Technology Day

Choose the right coupling for the application

October 17th, 2013

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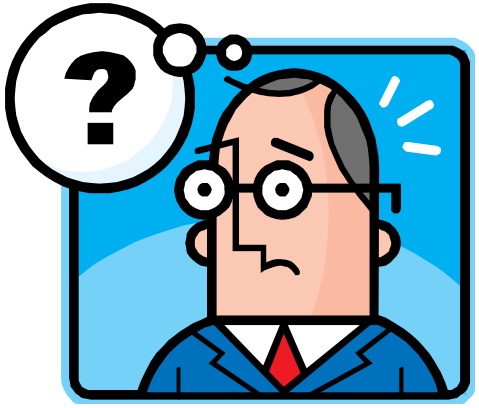
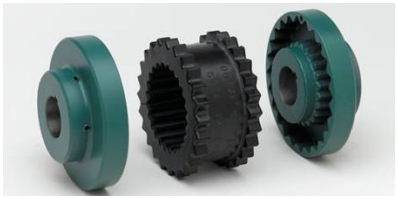
Choices abound…..which one is best for my application?



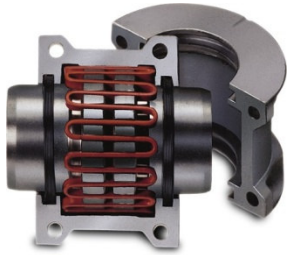
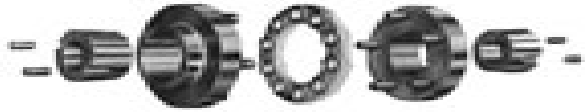











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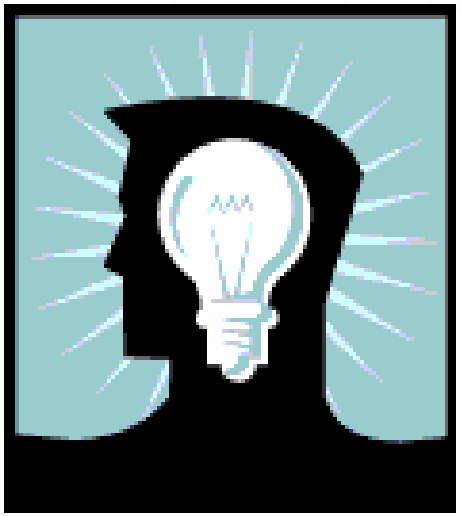
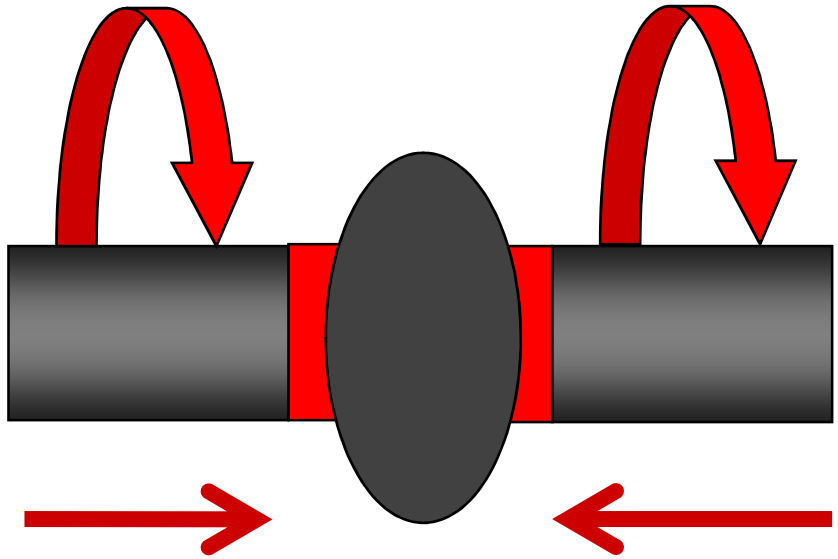
Its all about the application



- **What is critical in the application?**
  - **Speed?**
  - **Balance?**
  - **Torque?**
  - **Alignment?**
  - **Temperature considerations?**
  - **Application hazards? Chemicals?**
  - **Power density- size limitations?**
    - **A balance or mix of all these may be required**
    - **Consider what is most important, then next, then next…**
    - **The coupling choices become more clear!**

