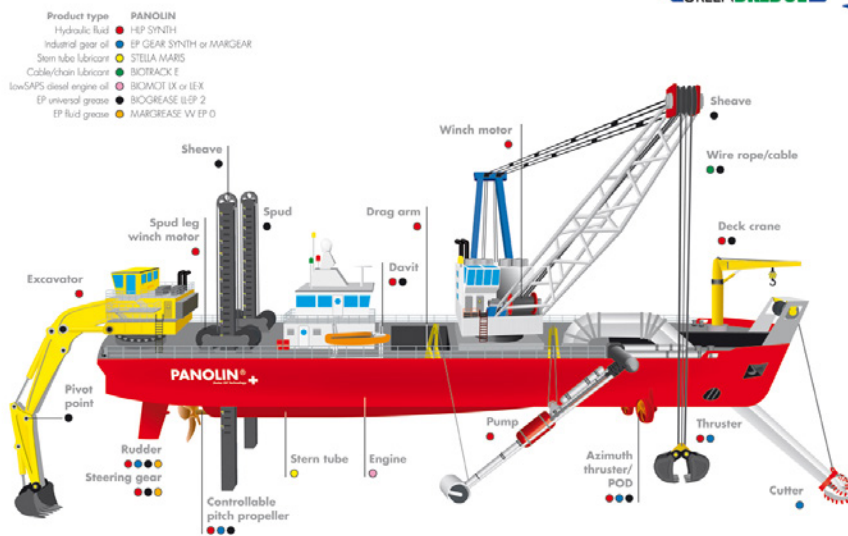
Environmentally Certified and OEM Approved

Panolin Margear offers antiwear and anticorrosion properties, and has been successfully used in a variety of applications including, but not limited to:

- Gearboxes
- Roller Bearings
- Propulsion systems including bow thrusters, Azipod thrusters, azimuth thrusters
- CPPs

panolin.com

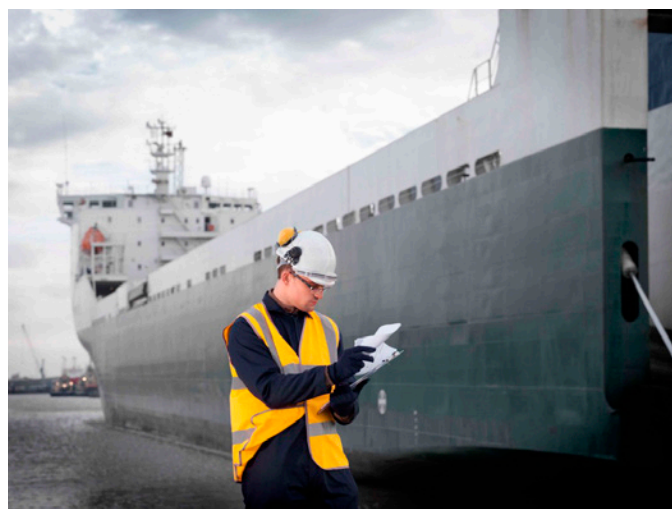
PANOLIN EALS application guide



Greendredge, a lubricant concept developed by Panolin specifically for the dredging industry puts great emphasis on safety, environmental protection, and sustainability.

Klüber on the Way to a Clean Future in Shipping

Between 2006 and 2013, Klüber Lubrication developed EALs for stern tubes (Klüberbio RM 2 series) and thrusters (gear oils, Klüberbio EG 2 series) based on ester-oil technology. Both oil series are benchmarks for ester oil-based EALs and gained approvals from all leading propeller equipment and thruster manufacturers.



Klüber Lubrication was one of the first lubricant makers to conduct research and development in the field of readily biodegradable lubricants that are nontoxic and meet the tribological performance for lubrication of propeller shafts and thrusters.

A primary goal in the development of a new type of EALs has been to maintain the advantages of their ester-based lubricants while extending oil change intervals to line up with a typical five-year dry-docking schedule. Klüber Lubrication's first product based on the new technology is a stern tube lubricant conforming to VIDA requirements and offering similar or

better performance characteristics as a mineral oil-based lubricant. This innovation was a much-needed quantum leap in the lubrication of ship propulsion systems—a vital prerequisite for a clean future in shipping. The new stern tube oil was recently launched under the name Klüberbio RM 8-100.

The Problem with EALs Under High Loads

For the lubrication of the propeller shaft running in the stern tube and propeller shaft seals, the VIDA stipulates the use of EALs for the protection of the environment as an escape of oil into the sea through the propeller seal cannot be completely prevented. Biodegradable lubricants for stern-tube application from several suppliers have been available for nearly two decades. So far, however, no one has succeeded in offering an EAL with a performance capacity equaling that of a mineral oil-based product in all important performance criteria such as a strong lubricating oil film, consistency in the presence of water in the oil, and excellent seal compatibility.

Why can an insufficiently strong oil film be a problem? Under particularly high loads, for example during voyages with partially immersed propellers or at hard maneuvers, insufficient strength of a lubricant film can lead to metal-on-metal contact and higher journal bearing

temperatures eventually causing bearing damage. Many commercially available EALs show insufficient resistance to oxidation and hydrolysis as well as poor lubricating capacity under high loads. Excessive shear loads may cause them to lose their viscosity and hence their ability to form a load-bearing lubricant film. High oxidation and aging can cause their viscosity to increase in an undesirable way. Chemical processes and the presence of water tend to decompose the lubricant. A failure of components and possibly even a breakdown of the propulsion system are possible. Frequent oil changes are therefore inevitable with some commercially available EALs, leading to additional operating costs.

An additional challenge in propeller shaft lubrication is that not only does lubricant leak into the water, but vice versa: The lubricant becomes contaminated with water via the same path. The insufficient resistance to hydrolysis of most commercially available ester oil-based EALs results in a rising TAN (Total Acid Number), leading to an unscheduled complete or partial oil change and a shorter service life of the seal in the stern tube. The only way to prevent early oil changes due to a rising TAN has so far been the installation of expensive filter systems and oil dryers. This, however, constitutes a major investment and increases complexity on board.

The Role of the Stern Tube

All types of vessels, whether container ships, bulk carriers, harbor tugs, or cruise liners, have one thing in common: propulsion is by means of large propellers of varying design. With few exceptions, the shafts of fixed-pitch and controllable-pitch propellers run in journal bearings mounted inside the stern tube filled with oil. The radial movements of the propeller shaft in the bearing are larger than those of other industrial shafts and may be intensified by the force of waves or vibrations.

Radial shaft seals or mechanical seals prevent the oil from leaking into the sea and keep the stern tube tight against the engine compartment. Thrusters are filled with gear oil and must be sealed at the propeller shaft as well as at the rotating steering shaft of azimuthing thrusters to prevent leakage into the water. It is, however, not possible to seal the stern tube or the thruster 100 percent tight against exiting oil.



Typical arrangement of a propeller shaft, bearings, and seals in a stern tube.

Eco-Compatibility vs. Performance

The objective of developing Klüberbio RM 8-100 was to obtain a stern tube oil that is not susceptible to hydrolysis, extends service life in comparison to conventional EALs, and meets all sustainability requirements of the EU Ecolabel and the former VPG and current VIDA for operation of ships in the United States. Besides biological eco-compatibility, the new product was designed to achieve excellent performance in terms of compatibility with seals, shear stability, wear behavior, corrosion protection, and friction. While the lubricant films formed by some EALs found in the market are not thick enough to prevent damage to stern tube bearings under unfavorable load conditions, the new product is designed to build up a load-bearing film that is close to that of a mineral oil-based product.

Next Generation of EAL Lubricants

The newly developed Klüberbio RM 8-100 successfully meets maximum environmental as well as performance requirements. Klüberbio RM 8-100 generates a lubricant film of excellent thickness that persists even under high edge loads in the propeller shaft bearing. Due to this lubricant film, the propeller bearing, and the shaft remain separated and overheating of, or damage to, the bearing is prevented. Klüberbio RM 8-100 shows very good compatibility with the elastomer material in the propeller shaft seal, providing it with optimal lubrication. This ensures a long service life and full function of the components.

Regarding TAN and resistance to hydrolysis, the new product's performance ratings are multiples of those of ester-based EAL stern tube oils—almost up to the

standard of mineral oil-based lubricants. This means the oil's chemical composition prevents it from reacting with water getting into the stern tube through the elastomer seal. The TAN hardly rises, leading to a significantly longer life expectancy for both the propeller shaft seal and the oil.

Two Worlds Come Together

Klüber Lubrication already showed in the past that bio in a lubricant no longer stands for a compromise of a product being green but having weaker technical performance. With the new generation of Klüberbio stern tube and gear oils, Klüber provides excellent lubricant performance, often considerably better than the direct mineral oil-based competition, and the products are also biodegradable and nontoxic.

With Klüberbio RM 8-100, users obtain a technology-leading product meeting legal environmental requirements and offering at the same time the extremely good performance ratings of a conventional, mineral oil-based lubricant. This is important for international shipping operations, where sustainable approaches are increasingly required.

klueber.com

PTE

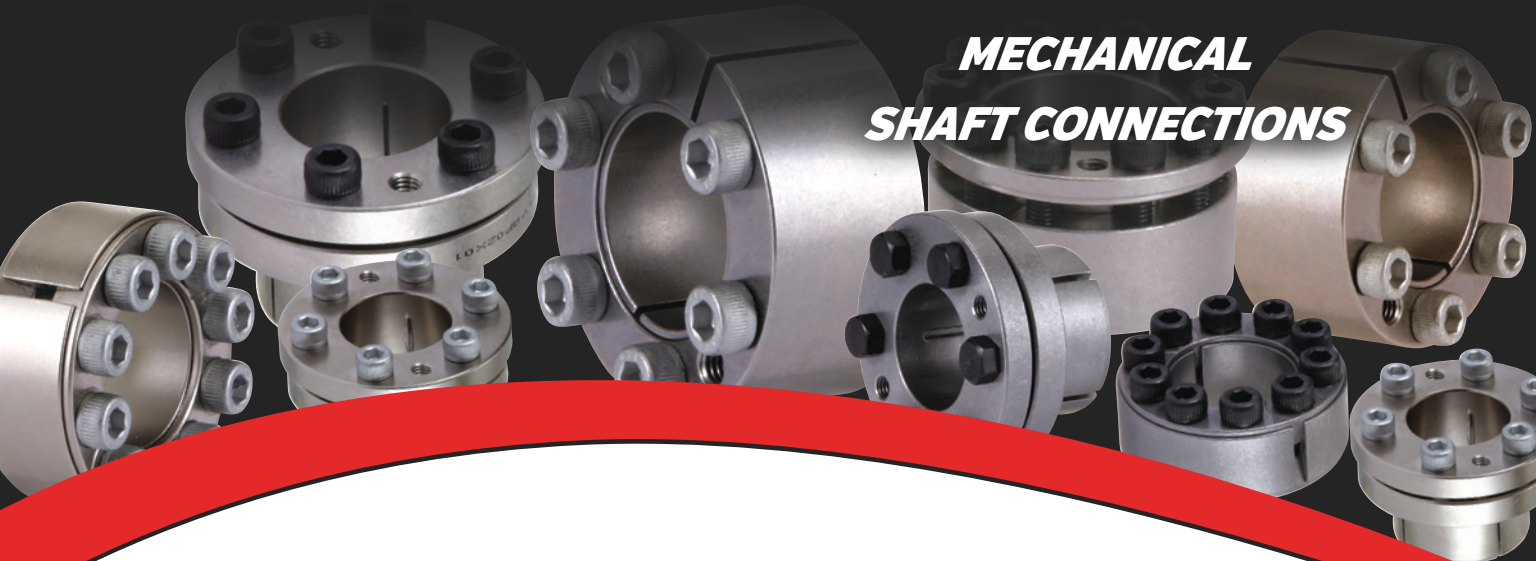


Klüberbio RM 8-100 is the first lubricant based on a new technology Klüber Lubrication will adopt into its range of EAL gear oils designed for tunnel and azimuthing thrusters.

