COUPLING CONNECTION

COUPLINGS AND HARSH ENVIRONMENT USE

Jack McGuinn, Senior Editor

Simply defined, a coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. The coupling has been around since shortly after the invention of the wheel, i.e. — no wheel, no coupling. And something that has been around even longer than that is the often harsh and extreme environments in which couplings are at times required to function. Considering the seemingly endless list of coupling applications — from mining to the space station — it's a given that couplings are often subjected to, among other things, extreme heat, cold, sand and degraded lubrication.

Some high-temperature examples:

- Degradation of a coupling's elastomer inserts, thus reducing torque capacity
- Grease from gear and grid couplings can start to break down
- The adhesive used in bonded couplings may weaken due to extreme conditions
- Heat-induced thermal shaft expansion can place axial loads onto disc couplings (high-performance motion control couplings that serve as the torque-transmitting element)

Regarding low-temperature extremes, the effects are very similar to extreme heat; e.g., plastics (elastomers) become brittle; adhesive and lubrication break down.

And then there is commonly harsh chemicals exposure that, like the elements, weakens the aforementioned elements that constitute a coupling.

And last — wash down — during which precious grease can be blown free of gear and grid couplings.

We talked to two companies that know bearings — R+W Coupling Technology and Nordex, Inc. Joining in are Nordex mechanical engineer Nicholas Antonelli, and Andy Lechner, sales & marketing manager, R+W Coupling Technology.

While several topics are raised, coupling performance in harsh environments is the focus.

Andy Lechner

Nicholas Antonelli

Say a customer is specifying couplings for a new "high-temperature" application, with the desired maximum allowable high temp yet to be determined. Who in a scenario like that assumes R&D responsibilities?

(It's) typically a joint effort between Nordex and our customer," says Antonelli. Lechner adds that "For a manufacturer to determine if a custom solution can be provided, it's necessary for the customer to identify the parameters;

he needs to fulfill to achieve the application's desired result."

Are there any new material breakthroughs that you are aware of; materials that might open new opportunities for plastic-for-metal couplings and components?

"Yes, new materials such as Dupont Zytel and Hytel," Antonelli says. R+W's Lechner recalls that "A few years back, R+W developed a glass-reinforced, nylon hub material for corrosion proofing elastomer couplings without going to relatively more expensive stainless steel materials. Quite a lot of research went into designing specific hub structures to tolerate high torques in smaller sizes, and to maintain precision geometry. The product line has been a success—especially for outdoor applications."

How does future 3-D printing work for coupling makers? Is additive manufacturing technology embraced by coupling manufacturers? Can they afford not to?

"Additive manufacturing is an increasingly attractive means of rapid prototyping for new designs," Lechner points out. "Some opportunities exist to take advantage of the same for low-quantity production runs of otherwise capital-intensive production processes. Still, so many varieties of simple, flexible couplings already exist at low costs that it would take a completely new and uniquely beneficial design concept—best mass-produced by 3-D printers—for it to become a truly viable option for the coupling industry. So far, I'm unaware of such designs; however as the speeds, materials and costs continue to improve, it's candidacy for mass-production of couplings does as well." "(Three-D) printing) can aid prototype development/testing," says Antonelli. "Also, the new polymers previously spoken about are available for 3-D printing."

Even in harsh environments, can breakdown of elastomer inserts be avoided with robust preventive maintenance schedules?

"Possibly," says Antonelli, pointing out that "it is dependent on duty cycles and usage." For Lechner, "Up-front coupling selection and installation are the highest predictors of long life as required torque and shaft alignment are the critical elements for minimizing wear. Many different materials are available for elastomer inserts, with the most commonly used by R+W being thermoplastic polyurethane. When properly aligned and installed—and with the torque and temperature ratings not exceeded—they require very little maintenance and can run for years without the need to replace them."

Is lubrication as critical to couplings as it is, for example, gears and bearings—and even more so for harsh environment applications?