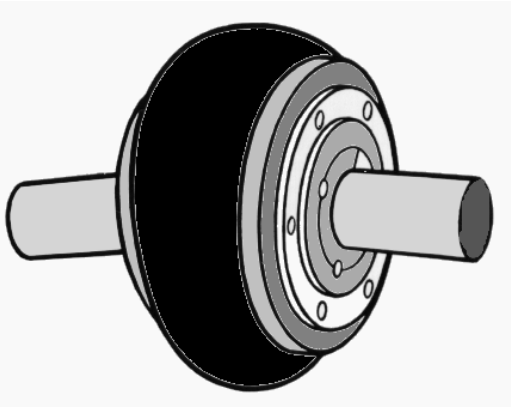
Primary Functions

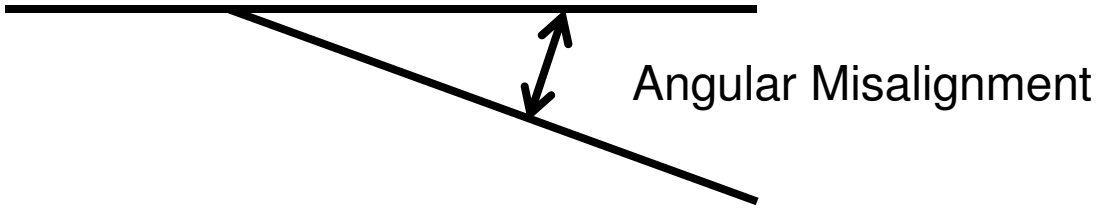
- **Transmit rotary power called “Torque” – usually measured in Newton Meters (NM) or inch-pounds (in-lb)**



Secondary Functions

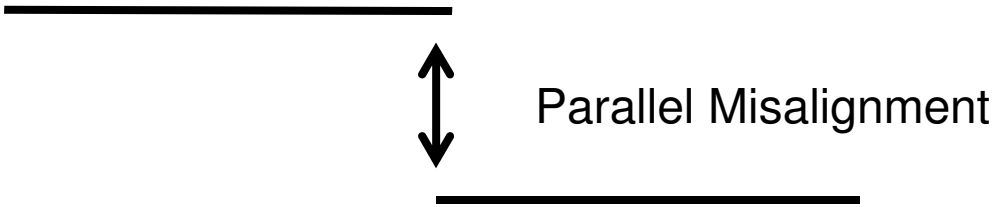
- **Accommodate shaft misalignment**
  - Angular misalignment
    - Measured as an angle between shafts (degrees)
  - Causes
    - Improperly mounted motor
    - Bent shaft
    - Skewed bushing



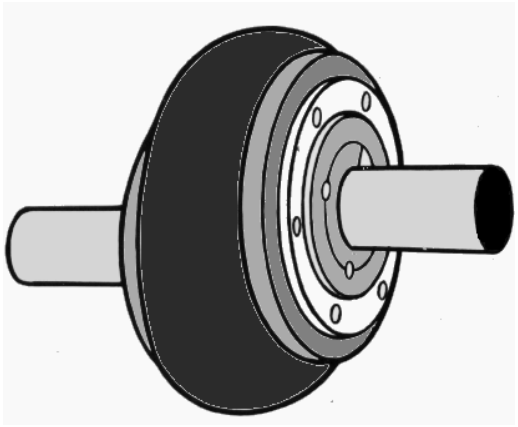


Secondary Functions

- **Accommodate shaft misalignment**
  - Parallel misalignment
    - Measured as the distance between two shafts
  - Causes
    - Driver/driven equipment are on different planes
    - Shaft centerlines do not coincide



Parallel Misalignment

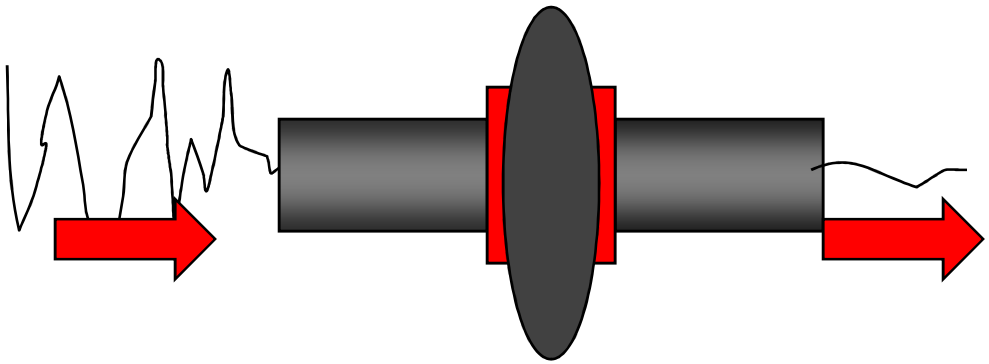


Secondary Functions

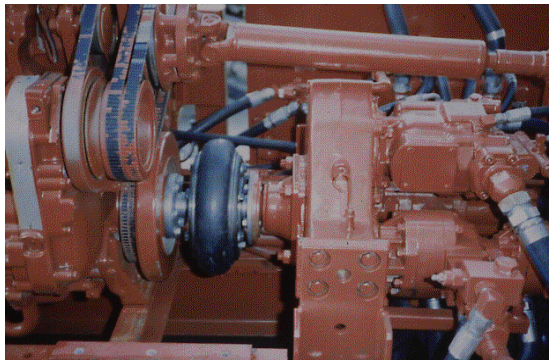
- **Accommodate End Float / Axial Misalignment**
  - Measured as the overall amount of movement axially
  - Causes
    - External thrust/axial load
  - Rubber elements allow for various amounts of end float

Secondary Functions

- **Shock loading**
  - Impact loading from a driven source
  - Combustion engine as driver source