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Condition monitoring vital to future proof components and equipment in wind applications

Ian Prowell, principal engineer, ONYX Insight

In the first three months of 2023, wind power generated more than a third of the UK's electricity, overtaking oil and gas as the country's main source of energy for the first time. In the United States, current estimates suggest that installed wind capacity could power up to 46.7 million homes, approximately a third of all households in the country. Such figures have emerged as investment in both onshore and offshore wind projects rises, and the global race toward net-zero targets begins to pick up pace.

However, there is growing financial risk to maintaining operational wind turbines. The average lifespan of a wind turbine is around 20 years and as components within turbines begin to approach the end of their lifecycle, performance can decline resulting in reduced productivity. Meanwhile, recent reports have highlighted that new, larger capacity machines could lead to a rise in component failures and mechanical breakdown issues as manufacturers push to develop bigger turbines, faster.

Deployment of predictive maintenance strategies can deliver significant benefits to new and existing wind farms. Condition monitoring systems (CMS) in particular play a role in tracking asset performance to drive data-based decision-making, meaning operators can future proof their turbines.

Repowering, both partial and full, is increasingly considered as a key element of effective operations and maintenance (O&M) strategies, with a focus on extending turbine lifespan while maximizing productivity.

Component Maintenance

Turbines are subjected to harsh environmental conditions; therefore, it is not uncommon for the components most exposed to the elements to require regular refurbishment or replacement. Repowering can therefore be used as a method to boost windfarm performance, or to address issues with impaired components due to high usage or unexpected damage.

Full repowering involves the complete dismantling of an old wind farm and replacing nearly all turbine components with new ones. Partial repowering involves replacing only some or multiple components while keeping others like the substation, distribution lines, foundations, and usually the towers, in place. This is often completed to improve the capacity factor of the wind farm by installing a larger rotor that can generate more energy over a wider range of wind speeds, thus increasing the project efficiency and overall greater generation.

When approaching any form of repowering, accurate data and realistic expectations are critical to decision-making.



Regional Disparities

The uptake of repowering contrasts regionally and current government policy also plays a role in owners' decisions to invest in repower activity. In the United States for example, there has been a significant increase as companies seek to take advantage of the production tax credits (PTC) that the recent Inflation Reduction Act (IRA) offers. The IRA was passed in 2022 and crucially, it extended PTC for wind energy projects providing certainty for companies looking to invest in wind energy projects by offering assurance they can take advantage of the credit for a longer period.

In stark contrast, in European wind markets where assets are often more mature, full repowering is less common. Owners tend to continue operating their wind farms with minimal additional investment as long as power production is continuing, rather than spend significant capital on life extension procedures. However, with many European onshore wind farms reaching the end of operational life in the coming years, this approach is likely to change.

It was recently announced that one of the oldest onshore wind farms in Britain, Hagshaw Hill, is set to undertake a full-scale repowering that is due for completion in early 2025. The process will see the number of turbines required by the farm reduced by more than 45 percent, while enhancing its green electricity output by more than five times. The project is set to expand the UK's renewable energy capacity in a clear example of how repowering can support energy demands.

CMS Adoption for Effective Decision-Making

As operators endeavor to maintain high productivity, there is a growing need for data-driven monitoring as part of an ongoing maintenance program. With more than 58 percent of windfarm operational expenditure attributed to operation and maintenance costs, 65 percent of which being unplanned, this is a crucial area for improvement.

Condition Monitoring Systems (CMS), such as ONYX Insight's *ecoCMS*, are increasingly critical in optimizing full and partial repowering projects

amidst these wider programs. Many existing strategies to maximize turbine life and output are challenging to optimize however, for full repowering, CMS can help owners understand the current state of their components and make financial decisions without relying on future-gazing simulations, which can often underestimate the remaining useful life.

Similarly, for partial repowering, the CMS can clarify the condition of components. Owners are therefore empowered with accurate data that enables them to make informed decisions to determine which repairs are needed in advance. This can prevent owners from paying for costly upgrades, such as foundation retrofits, on a sitewide basis and allows them to focus on only addressing needed improvements.

Even in situations outside of repowering, condition-based maintenance can be a valuable tool in avoiding the replacement and servicing of components on a predetermined schedule that does not consider whether components are performing better than would otherwise be anticipated.

Optimizing Turbine Performance

Increasing demand for renewable energy production means margins for failure within windfarms today are steadily decreasing. Repowering is emerging as a long-term cost-effective approach to maintenance that optimizes turbine performance throughout component lifespan, thus reducing financial strain for operators.

Both partial and full repowering projects can be supported by applying appropriate condition monitoring systems which avoid unnecessary expenditure on nonessential component replacement. This ultimately provides a clearer assessment of asset health visibility, enabling data-driven decision-making.

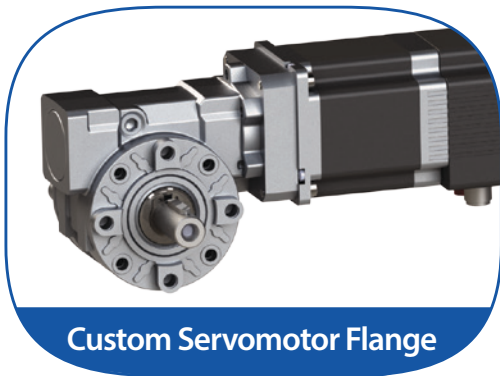
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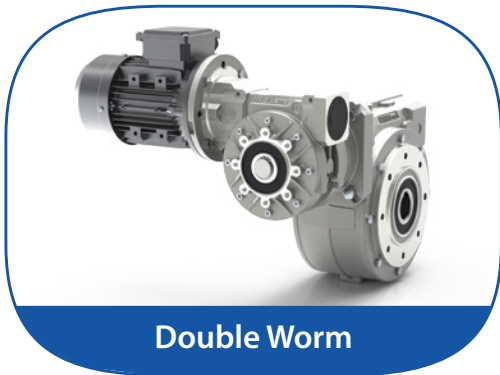
With our extensive range of standard components and custom machining capabilities, a custom-designed and manufactured gearbox for specific applications is something we do all the time.



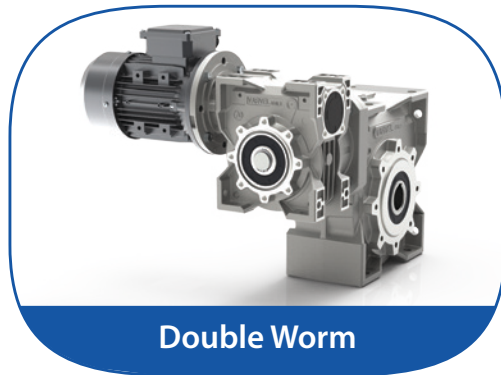
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Digital Transformation Drives the Future of Packaging

Expanding use of new and emerging technologies offers major opportunities to improve sustainability, efficiency, and production.

Samuel Orozco, Emerson

Consumer packaged goods companies (CPGs) face intense pressures to stay competitive in today's markets. They must sustain profitability, improve production line throughput and flexibility, manage rising material costs and meet critical sustainability and decarbonization goals.

Digital transformation is one of the most effective approaches to help today's CPG companies solve productivity and sustainability challenges. There are new and emerging automation technologies that CPGs can integrate within production lines to reduce energy consumption, streamline processes, increase machine availability and drive new levels of productivity and sustainability.



CPG companies can optimize CIP cycles and reduce energy use with Emerson's CIP Utilities & Automated Reporting Analytics software package, providing real-time insight to digitally transform a range of manual and semi-automated systems. (All images courtesy of Emerson)

Digital Transformation Is Key to CPG Growth

Many CPGs have valuable data they could use to solve productivity and sustainability challenges but no way to access it. Digital transformation technology gives CPG operations new understanding about where waste and inefficiency exists in single machines and across production lines, as well as providing an array of integrated tools to help operators analyze and better control these issues.

Digital transformation integrates multiple types of components and technology at every level of packaging operations. Intelligent sensors and valves generate critical data on asset performance, while smart protocol converters release machine data in existing automation controllers and share it across all packaging lines.

Innovative software formats and organizes data into actionable insights and real-time information on machine health. The information is scaled to cloud-based analytical tools, giving packaging companies a more sophisticated understanding of energy usage, throughput and scrappage patterns. By integrating intelligent solutions that automate and optimize packaging processes from the factory floor to the cloud, CPGs can simultaneously improve sustainability, efficiency and productivity.

This floor to cloud approach unlocks trapped data and connects islands of automation, giving manufacturers the visibility and control to solve critical challenges and meet ambitious goals. As CPG companies develop the next generation of their manufacturing platforms, using this complete floor to cloud approach can improve overall equipment effectiveness (OEE), increase energy efficiency while reducing waste, and create safer operations and digital record-keeping.

There is a broad range of smart technologies that can contribute to this digital transformation. From linear motion technologies used to move and drive packaging assembly processes to systems that monitor compressed air use—and many others—there are multiple opportunities to “weave in” emerging technologies to current and new production lines.

Improve Line Productivity with Hybrid Automation Systems

Traditionally, automation systems only used pneumatic or electric linear motion control—and only benefited from that specific technology’s advantages. In many cases, electric or pneumatic linear systems can provide the right functionality for specific machine processes.

However, that doesn’t mean that once one technology is selected it has to be used for every application. Now, original equipment manufacturers (OEMs) can build packaging machines with hybrid automation systems that combine pneumatic and electric motion control, offering the greatest advantages of both technologies in one solution.

Using pneumatic actuators as well as electric actuators, hybrid systems allow OEMs to apply the most appropriate technology for each specific function and truly optimize packaging line flexibility, efficiency, and productivity. The latest electric actuators are energy-efficient and can



More efficient control of compressed air flow systems is provided through the high-flow model of the Aventics AF2 air flow sensor from Emerson. It monitors air consumption in large air lines and pneumatic pipe systems, providing actionable insights that help operators address potential issues and improve sustainability and machine uptime.

achieve unparalleled repeatability and uniformity, which can improve overall equipment efficiency and reduce scrap, while pneumatic actuators offer robust operation and easy maintenance. Additionally, overall system flexibility makes it possible for machines to produce a range of products and significantly reduce changeover time.

Boost Visibility with Smart Sensors and Analytics Software

The pressure to improve sustainability, efficiency, and productivity drives CPG manufacturers to optimize resource use and streamline operations in new ways. Many machines and production lines already have sensors and drives generating valuable performance data. Too often, that data is trapped or underutilized because it is not fully integrated into line-level, plant-level, or business wide analytical tools.

