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THERMAL GROWTH ISSUES AND SOLUTIONS FOR SHAFT COUPLINGS

Thermal Growth Issues and Solutions for Shaft Couplings

Nick Agius, National Rotating Equipment/ACHE Product Specialist

I have been researching "Thermal Growth" issues for decades across North America. Many refineries and chemical plants are built with large pieces of rotating equipment in an outdoor setting exposed to the elements. This means the equipment (driver and driven) are often seeing forces beyond anyone's control called "Thermal Growth." This is especially true in colder climates (Zones 1 to 4).

The trouble is that often the root cause of the coupling or bearing failure is not identified by the reliability team at the end-user level. The actual equipment foundation is seeing massive forces as the ground heaves to frost. These forces are slow and unavoidable — the result is a shaft misalignment. This is hard to detect if you do not know what you're looking for, but the tell-tale sign is that this issue is seasonal. For example, the bearing or coupling fails every autumn or spring.

The first common mistake is when coupling failure is not properly recognized by maintenance. They often think they did a poor alignment job. As the coupling fails, they focus only on that part. They usually ask their power transmission supplier for a better shaft coupling that can handle more misalignment, which is the second mistake. They may also buy some laser alignment equipment to help with the process, which is never a bad investment. Many shaft coupling manufacturers advertise massive shaft misalignment capabilities, as that sells the product. Having a shaft coupling to handle excess misalignment is what the uninformed maintenance technicians are requesting. The issue is the coupling insert may be able to handle the misalignment, but the bearing on either side cannot, so we are simply passing the unidentified issue to the next piece of rotating equipment which is usually the bearings.

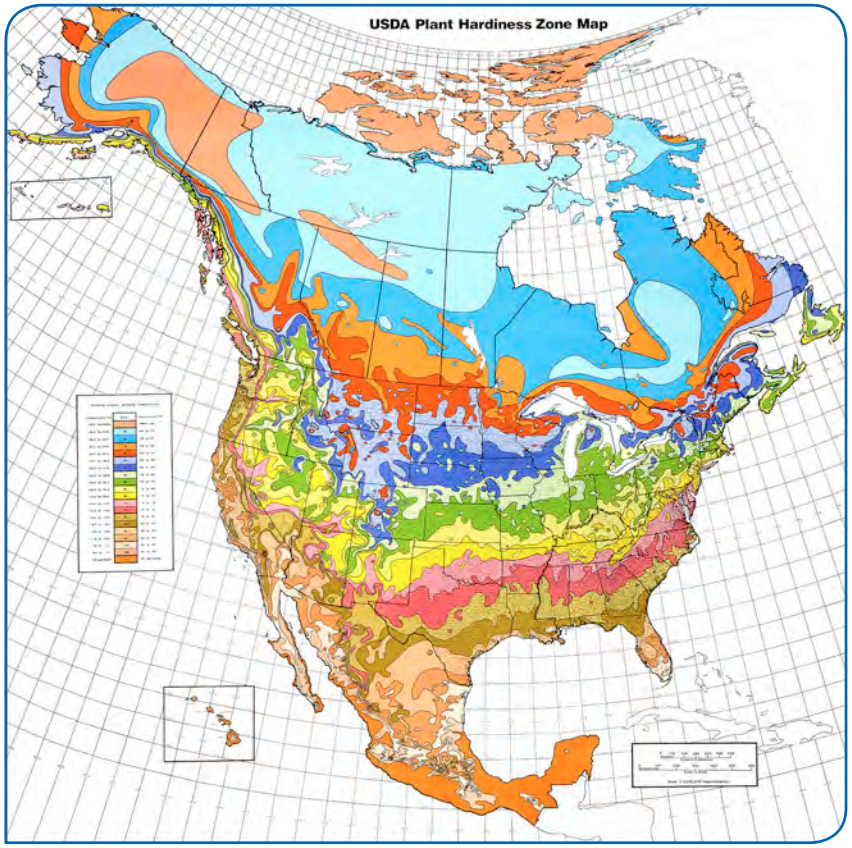
The next issue, after they feel they have solved the coupling, is the bearings start to fail (seasonally). The next call is typically to the bearing supplier, as the root cause has not been clearly identified yet. Now a process is started to redesign the bearings and find solutions to an unidentified rotating equipment condition. If the technician is lucky, he or she is calling the very same supplier who supplied the coupling. If the supplier has technical aptitude, they may start to ask some questions and realize this issue may be more than the local team thinks. First coupling issues, now bearing issues on the same unit?