Lechner says "The most commonly used coupling which requires lubrication is actually the gear coupling. As the teeth rock back and forth with each rotation, it is critical that friction be kept to a minimum. Proper maintenance intervals should be observed, and in cases where that's impractical, maintenance-free couplings should be considered." Nordex's Antonelli explains that "In many cases, materials such as Delrin have a built-in lubricity."

There seems to be almost as many applications for couplings as exists for gears. Can you think of one (coupling application) example that most people would not be aware of?

Lechner says "Just about anything that rotates could use a coupling, depending on how things are laid out, so I'm not sure what applications would be surprising to people. One unusual application R+W worked on though was a torque limiter for disengagement at 18 million Nm, which is being used for gearbox testing for large offshore windmill applications." Antonelli adds, Extreme angular change, such as using this feature in place of a right-angle gear box."

How is adhesive used in a coupling? Is conditions-induced adhesive breakdown an expensive problem?

Lechner: "In cases where the coupling will be deployed in corrosive environments or be subjected to temperature extremes—either of which can cause the bond to break down—welded bellows-hub connections are preferred. With some exceptions, most bellows used in shaft coupling applications are made from one or more layers of high-grade, stainless steel sheet; formed and plasma-welded into a seamless tube, and either rolled or hydro-formed to produce the deep corrugations (convolutions) which provide its flexibility. The resulting shape is one which is continuously symmetrical and highly rigid about its rotational axis, while remaining flexible across all three other axes: parallel, angular and axial. Bellows are joined to the hubs by crimping, welding, or bonding. The end hubs and bellows are mounted onto a single mandrel during assembly, with the ends of the mandrel matching the respective bore diameters of the coupling hubs, guaranteeing concentricity. Bonding came into common practice in the late 1980s, with the advantage being that it allows for the bellows to be floated between the two hubs, free of stress, until the bonding agent cures. This helps to avoid deformation or stress concentration on the bellows, ensuring that it will run smoothly, with consistent output rotation, once installed." Antonelli: "In bellow couplings an adhesive is often used to bond the flexible stainless bellow element to the aluminum or steel hub. The torque capacity of this connection is usually a multiple of the capacity of the bellow. If applied properly and used in the proper environment, adhesive breakdown is rarely an issue."

Assuming excessive heat is the common culprit for thermal shaft expansion, how is it prevented?

"As metals heat up they have a tendency to expand," says Lechner, "and in the case of power transmission shafting the result is often an elongation of the shaft. The amount of elongation which can be expected depends on the material and the physical size of the shaft, with more movement to be expected from larger and longer shafts. In some cases it's necessary to absorb this axial pressure, and couplings which can tolerate axial misalignment are a common solution."

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Environments like excessive noise and/or vibration—is either a major consideration in coupling design and performance?

It's a "Yes" for Antonelli, adding, "This is speed-dependent, of course. And for Lechner, "Depending on the application, vibration can be a major concern for couplings. Reciprocating loads like combustion engines and some pumps and compressors require couplings to be able to absorb high amplitude torsional vibration and normally use very soft compensating elements. Conversely, servo applications typically call for a torsionally stiff coupling to prevent vibration resulting from a need to rectify velocity and position errors which can result if the load inertia will have a delayed back-driving effect on the motor shaft as a result of torsional softness."

With the advances in mechatronics and industrial automation (IIoT, etc.) how do coupling makers work with system integrators to ensure seamless design and performance—even in challenging conditions?

"One way in which R+W helps to ensure seamless design and performance is through its sizing verification tool, which allows users to enter inputs based on the drive and application parameters and then test various coupling sizes with pass/fail results," Lechner says. "This helps to speed up the process when compared with longhand sizing calculations. Another timesaver R+W offers is a CAD configuration portal, which allows the user to enter bore diameters and other options and then directly insert couplings into their models." **PTE**

For more information:

Nordex, Inc.
426 Federal Road
Brookfield, CT 06804
Phone: (866) 931-0582
Fax: (203) 775-6552

R+W America
1120 Tower Lane
Bensenville, IL 60106
Phone: (630) 521-9911
info@rw-america.com

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