Improving resource utilization and reducing energy waste requires using this data for better insight and understanding of packaging system performance. This includes gaining greater visibility and better analytics of processes that use the most resources, like compressed air lines and clean-in-place (CIP) systems.

Typical food and beverage processing facilities devote about 30 percent of utility resources to CIP operations and lose time during changeovers. CIP skids without sensors and analytics software can run at unnecessarily long preset cycles, which waste time and resources. In many packaging operations without these digital resources, this data is captured via manual reporting, a time-consuming, error-prone process.

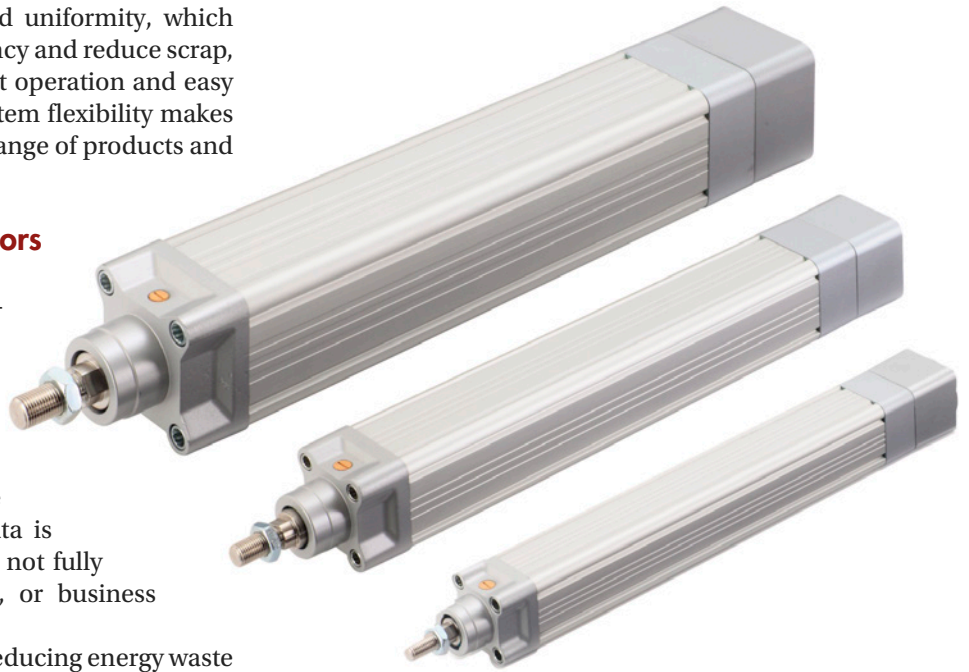
New analytics software automates CIP and steam-in-place (SIP) utilities monitoring and reporting, allowing operators to optimize resource use, benchmark against known cycles and generate automated reports. Stakeholders can use data to make decisions that reduce energy consumption and improve system or overall facility productivity.

Another way to reduce energy consumption is through improved compressed air monitoring. Most packaging facilities use pneumatic systems that require compressed air. Unfortunately, some air can be lost to undetected leaks, resulting in wasted energy and unnecessary costs.

Smart air flow sensors are proven to detect leaks in pneumatic systems and now come in high-flow models that can help reduce energy consumption in larger air lines and systems. This expanded capacity makes it possible for personnel to clearly see compressed air use, identify and address leaks quickly and optimize energy efficiency across an entire packaging facility.

Smart Technology Drives CPG Innovation and Growth

CPG companies have long been leaders in implementing new automation technologies to sustain their competitive advantages. As the packaging industry continues to evolve,

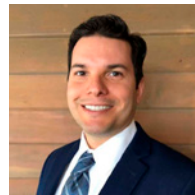


The Aventics Series SPRA electric, rod-style linear actuator from Emerson offers greater load capacity and more accurate, reliable motion to help maximize CPG productivity. They are available in three different screw technologies to meet exacting application requirements.

digital transformation technologies offer new ways to continue that record of innovation. Working together, CPGs, OEMs and technology providers can leverage the inherent advantages digital automation technologies offer to solve the most demanding packaging and production challenges. Each innovation brings unprecedented benefits—and opportunities to significantly improve sustainability, efficiency, and production.

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Samuel Orozco is a product marketing manager for fluid and motion control at Emerson. He holds a bachelor's degree from the University of Detroit Mercy and earned his MBA from Oakland University.

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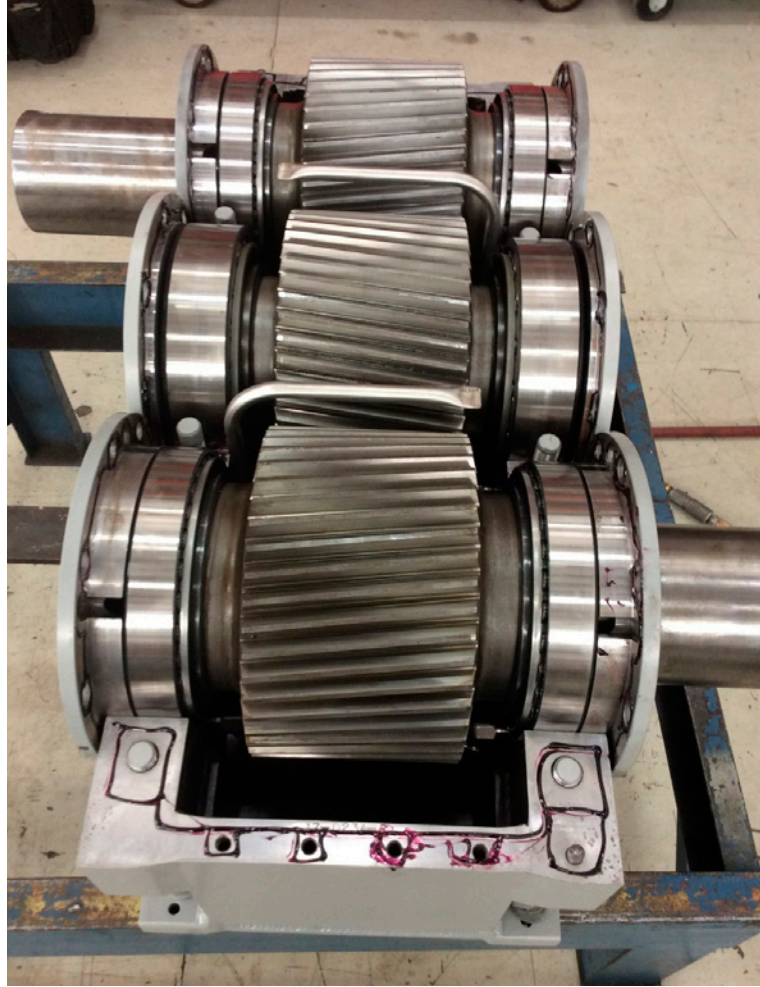
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Paper Mill Precision

Atlanta Gear Works offers a step-by-step process for rebuilding a Beloit differential

Taylor Sims, BSME, CRMT,
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Introduction

In paper mills throughout the country, gearboxes provide an integral solution for power transmission. Each is selected particularly and directly to perform a specific task in the production of paper. Due to the critical nature of the equipment, all gearboxes are heavily monitored and periodically inspected for preventive maintenance. If necessary, gearboxes can be reconditioned by replacing or repairing components with the intent to rebuild the entire gearbox to OEM specifications.

In a paper mill, one of the gearboxes used on the paper machine floor is a Beloit differential drive. These gearboxes provide four basic functions:

- Precise, positive sheet tension control from section to section by mechanically tying the sections in the whole paper machine together while at the same time allowing each section speed to be controlled independently.
- On-the-go-speed changes for each section to be precise, stepless and infinitely variable within a given range.
- Accurate monitoring of the horsepower demand of each section.
- A right-angle drive from the line shaft to power the paper machine.

These functions are critical in the production of paper. Generally, if well maintained, Beloit differentials can operate properly for many years. However, when one fails, it is critical to rebuild it to OEM specifications for proper operation.

The Beloit differential consists of seven shaft assemblies. Power is inputted into the gearbox through the line shaft assembly. The line shaft gear drives the outer gear on the differential shaft assembly at a constant speed proportional to the line shaft speed, which is generally 1,000 rpm. The first outer gear, which is a Zerol bevel gear, drives one side of the Zerol bevel spider gears on the differential shaft, as well as the PIV input shaft. The PIV, through a variable speed arrangement, changes the ratios as required and drives the PIV output shaft. The PIV output shaft gear drives the differential second outer gear through the primary and main variable shafts. The second outer gear, which is a combination spur-Zerol bevel gear, drives the outer side of the Zerol bevel spider gears on the differential shaft. The spider gears cause the differential shaft to average the input speeds of the first and second outer gears of the differential. The differential shaft drives the bevel output shaft, which transfers power to the transfer case gearbox.

Atlanta Gear Works, located in Dawsonville, GA, specializes in rebuilding power transmission equipment. Since 1988, the company has been rebuilding Beloit differential gearboxes with a commitment to repair or rebuild every differential equal or better than OEM specifications. Since a failed differential can have a multitude of wear-damaged components, Atlanta Gear Works follows a time-proven process that starts with a thorough analysis of all components.

Disassembly and Inspection

When we receive a damaged differential at our repair facility in Dawsonville, the first thing we do is issue a quote number and oversee an engineer to oversee the rebuild. Before disassembling the gearbox, we perform a complete inspection documented by photos of each step in the inspection. During this step, we measure each shaft assembly's end float and runout, as well as roll a pattern and measuring backlash for each gear mesh. We use these measurements as indicators in the root cause failure analysis.

After the inspection and documentation, we then completely disassemble the gearbox, removing all components from each assembly. As a Platinum Timken Certified Service Center, we then submit each component potentially suitable for reuse to a 12-point bearing measurement inspection to verify the condition of the bearing mounting surfaces per the Timken Specification. We perform in-house NTD inspection on all gearing being reused to assure there are no cracks and the gears are suitable

for reuse. Additionally, we can “kiss grind” the gears to improve quality.

At the completion of disassembly, the engineer assigned to the gearbox reviews the condition of all gearbox components with the disassembly technician. The engineer then uses the data to generate a reconditioning report. This report illustrates the root cause of failure for the gearbox as well as the condition of all internal components. This report provides the customer with a complete picture of their gearbox's present condition and what is necessary for the gearbox to be rebuilt to OEM specifications.

Gearbox Rebuild

Upon customer approval, we begin the gearbox rebuild procedure. The Engineering Department generates and distributes all required component drawings and production routings. To ensure OEM quality, we machine all gear clusters in-house based on Beloit OEM gear cluster set-up fixtures we purchased years ago. After all components have passed QC measurements, we gather them for assembly.

All gears and shafts are reassembled in complete working order. Each shaft assembly is dynamically balanced to the required specification given the application. This assures there are no issues regarding unbalanced components in the gearbox assembly. All bearings are then assembled to the shaft assemblies, with assemblies then placed into the gearbox housing.

With assembly of the differential complete, we perform a no-load spin test at the design input speed of 1,000 rpm. We run the test for a minimum of two hours, during which we measure bearing temperatures, shaft assemblies' vibration and the gearbox's overall noise level. If the differential testing temperature, vibration, and auditory values are verified to be of an acceptable value, we move to the final step in the rebuild.