In today's fast-paced world it is easy to get blinded by too much information, yet not see the real issue(s). If the supplier or end-user has access (internally or externally) to an experienced rotating equipment specialist, this is the time to ask for outside technical support.

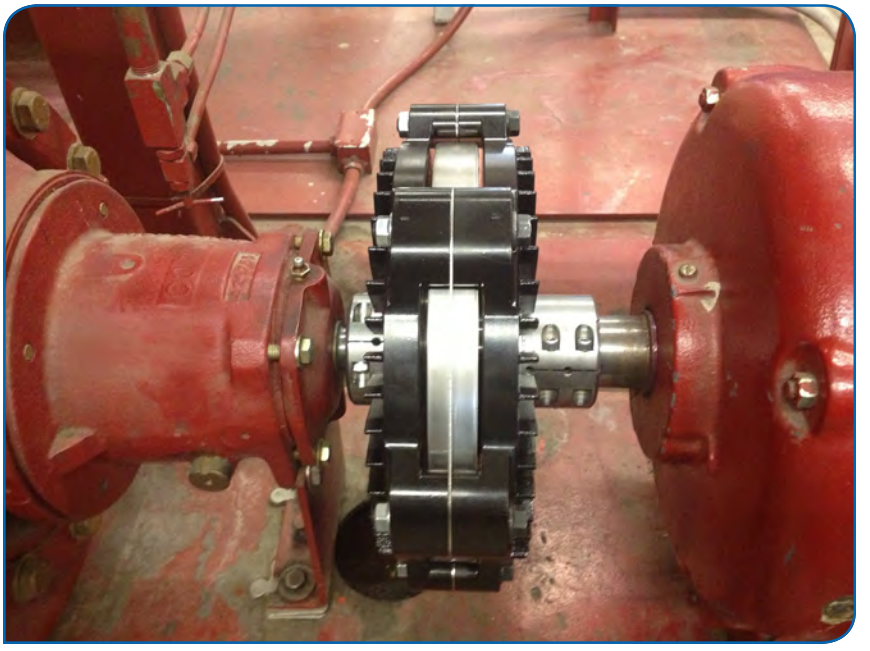
A skilled rotating equipment specialist will step back and perform a "Root Cause Failure Analysis" of the broken parts (coupling and bearings). Often, the end-user is not willing to spend the time or money, so the issue is not yet properly identified and the costs rise.

Now let's focus on the best solution.

From my experience, I have discovered that the best way to deal with slow seasonal thermal growth



Thermal Growth, especially in colder climates, can be the root cause of coupling or bearing failure.



Magnetic couplings in service.

is to use a shaft coupling with no connection between the driver and driven.

Does this exist? Yes it does: think magnets!

Magnetic couplings depend on an air-gap and powerful magnets between the driver and driven. They are one of our industry's best-kept secrets. If they had a lower cost, they would be more mainstream so they need to be solving an equipment issue to be considered. The air gap is not a physical connection, so if the equipment shifts seasonally within the magnetic couplings' ability, then the misalignment is absorbed and not passed to the bearings or other parts of the machine.

Magnetic couplings solve another issue as well. If we need a soft start between driver and driven to absorb start-up or a shock load. This is a market which fluid couplings have targeted and done very well. A fluid coupling will not solve a thermal growth issue and it requires transmission fluid to be inside the coupling. No shaft coupling can handle both issues articulated in this article as effectively as a magnetic coupling.

- Magnetic couplings will create a slight bit of speed slip so this needs to be taken into consideration
- Magnetic couplings can handle massive misalignment, as shown here, up to .300"

Magnetic coupling suppliers have a unique ability to install shims to allow for more slip. Think about the possibilities and why this is so revolutionary. I will give you one very common application where this concept is so very unique (and needed). The image at the bottom of page 20 shows a typical cooling tower application. The fan inside the velocity stack is driven by a large motor and coupling as shown here. The coupling shaft goes into the middle of the tower and drives a right angle gearbox, which has a large axial fan on the output of that gearbox. The fan blade pitch is set for the lowest ambient temperature year round so the motor will not kick out when the air gets colder and heavier.

This is another seasonal issue we need to deal with in Zones 1 to 4. If the motor has a variable frequency drive (VFD), the seasonal issue doesn't occur as the fan blade-pitch is set to be more aggressive in the hotter summer months, then the VFD simply adjusts the speed down, allowing the motor to stay under full load amps (FLA) during winter.