The final steps include installing any couplings the customers requested, final painting of the differential with a two-part epoxy paint and rust prevention. The result is a like-new Beloit differential gearbox that we will prepare for shipment back to the customer.

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“Since a failed differential can have a multitude of wear-damaged components, Atlanta Gear Works follows a time-proven process that starts with a thorough analysis of all components.”

Engineering sMART

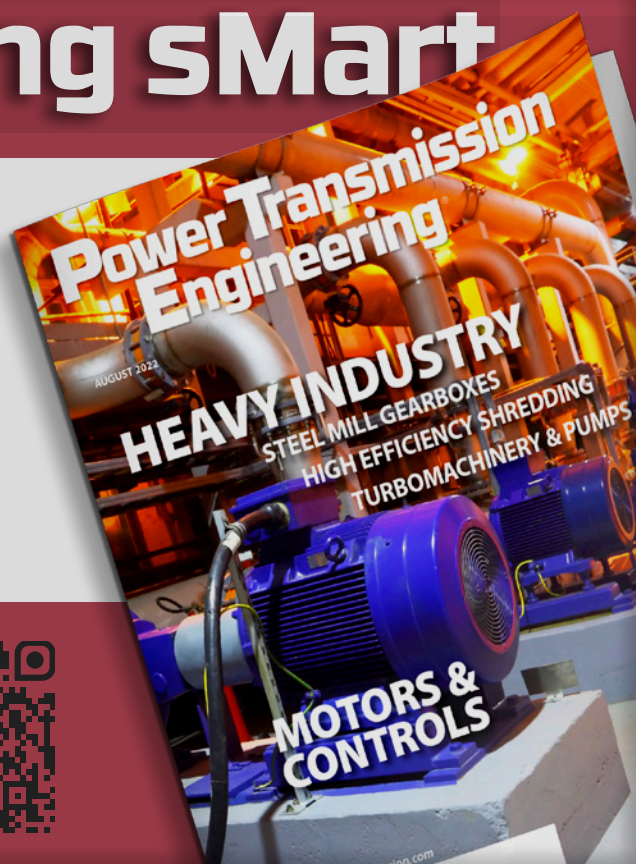
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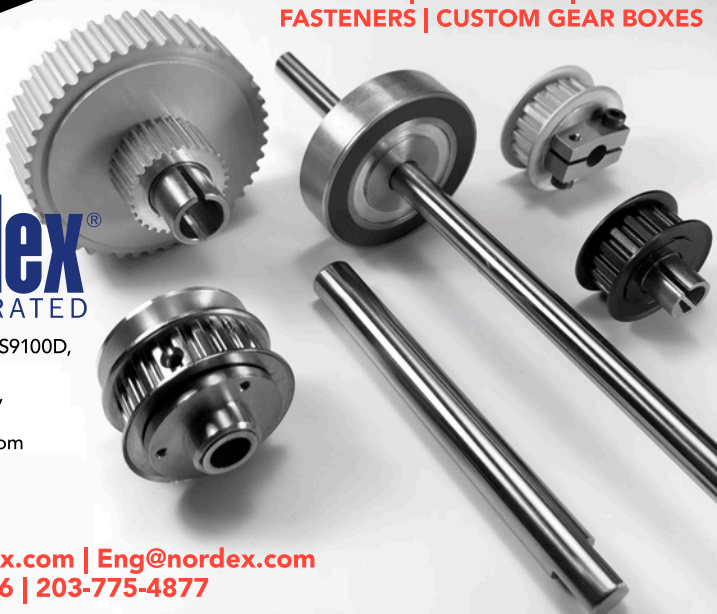
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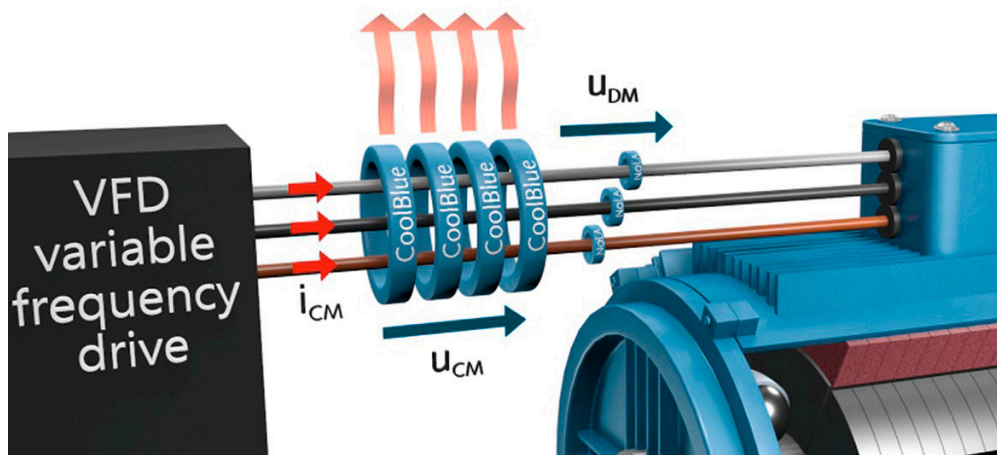
Extending Inverter-Motor Systems Service Life

Protecting electric drives from erosion caused by motor-bearing currents

Andreas Heim, Magnetec GmbH



Current-compensated CoolBlue toroidal cores made of the nanocrystalline material Nanoperm from Magnetec have proven to be effective protection against conducted interference and its consequences. With Nanoperm Line Absorbers NaLA from Magnetec, symmetrical interference currents can also be significantly suppressed. (Courtesy of Magnetec)



Conducted interference results from over voltages caused by switching operations in the frequency converter (VFD). As asymmetrical interference currents in the range from about 300 kHz to 400 kHz, they flow from there to the motor.

More energy efficiency, higher performance and better controllability are the main reasons why more electric drive systems are being operated with frequency converters. However, these devices can cause high-frequency, asymmetrical interference currents, which, as a current passage through the output and fan-side bearings, can cause damage and premature failure.

Current-compensated CoolBlue toroidal cores made of Magnetec's nanocrystalline material Nanoperm have proven to be effective protection against such conducted interference and its consequences. In addition, the Nanoperm Line Absorbers NaLA can also be used to significantly suppress symmetrical interference currents.

Together, these technologies offer optimal protection of inverter-motor systems against motor bearing damage caused by interference current, thus significantly increasing the availability and service life of electric drives in complex industrial applications including chemical, paper, rail, shipping, logistics, or energy generation with solar and wind power plants.

Current Passage Causes Electrical Erosion in Gearbox Bearings

The wiring of converter-motor systems is very often carried out exclusively with shielded three-phase cables.

Although these can shield radiated interference of the three-phase AC voltage from other systems when connected in accordance with EMC, they do not completely protect against conducted interference. These result from over voltages caused by switching operations in the frequency converter. As asymmetrical interference currents in the range from about 300 kHz to 400 kHz, they flow from the frequency converter to the motor. Before they start their return journey via ground and earth, the interference currents in the motor from the stator and rotor are coupled via—almost like a capacitor. From there, they flow in the contact zone of the rotor and housing through the output- and fan-side bearings. This results in an electrical discharge from the inner ring via the balls to the outer ring, the energy of which leads to sparks and the formation of electric arcs. The high punctual thermal energy released in this process melts the bearing treads at the transition point. As a result, microcraters and loose particles of molten material are formed there. These delicate consequences of electrical erosion become visible under the microscope—without a microscope, a matte, greyish tread indicates the consequences of the passage of electricity. In further operation, washboard- or zebra-like, gray corrugations can be seen on

the treads, which are the result of the melted out microcraters and particles. The course of damage in the gearbox is accompanied by the fact that the heat generated by sparks destroys the lubricant in the rolling bearing. The base oil burns, additives char—the lubricant decomposes rapidly. This turns dark—an unmistakable indicator of rapid aging, poor lubricity, and shortened service life.

The result is a premature failure of the gearbox—often years earlier than in the case of purely mechanical wear. With CoolBlue toroidal cores and Nanoperm Line Absorbers NaLA, common-mode and push-pull interference currents can be compensated and the effects on the motor bearings can be avoided.

CoolBlue: An Efficient Compensation Against Interference Currents for Small and Large System Powers

Magnetec's CoolBlue toroidal cores have been specially developed to prevent the transmission of conducted interference in inverter motor systems with system outputs ranging from one kilowatt to the high megawatt range. They absorb common-mode interference currents caused by the frequency converters, which, in contrast to the push-pull currents, are not fed back via the cables, but seek

their way back through the motor and its bearings via a path with low electrical resistance. To absorb the interference, the CoolBlue toroidal cores are placed as close as possible to the frequency converter in a non-shielded location and all three phases are passed through the ring. For the common-mode current, the toroidal cores represent both an inductance and an impedance. The current flowing through the cable creates a magnetic field that is attenuated by the toroidal cores. Their size depends on the system performance, so that the size and number of the CoolBlue toroidal cores are dimensioned accordingly via a selection table so that they can absorb the fault in the best possible way and do not over-

drive beforehand. The cores, which can be selected or dimensioned in size, diameter and shape, are controlled and absorb the interference, converting the absorbed energy of the common-mode interference currents into heat. In this way, the ball bearings are effectively protected against electrical erosion—and permanently without any maintenance or repair effort for the toroidal strip cores.

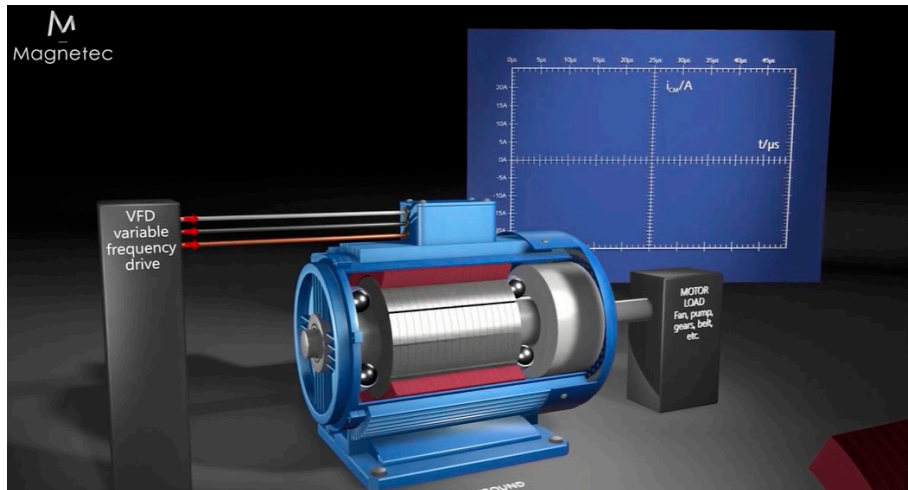
Nala Protects Against Symmetrical Currents

Nanoperm Line Absorbers, NaLAs, complement CoolBlue toroidal band cores in inverter motor systems. Although they do not primarily reduce the common-mode interference that is responsible for the destruction of

the ball bearings, they improve the general EMC properties in the system and thus also protect the surrounding devices. In addition, they also reduce conducted interference towards the grid. CoolBlue and NaLa have proven to be an economical solution for the protection of industrial inverter motor systems due to their particularly absorption behavior in common-mode and push-pull interference currents, their simple installation, and their maintenance-free operation. Due to their wear-free and maintenance-free broadband filter effect, they also offer significant advantages over possible alternatives such as grounding brushes that wear out during operation, expensive and only limited effectiveness of current-insulated



When electrical discharge of interference currents, their energy generates a breakdown and the formation of electric arcs. The result is melted out microcraters and particles that can be seen on the treads as washboard- or zebra-like, gray corrugations.



The Magnetec CoolBlue and NaLA cores made of nanocrystalline material Nanoperm are used to reduce damaging motor bearing currents in inverter—motor systems. This method significantly increases the service life of the motor bearings and thus reduces maintenance costs and standstill periods.

bearings, inhospitable hybrid bearings with ceramic balls or large and expensive all-pole sinusoidal filters.

Nanoperm—Nanocrystalline Iron-Based Alloy with Special Soft Magnetic Properties

Nanopermium is a rapidly solidified iron-based alloy that changes from an amorphous to a nanocrystalline structure with grain sizes of 10 nm after annealing. This, in turn, in combination with a significantly higher lithium content than hard magnetic ferrite materials with a crystal lattice structure, is the cause of the extraordinarily good soft magnetic properties of Nanoperm, which can also be adjusted in wide ranges by heat treatment under the influence of external magnetic fields. Nanoperm is produced in a special process as a continuous strip material with a thickness of 16 μm to 20 μm and, in contrast to ferritic materials, achieves a broadband interference suppression effect up to high frequency ranges. It is extremely heat-resistant at > 120°C

and remains stable in its inductance over the entire specified operating temperature range of -40°C to +200°C and its Curie temperature of around 600°C. The permeability is up to a factor of 10 and the saturation up to a factor of 3 is higher than that of ferrite materials. The Nanoperm tape can be processed into any light and compact size and design. Nanoperm LM toroidal cores are particularly used in applications with a high proportion of asymmetrical interference currents (e.g., frequency converters), for example CoolBlue toroidal cores to reduce harmful motor bearing currents. Nanoperm LC toroidal cores are cost-effective cores to produce Magnetec's single- or multi-phase current-compensated EMC chokes. They also offer an excellent alternative to existing ferrite-based solutions. The soft magnetic cores of the Nanoperm MR series are mechanically compatible with common ferrite designs and can replace ferrites from a size of 56 mm 1:1 in interference suppression applications.

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Andreas Heim is currently head of sales industry, Magnetec GmbH.

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Derivation of Relative EHL Film Thickness

Robert Errichello

This report derives the equation for relative elastohydrodynamic lubrication (EHL) film thickness. Mineral (MIN), poly-alphaolefin (PAO), and polyalkylene glycol (PAG) lubricants with viscosity grades of ISO 320, 150, and 32 are analyzed.

Background

In 2002, GEARTECH published an equation for relative EHL film thickness in GEARTECH Report No. 2038 (Ref. 1). The research was intended for developing guidelines for selecting wind turbine gearbox lubricants and was focused on rating bearing life in accordance with DIN 281, which considers EHL film thickness. ISO VG 320 MIN, PAO, and PAG lubricants were analyzed.

Discussion

EHL film thickness is calculated in accordance with AGMA 925 (Ref. 2) using the following equation:

$$H_c = 3.06 \left(\frac{G^{0.56} U^{0.69}}{W^{0.10}} \right)$$

(1)

Where

H_c = dimensionless central film thickness

G = materials parameter

U = speed parameter

W = load parameter



$$G = \alpha E_r \tag{2}$$

$$U = \frac{\eta_M \nu_e}{2E_r \rho_n} \tag{3}$$

$$W = \frac{X_\Gamma w_n}{E_r \rho_n} \tag{4}$$

Where

- α = pressure-viscosity coefficient
- η_M = dynamic viscosity at gear tooth temperature
- E_r = reduced modulus of elasticity
- ν_e = entrainment velocity
- X_Γ = load sharing factor
- w_n = normal unit load
- ρ_n = normal relative radius of curvature

For a given gear set, the material elasticity E_r , entrainment speed ν_e , geometry ρ_n , load sharing factor X_Γ , and load w_n , can be considered constants. Therefore, the EHL film thickness equation reduces to:

$$H_c = C \cdot \alpha^{0.56} \eta_M^{0.69} \tag{5}$$

Where

- C = gear set constant (includes E_r , ν_e , ρ_n , X_Γ , and w_n)
- α = pressure-viscosity coefficient
- η_M = dynamic viscosity at gear tooth temperature

The value of constant C is independent of the lubricant and depends solely on the properties of the gear set.

Baseline Film Thickness

The gear set baseline EHL film thickness is:

$$H_c = C \cdot \alpha^{0.56} \cdot \eta_{M_{base}}^{0.69} \tag{6}$$

Relative EHL Film Thickness

The relative EHL film thickness is defined by:

$$H_c = \frac{C \cdot \alpha^{0.56} \cdot \eta_M^{0.69}}{C \cdot \alpha_{base}^{0.56} \cdot \eta_{M_{base}}^{0.69}} \tag{7}$$

The constant C in the numerator and denominator of Equation 7 cancel, and the relative EHL film thickness equation reduces to:

$$H_c = \frac{\alpha^{0.56} \cdot \eta_M^{0.69}}{\alpha_{base}^{0.56} \cdot \eta_{M_{base}}^{0.69}} \tag{8}$$

Therefore, the relative EHL thickness is normalized and dimensionless, and can be calculated without regard to the fixed parameters included in the constant C of the gear set.

The baseline parameters α_{base} and $\eta_{M_{base}}$ can have arbitrary fixed values. For example, Table 1 shows the baseline parameters for ISO VG 320 mineral oil arbitrarily chosen at 80°C are $\alpha_{base} = 0.017246$ and $\eta_{M_{base}} = 40.49869$. With these baseline values Equation 8 becomes:

$$H_c = \left(\frac{\alpha}{0.017246} \right)^{0.56} \left(\frac{\eta_M}{40.49869} \right)^{0.69} \tag{9}$$

Temp °C	MIN		PAO		PAG	
	Visc (cP)	Alpha	Visc (cP)	Alpha	Visc (cP)	Alpha
50	158.61090	0.02073	170.75820	0.01340	228.82000	0.01104
60	94.98155	0.01935	110.41060	0.01311	164.62000	0.01048
70	60.44313	0.01820	74.69445	0.01285	121.81000	0.01000
80	40.49869	0.01725	52.54688	0.01262	92.42000	0.00958
90	28.35234	0.01644	38.24137	0.01242	71.69000	0.00920
100	20.60709	0.01575	28.66405	0.01224	56.71000	0.00887

Table 1 — Dynamic viscosity and P-V coefficient versus temperature for ISO VG 320.

Equation 9 differentiates the film forming behavior of various lubricants because it accounts for differences in α and η_M . Applying Equation 9 to the Table 1 values gives the relative EHL film thickness values shown in Table 2. Figure 1 is a graph of the Table 2 values.

Temp °C	MIN H_c	PAO H_c	PAG H_c
50	2.84345	2.34348	2.57309
60	1.92036	1.71324	1.99154
70	1.35868	1.29388	1.57558
80	1.00000	1.00496	1.27097
90	0.76114	0.79986	1.04306
100	0.59620	0.65022	0.86916

Table 2—Relative EHL film thickness for ISO VG 320 (dimensionless).

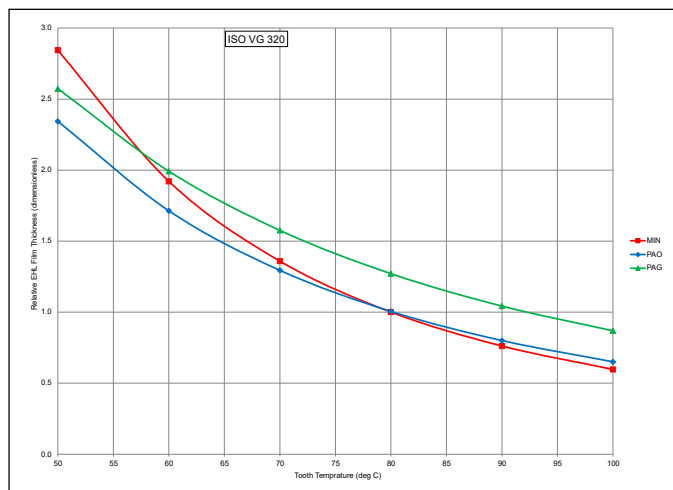


Figure 1—Relative EHL film thickness for ISO VG 320 lubricants.

All that is necessary for converting Table 2 to actual film thickness values in microns is to calculate the EHL film thickness for the gear set with a mineral oil at the baseline temperature of 80°C and baseline values of $\alpha_{base} = 0.017246$ and $\eta_{Mbase} = 40.49869$, and then multiplying the Table 2 values by the EHL film thickness obtained for the gear set at the baseline values. For example, EHL film thickness for an FZG C gear set with ISO VG 320 MIN at the baseline values is $H_c = 0.43376 \mu\text{m}$. Multiplying Table 2 values by 0.43376 gives the Table 3 values. Figure 2 is a graph of the Table 3 values.

Temp °C	MIN H_c	PAO H_c	PAG H_c
50	1.23338	1.01651	1.11611
60	0.83298	0.74314	0.86385
70	0.58934	0.56123	0.68343
80	0.43376	0.43591	0.55130
90	0.33015	0.34695	0.45244
100	0.25861	0.28204	0.37701

Table 3—FZG C gear set EHL film thickness for ISO VG 320 (μm).

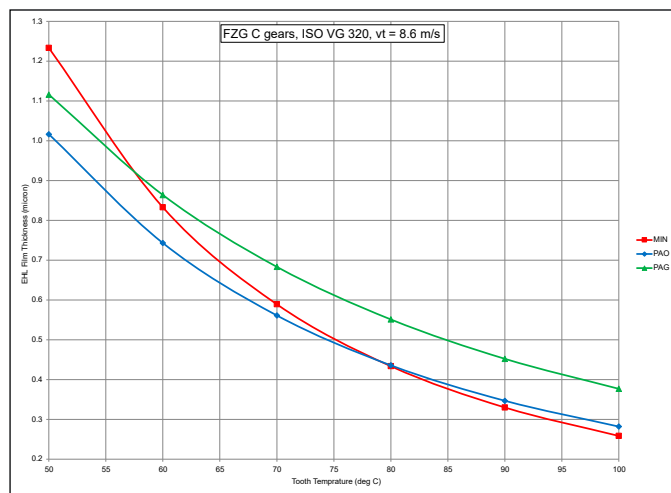


Figure 2—EHL film thickness for an FZG C gear set with ISO VG 320 oil.