Years ago, most end-users in northern zones would set a winter and summer blade pitch to maximize the performance of the axial fan. Today this is not as common, due to safety issues inside these large, wet towers. A wet cooling tower is a nasty environment. Google "Cooling towers and Legionnaires' disease." The less anyone has to go inside a tower is the better.

Now the real benefits of this magnetic coupling are revealed. Think about how easy it is to adjust a set of shims on the outside of the tower, to slow the fan speed down a bit, so summer blade-pitch can run all year. This adjustment is easy to do quickly, for less cost and much safer. No confined space permit.

The other massive benefit of this magnetic coupling, in a cooling tower, is the "soft start" capability that the coupling inherently has. This allows the gearbox, fan and shaft coupling a much longer component life due to less stress. If the cooling tower is windmilling (which is very common) this magnetic coupling also solves that issue as well.

Magnetic couplings have ventured into full adjustable speed drives (ASDs), which is so very unique. Electrical variable frequency drives (VFDs) have a lot more baggage then most end-user identify with. VFDs require new wires, and they also require more space in the MCC room, which older plants simply do not have.

Consulting with a rotational equipment specialist is recommended to analyze VFD issues which show up in the form of a torsional vibration. There is one paper in the reference section below that is worth reading. A magnetic ASD will never create a torsional vibration issue due to design.

There are two leading magnetic coupling manufacturers that

seem the same on the surface, but you need to do your homework, because each uses different magnetic technology. I personally prefer the magnet that delivers 140% torque during slip (start-up) over the Eddy Current technology that drops off and generates more heat during start up (slip).

Conclusion: Thermal growth issues in rotating equipment are not easy to identify, so we can waste time and resources chasing the wrong solution(s). Consult with a senior rotating equipment specialist or do you own detailed "Root Cause Failure Analysis." This article was built to reveal the issue(s) and possible solution(s). This article went one step further to show how this unique magnetic coupling technology has helped solve another seasonal issue for cooling towers using the same magnetic technology. **PTE**

Outdoor boiler feed pump at a refinery in Canada with thermal growth issues due to seasonal pipe strain.

References

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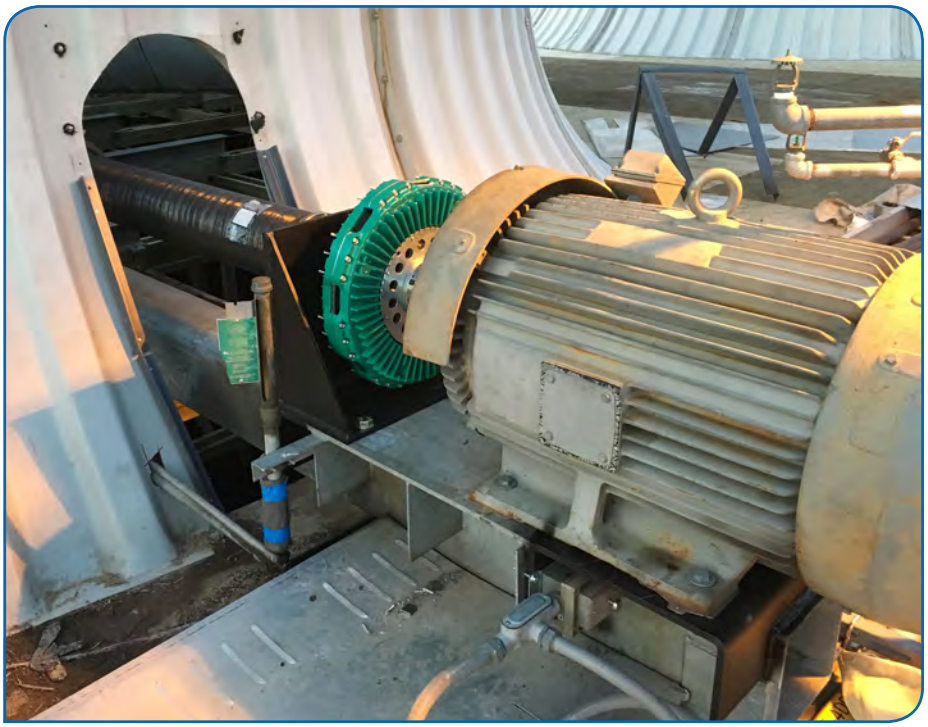

Flux Drive's rotor design provides full torque/power when needed for high-starting torque loads.

Nick Agius is a rotating equipment specialist. His Anti-Rotation Device (ARD) solution for Canada and the US was first patented in 1996, followed by two other patents. Visit thefanguy.ca or thwfanguy.com