Influence of ISO VG

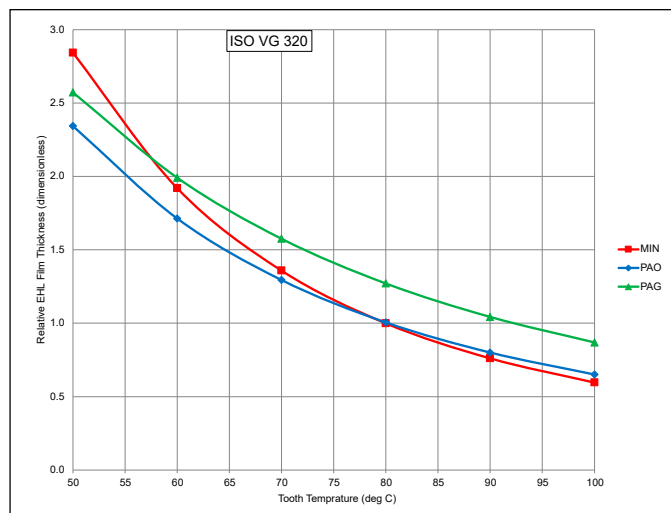


Figure 3—Relative EHL film thickness for ISO VG 320 lubricants.

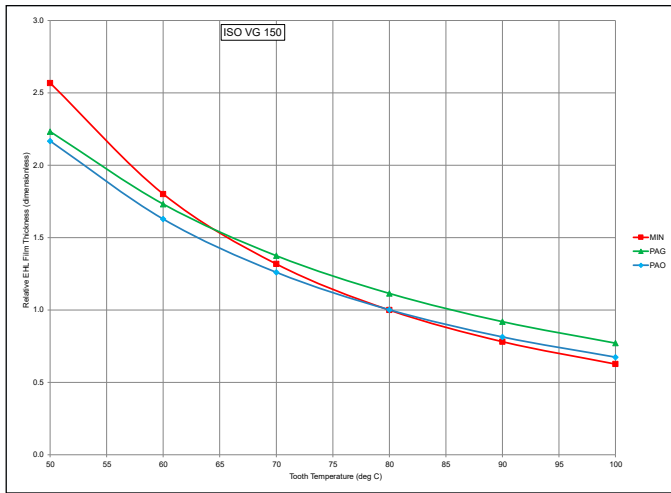


Figure 4—Relative EHL film thickness for ISO VG 150 lubricants.

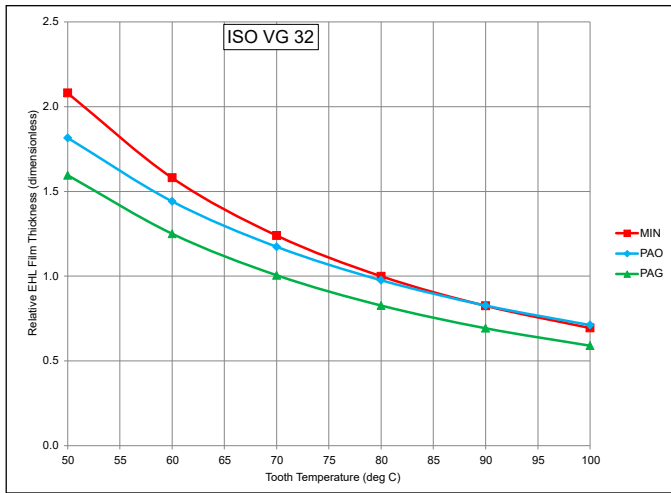


Figure 5—Relative EHL film thickness for ISO VG 32 lubricants.

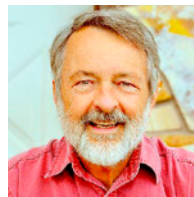
Conclusions

1. The relative EHL film thickness is normalized and dimensionless, and it can be calculated without regard to the parameters of the gear set.
2. Equation 8 gives the relative EHL film thickness for a given ISO VG, several lubricant types, and range of temperature.
3. The relative EHL film thickness is normalized to an arbitrary baseline consisting of a lubricant type, ISO VG, and baseline values of temperature, dynamic viscosity, and pressure-viscosity coefficient.
4. The actual range of EHL film thicknesses for a given gear set can be obtained from a single calculation of EHL film thickness for the gear set by assuming the baseline values of a lubricant type, ISO VG, tooth temperature, dynamic viscosity, and pressure-viscosity coefficient,

and then multiplying the calculated gear set EHL film thickness by the relative EHL film thickness.

5. The graph of relative EHL film thickness is the same as the graph of actual EHL film thickness except for units of the ordinate (dimensionless versus μm).
6. Relative EHL film thickness varies with ISO VG.
7. Figure 3 compares performance of the three ISO VG 320 lubricants:
 - a. MIN outperforms PAO at temperatures $\leq 80^\circ\text{C}$.
 - b. MIN outperforms PAG at temperatures $\leq 58^\circ\text{C}$.
 - c. PAG outperforms MIN at temperatures $\geq 58^\circ\text{C}$.
 - d. PAG outperforms PAO at all temperatures.
 - e. MIN and PAO perform similarly at temperatures $\geq 80^\circ\text{C}$.
8. Figure 4 compares performance of the three ISO VG 150 lubricants:
 - a. MIN outperforms PAO at temperatures $\leq 80^\circ\text{C}$.
 - b. MIN outperforms PAG at temperatures $\leq 65^\circ\text{C}$.
 - c. PAG outperforms MIN at temperatures $\geq 65^\circ\text{C}$.
 - d. PAG outperforms PAO at all temperatures.
 - e. MIN and PAO perform similarly at temperatures $\geq 80^\circ\text{C}$.
9. Figure 5 compares performance of the three ISO VG 32 lubricants:
 - a. MIN outperforms PAO at temperatures $\leq 90^\circ\text{C}$.
 - b. MIN outperforms PAG at all temperatures.
 - c. PAO outperforms PAG at all temperatures.
 - d. MIN and PAO outperform PAG at all temperatures.
 - e. MIN and PAO perform similarly at temperatures $\geq 90^\circ\text{C}$.

PTE



Robert Errichello heads a gear consultancy called GEARTECH, is a member of several AGMA Committees, and is a technical editor for Gear Technology. Errichello is a recipient of a variety of honors including the AGMA Lifetime Achievement Award, the STLE Wilbur Deuch Memorial Award, and the AWEA Technical Achievement Award.

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Colorado University

LAUNCHES LEARNING EXPERIENCE ON ROCKET TURBOPUMP DESIGN WITH AM SOLUTIONS

Hard work and good help can pay off, two young engineers have learned. Mixing undergraduate curiosity and real-world engagement together, two students from Colorado University (CU) Boulder Aerospace Engineering Sciences program, Zachary Lesan and Patrick Watson, started an independent effort on turbopump design and manufacture that is a lesson in determination and industry collaboration. Along the way, their project reinforced some significant points being made about next-generation rocketry.

As the aerospace industry speeds toward Additive Manufacturing (AM) to bring new, physics-based designs into higher-performing parts, the race is also on to make space components more reliable, economical, scalable, and producible through agile manufacturing strategies.

How is this being done? All eyes are on metal AM to reach the ideal of single-part rocket construction, whereas many parts and sections as possible are combined for material integrity, maximum weight reduction, performance, and speed-of-manufacture.

Maybe one way to start on these bold objectives is to be handicapped with an intern salary, an outside-of-work-and-classroom timeline, and only negotiating skills to secure print, machining, and accessory parts. Those factors are likely to be as strong a motivation as any for adopting quick, lean process approaches.

Curiosity Fuels a Passion

Zach Lesan, the initial lead on this college team of two, conceived of the project in January of 2021 while in his junior year of undergraduate schooling. Watson joined and took over most of the duties in the fall of 2022 once Lesan graduated and began an internship at SpaceX.

Against all odds and the practical wishes of his professors, Lesan pursued his passion for rockets despite

the scope of the challenge, academically and financially. “I started this project because I loved rockets and turbomachinery,” said Lesan. “I knew how solid-state rocket motors worked and designed them in the past while in high school. However, liquid-propulsion rockets captured my imagination. I wanted very much to understand all the details.”



Zach Lesan, student, Colorado University.

Finding little to no evidence that such a project was taking place formally on the undergraduate level, Lesan decided to dive in. With one graduate-level course on propulsion in progress, he felt confident that he could accomplish something in parallel with his studies. But he had to move fast with graduation approaching.

“I attacked the problem head-on,” said Lesan. “It was a huge opportunity to learn component design, complex assembly design, CAD, 3D-printing design principles, and a variety of software modeling solutions to first principles problems.”

Learning to solve these engineering problems was an obvious benefit to the undertaking, but it was far from the only challenge to overcome in the design and build process for the turbopump. The hardest, yet perhaps most rewarding, task was to reach out to industry for collaboration partners who could offer 3D printing, machining, off-the-shelf parts such as seals and fasteners—and advice. Such efforts are normally handled by seasoned managers. Yet Lesan, and then Watson, made acquiring partnerships a major element in moving

support and production beyond the school-run manufacturing lab to more advanced industrial sites.

Liftoff on Collaboration

Early on, with an objective of single-part construction, Lesan went online and contacted metal-AM provider Velo3D through the company’s website. He knew from his reading that their advanced laser-powder-bed-fusion (LPBF) print capabilities were central to the production of the SpaceX Raptor engine. This online inquiry led to a conversation with Velo3D’s Zach Murphree, vice president of global sales and business development and Gene Miller, director of technical sales. Both encouraged Lesan and offered the company’s technology and services for the project.

“Zach and Gene were super excited about the project,” said Lesan. “And their excitement made me further committed. The design capabilities of the Velo3D printers and their personal encouragement ultimately drove me to go through the whole design process on the turbopump.”

Following Lesan’s call to Velo3D, another breakthrough happened. With the turbopump redesign underway, Lesan met soon-to-be fellow co-designer Watson at the CU Sounding Rocket Laboratory (CUSRL). There they discovered a common interest in turbomachinery—and the joint adventure began. “Zach [Lesan] showed me his engineering presentation, and I was blown away by how technically advanced it was,” said Watson. “Zach is like a juggernaut. That energy drew me into the project and I felt we could accomplish anything at that point.”

The admiration was mutual. “Patrick stepped in around the Christmas 2021 timeframe,” said Lesan. “I learned that he was working on turbomachinery through his internship at Launcher [a Vast company]. That set the stage for our collaboration right there. Patrick learned more and more about my initial design in early 2022, and then took over our project entirely that year in terms of getting parts made and working with partners. He carried on with the drawings, manufacturing

documents, CFD and final deliverables,” said Lesan.

The Push Toward Part Consolidation

The last five years have seen tremendous advances made in space and rocket technology. Independent engineers and commercial companies alike are working toward single-part rocket designs and consolidated manufacturing approaches. The goal is to rely less on machining, casting, brazing, and traditional joining techniques that hold back functional performance, decrease reliability and source from a dwindling supply chain. Lesan and Watson embrace these targets as well.

“A lot of companies cast their parts,” said Watson. “The real big breakthrough in turbomachinery for space or energy is 3D metal printing, Laser Powder Bed Fusion (LBPF), mostly. We can now print the performance geometries we want, iterate the designs, get the surfaces we need, and use machining more selectively. Metal 3D printing makes our project possible. Zach and I used our intern salaries to fund what wasn’t donated or discounted. Imagine us spending tens of thousands of dollars on machining traditional parts or removing support structures.”



Patrick Wilson, student, Colorado University.

The academic aims of the Reaper engine (named after a South Carolina hot pepper), were to explore agile and more economical means of rocket

manufacture. Both Zach and Patrick understood that the success of this project and, to a degree, the nature of their future aerospace careers depend on lowering the cost of space flight.

AM Benefits Inform the Design

With his early studies in solid-state rockets as a teenager and so much data on turbopumps in hand since 1960s, Lesan had the basics in place for the design work he was to undertake at CU Boulder. He now needed to create his own MethaLOX model, one that took advantage of advanced metal AM. Here was the only distinction he felt he could make. Turbopumps are a known entity. Lesan didn’t expect to improve upon their performance, but perhaps through AM he and Watson could lower costs and improve reliability over existing systems.

Part consolidation serves to boost quality by eliminating component sealing interfaces, an historic source of failure. Turbopumps have long relied upon seals to join their sections. Despite generational advances, seals are still a risk area given the high fluid/gas pressures involved in the pump and turbine units.

“We have gotten rid of so many potential traditional failure modes by minimizing part count,” said Lesan. “The issue then with AM is porosity and part verification. We can look at our Velo3D build reports and see there were no errors in the process impacting quality.”

“There are some parts we had to buy or conventionally manufacture,” said Watson. “The purchased parts are fittings, bearings, seals, and fasteners to join flange sections. But otherwise, the focus was on creating a work-friendly, lower-cost system, that avoids traditional fit problems through combined parts. There is a safety issue here, too,” notes Watson. “The inner propellant seals, made as one part, is outside the norm. By using a nitrogen-purge system, that is integrally printed throughout the Reaper turbopump housings, we effectively eliminate the chances of propellants mixing and

causing catastrophic failure. We are able to reduce leakage losses, avoid performance problems, and even explosions. A single AM-produced part, relying on challenging overhang angles and approaches, accomplishes this goal.”

Partner Help

Lesan and Watson’s fast track to rocket development was aided by many who share a passion for space. From the CU Boulder Aerospace program there was Professor John Farnsworth, and Cameron Micksch and Paul Wingrove from the university’s machining lab.

Private industry stepped in with software, services, parts and advice. The core team of two did their metal printing with Velo3D, used critical design software and ongoing help from CFturbo, and machining services from Silicon Valley Elite Manufacturing and EMP. They also received seals from Gallagher Fluid Seals and instrumentation from Kulite and Omega. Advice flowed informally from individual engineers at both their internship companies, SpaceX and Launcher, as well as Ursa Major and from Andrew Mitchell, formerly with Masten Space Systems, now Astrobotic.

“The extent of industry collaboration that Zach and Patrick have created is truly impressive,” said Sid Raje, Velo3D business development account manager. “They have built upon where industry is headed with liquid oxygen and methane propulsion, but the extent of their use of advanced AM for part consolidation and demanding geometries, surfaces and overhangs really stands out. The reduction of post-processing costs and improved system reliability is a lesson they and others will carry forward.”

velo3d.com



Croix Gear

ANNOUNCES NEW LOOK

Croix Gear, recognized as a leader in the custom manufacturing of loose gears, is excited to announce new branding for the organization. Ruthie Johnston, CEO/Owner, stated, “We are excited to have our brand reflect how Croix Gear has grown and developed over the past several years. It is a new look, but the same commitment to our customers, team members and industry.”

The most recognizable change with the rebrand is a fresh, new company logo. Most notably, the brand name has been shortened to “Croix Gear” denoting a clear focus on precision gear manufacturing. Secondly, the two gears working together within the logo demonstrates Croix Gear’s strong commitment to customer relationships.



Croix Gear

Johnston added, “Precision with Purpose remains our tagline as it means a great deal to us. Our customers require precision gears. Our commitment is to provide an exceptional experience. Fast turnaround. Responsive service. Meeting deadlines. Every gear. Every order. Every time.”

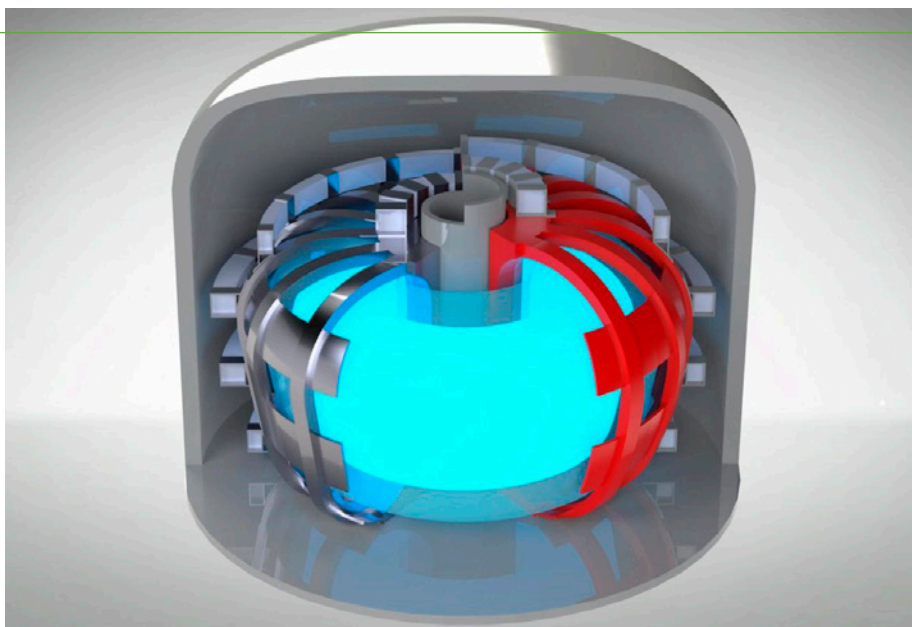
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Ansys and RBF Morph

JOIN FORCES ON MORPHING TECHNOLOGY FOR SIMULATION TOOLS

After a long and successful OEM partnership with Ansys, RBF Morph has two proprietary products featured among the world simulation leader’s offerings: Ansys RBF Morph Fluids and Ansys RBF Morph Structures.

The two simulation tools are based on RBF Morph’s 10+ years of experience with 100+ global customers, including some of the top players and OEMs in the automotive and aerospace industries.



Radial Basis Functions (RBF) are considered by the scientific community one of the best mathematical tools for mesh morphing, a technique used to modify or deform a geometric mesh while maintaining its overall structure and characteristics. This approach is crucial in developing safety-critical complex applications in the automotive, aerospace, and medical industries. Thanks to mesh morphing, companies can substantially reduce computational time while performing highly automated design optimization analysis, increasing products’ reliability and performance while cutting costs, delivery time and environmental impact.

Today’s products represent cutting-edge mesh morphing technology that can help companies optimize their products and achieve optimal efficiency within the Ansys simulation platform.

Ansys RBF Morph Fluids is an add-on that allows for automated shape optimization studies entirely within Ansys Fluent, leveraging morphing of the existing mesh. This new approach takes advantage of Ansys Fluent’s CFD technology and overcomes the limits of the mainstream methods by implementing dedicated morphing routines directly into Ansys Fluent’s CFD code.

Ansys RBF Morph Structures is an ACT extension that allows for automated shape optimization studies entirely within Ansys Mechanical and Ansys Workbench by morphing the existing mesh.

The main advantages of RBF mesh morphing are:

1. The capability of handling any mesh, making it very flexible and usable in any situation
2. Fully integrated with Ansys CAE solvers, with a seamless user experience
3. No need for remeshing and highly parallelizable to significantly cut computational time
4. A robust process with proven cost cutting and improved performance results, up to a 5x factor.

“Thanks to our partnership with RBF Morph, Ansys can offer users an advanced solution for mesh morphing that integrates seamlessly into the Ansys platform,” said Prith Banerjee, chief technology officer at Ansys. “These state-of-the-art tools are able to address the most challenging applications in any industry using the predictive power of simulation.”

“We have been proudly serving Ansys users since 2009,” said Marco Evangelos Biancolini, RBF Morph’s Founder and CTO. “We started with CFD, an Add-On for Fluent and since then we gradually expanded our integration within the Ansys product family: Ansys Mechanical, Design Explorer, Twin Builder, optiSLang and LS-DYNA. Today we have two solutions fully integrated with Ansys Fluids and Ansys Structure to enable the best multiphysics optimization and digital twin creation. The expanded OEM arrangement marks a new chapter in our cooperation with Ansys and will allow to jointly replicate the successes we have been bringing to 100+ Ansys customers.”

rbf-morph.com | ansys.com

October 24-26 – Southtec 2023



Southtec 2023 (Greenville, SC) draws manufacturing suppliers, distributors, and equipment builders from across North America and around the world. With hundreds of exhibiting companies, attendees can find all the latest technologies and services – plus the experts who build them—ready to demonstrate solutions that can help them grow their business. Visitors can make side-by-side comparisons, discover integrated equipment, hear about industry trends and forecasts, and leverage their purchasing power.

powertransmission.com/events/957-southtec-2023

November 1-2 – Advanced Engineering 2023



Advanced Engineering (Birmingham), has rebranded to celebrate the evolution and new developments in manufacturing. Sectors include aerospace, automotive, defense, composites, marine, rail, energy, medical and more. To ensure that visitors and exhibitors can still easily find relevant contacts, Advanced Engineering exhibitors will now be categorized by the services, products and solutions offered. They will have the opportunity to highlight all of the sectors they work in, removing any limitations created by the specific show zones. In 2023, Advanced Engineering will welcome back a full speaker program with representatives from some of the leading companies in UK manufacturing. Last year, attendees were treated to talks from Siemens, Ford, Jaguar Land Rover, Make UK, Rolls-Royce and Airbus.

powertransmission.com/events/963-advanced-engineering-2023

November 9-10 – Aachen Forum on Gear Production

In this seminar, attendees will learn about gearing, electromobility and their interrelationships. How gearing can increase the efficiency and performance of electromobility, and which components are needed for this. Also, a detailed look at the design and manufacture of gears for electric vehicles. Attendees will explore the challenges of gearing for electromobility, such as adapting to hard-to-reach places, increasing durability, and reducing energy consumption, and discuss how grinding technology and tool design must meet requirements to improve the properties and improve the quality of gears for electric vehicles. The Aachen Forum on Gear Production (AFGP) is held annually in alternation with the Aachen Conference on Gear Production (ACGP). While the Forum at the RWTH Aachen Campus is dedicated to a technical focus (2023 the interlocking in the e-mobility sector) the conference, on the other hand, is dedicated to various facets of gear technology.

powertransmission.com/events/962-aachen-forum-on-gear-production

November 12-15 – 2023 STLE TFC and E-Mobility Conferences

The 2023 STLE Tribology Frontiers Conference (TFC) will be held in Cleveland. The event will allow attendees to engage with world-renowned industry, academic and government researchers to learn more about the technical, environmental, and social issues impacting tribology research in the 21st Century. The 2023 STLE Tribology & Lubrication for E-Mobility Conference will be held in conjunction with the TFC from November 14-15. The event will feature educational sessions and networking discussions with leading industry experts covering technical content, analysis, and best practices for addressing the challenges and opportunities associated with electric vehicle technologies and how they will impact the tribology and lubrication field.

powertransmission.com/events/944-2023-stle-tribology-frontiers-conference-and-tribology-and-lubrication-for-e-mobility-conference

November 14-16 – SPS 2023

Numerous companies from all over the world have already registered for this year's automation highlight in autumn, SPS 2023 (Nuremberg). Among them are international key players such as Bosch Rexroth, SICK, Phoenix Contact, Beckhoff Automation, WAGO and Endress+Hauser, but also many small and medium-sized companies, start-ups and specialists who want to present their innovative automation solutions in Nuremberg. "After the successful restart last year, interest in the PLC has continued to grow and the feedback is already well above the previous year's level at the same time. In addition, we are currently in contact with many other companies, which makes us very positive and indicates that the SPS is developing again towards pre-corona levels," says Sylke Schulz-Metzner, vice president SPS at Mesago Messe Frankfurt. In order to meet the exhibitors' enquiries and wishes, organizer Mesago Messe Frankfurt is therefore planning to occupy two additional halls again.

powertransmission.com/events/949-sps-2023



BROWSE OUR BLOGS!

PTE features blogs to keep readers updated on the latest PT trends, technologies and industry solutions:

Bearings with Norm: After a several-years hiatus, we're pleased to welcome back our bearings blogger, Norm Parker.

Revolutions: Our editorial staff provides relevant and timely articles on a variety of PT industrial topics.

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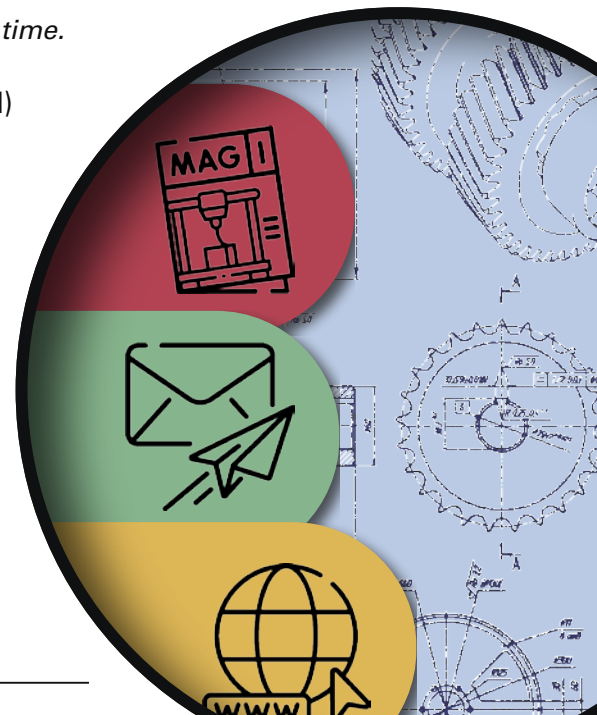
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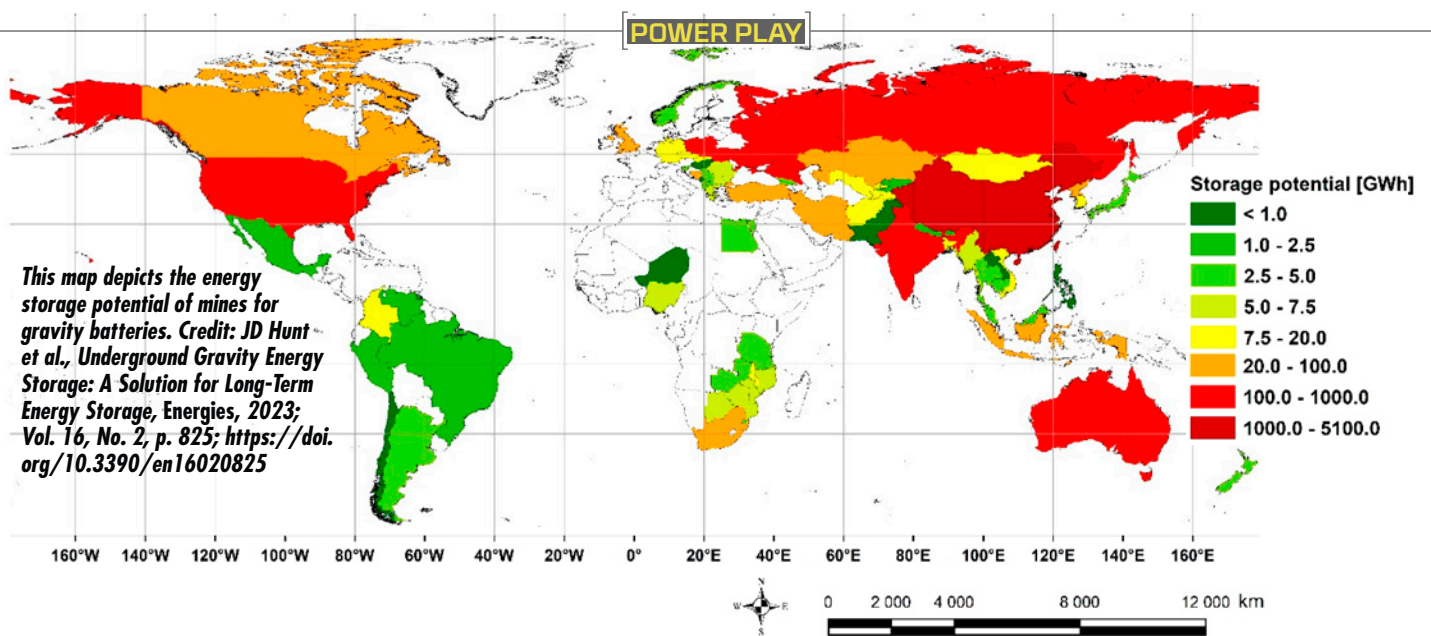
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This map depicts the energy storage potential of mines for gravity batteries. Credit: JD Hunt et al., *Underground Gravity Energy Storage: A Solution for Long-Term Energy Storage*, *Energies*, 2023; Vol. 16, No. 2, p. 825; <https://doi.org/10.3390/en16020825>

A Theory of Gravity

How gravity batteries could aid the electrification movement

Aaron Fagan, Senior Editor

In the middle of the last century, we had a golden hour to revolutionize global energy handling. The postwar boom period was characterized by exponential growth in the human population, fossil-fuel use, water use, food production, international communication, and the pace of land-use conversion. This boom period also marks the dawn of the so-called Anthropocene Epoch characterized as the period in which the collective activities of human beings began to substantially alter Earth's surface, atmosphere, oceans, and systems of nutrient cycling. Regardless of one's position, the fact remains we are transitioning away from fossil fuels while our energy demands outpace production, and it has put humanity in a tight spot.

The electrification movement has the potential to significantly impact the industrial motion industry in several ways, as industries seek to reduce their carbon footprint, increase energy efficiency, and adopt more sustainable practices. The movement could lead to advancements in energy storage solutions for motion systems, ensuring consistent and reliable operation.

As renewables like solar, wind, and hydropower expand global energy production worldwide, the energy from them isn't available on-demand but must be stored during the lulls, so the energy is sufficiently available during peak times. This energy-storage problem has been untenable for scaling up renewables thus far, but one age-old technology could address this issue: the gravity battery.

Gravity batteries, also known as gravitational energy storage systems, provide a means of storing and releasing energy in a sustainable and efficient manner. These systems utilize the force of gravity to store potential energy and convert it back into electricity when needed. The kinetic energy invested into raising a mass becomes potential energy that will never dissipate. Here's how gravity batteries could aid the electrification movement:

Energy Storage: Gravity batteries offer a way to store excess electricity generated from renewable sources.

Grid Balancing: Gravity batteries can provide a rapid response to fluctuations in demand by releasing stored energy into the grid during peak usage times.

Energy Shifting: Gravity batteries enable energy shifting from off-peak to peak hours.

Long-Duration Storage: Gravity batteries can potentially store energy for indefinite periods without appreciable degradation.

Environmental Impact: Gravity batteries typically use heavy objects that have minimal environmental impact compared to conventional batteries.

Scalability: Gravity batteries can be adapted to different energy storage needs from residential use to large-scale installations for grid-level energy storage.

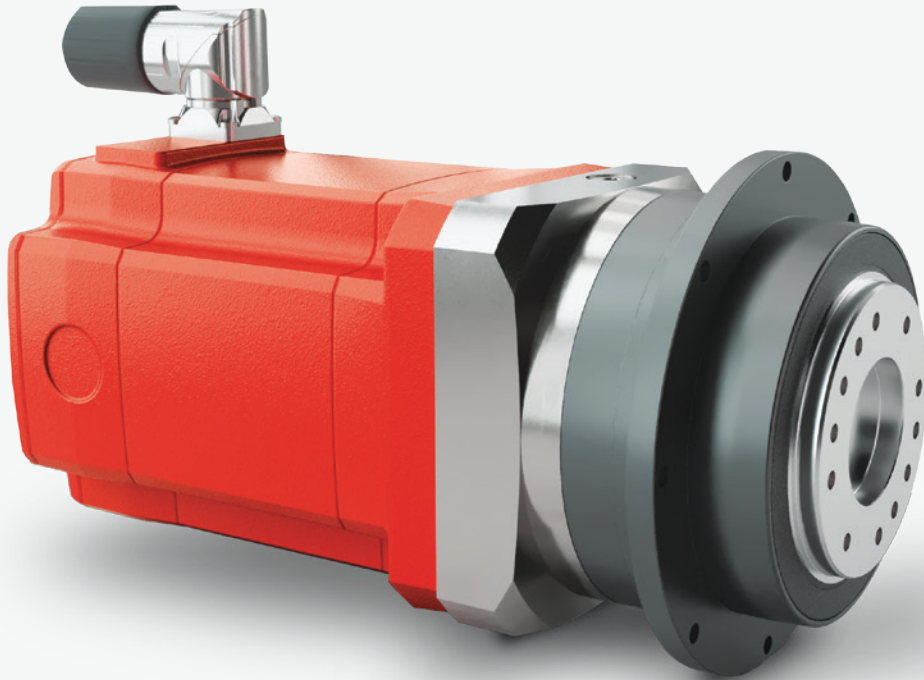
Location Flexibility: Gravity batteries don't have the same geographical limitations as some other storage technologies.

Energy Access: Gravity batteries can provide a decentralized energy storage solution that supports electrification efforts.

Reduction of Emission Peaks: Gravity batteries can help reduce the need to rely on fossil fuel-based power plants that are often used to meet high electricity demand quickly.

It's estimated that there are millions of decommissioned mines across the globe. By using decommissioned mines with a vertical shaft as the infrastructure for gravity batteries, enormous amounts of energy storage can be achieved. The technology is estimated to have a global energy storage potential of 7-70 TWh (terawatt hours). The high end is enough to power the entire world for a day. With nondissipative energy storage, such as that offered by the gravity battery, we could truly have a robust, grid-management solution that is shocking only in its simplicity.

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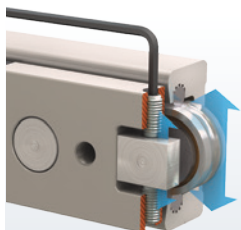
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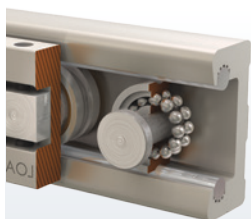
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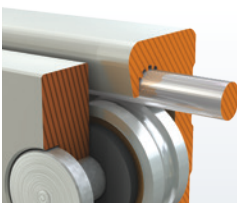
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