Combustion engines
- Engine cylinders firing



Steel mill
- Roll out table applications

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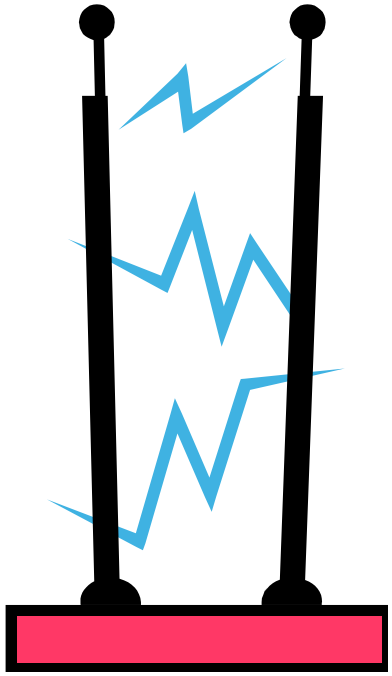
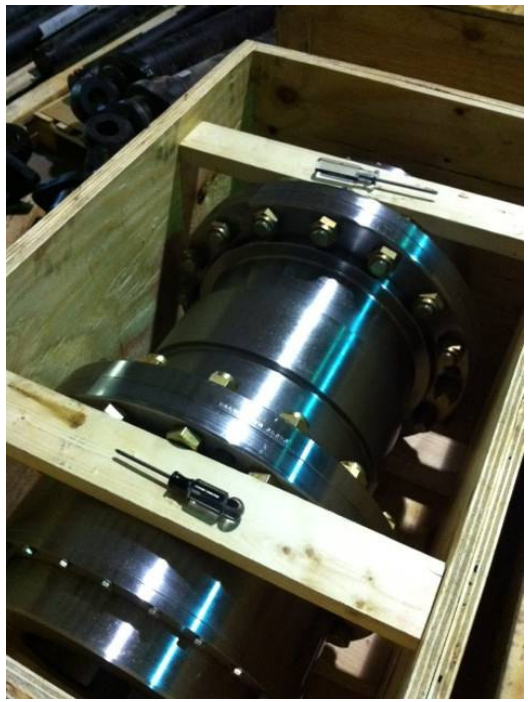
Secondary Functions

- **Electrical insulation application requirements**
  - Static electricity build up
  - Poorly grounded systems
  - If one piece of equipment is grounded and another is not grounded, the coupling must allow for built up static electricity to pass from the ungrounded to grounded equipment. Otherwise, an arc can occur.

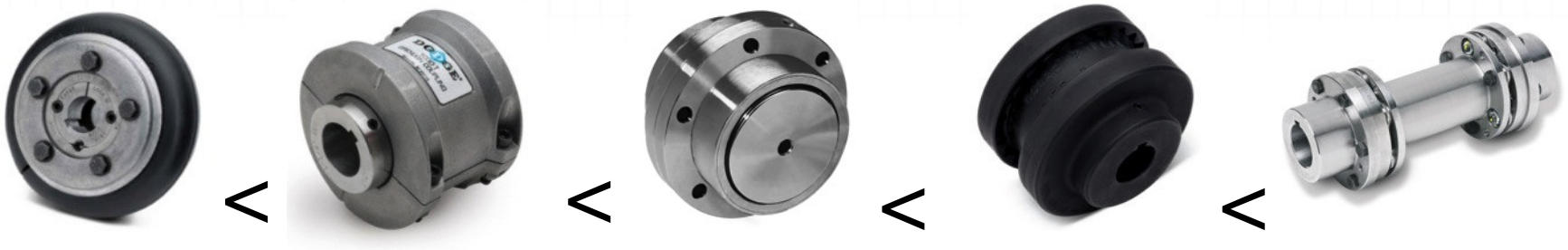


Secondary Functions

- **Coupling accessibility**
  - Standard pump sleds
  - Ease of element replacement/spacer



Balance Classes - AGMA



- **Differences in design leads some coupling styles to have better inherent balance characteristics than others**
- **If balance is important, it is critical to make sure you are using the right style of coupling**
  - Ex. – don't use a Para-Flex when AGMA 11 balance is required
- **Only the D-Flex and Disc Coupling have an "off-the shelf" balance standard (AGMA 9) specified**
- **All couplings can be balanced to improve performance, but it is important to evaluate the cost/benefit of additional balancing**

Torsionally Soft & Rigid Couplings

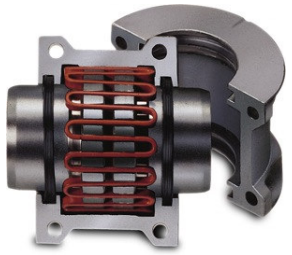
- Low resistance to twist is termed a torsionally soft coupling.
- High resistance to twist is termed a torsionally rigid coupling.
- Stiffness of the elastomer effects the rate at which vibration is dampened. A torsionally soft coupling will have greater vibration dampening characteristics.

Torsional Soft D-Flex

Size = 16

Max Torque = 47,250 in-lbs.

Torsional Stiffness = 3,150 in-lbs.



Torsional Rigid Grid-Lign

Size = 1090T

Max Torque = 33,000 in-lbs.

Torsional Stiffness =20,529 in-lbs.

Torsionally Soft & Rigid Couplings

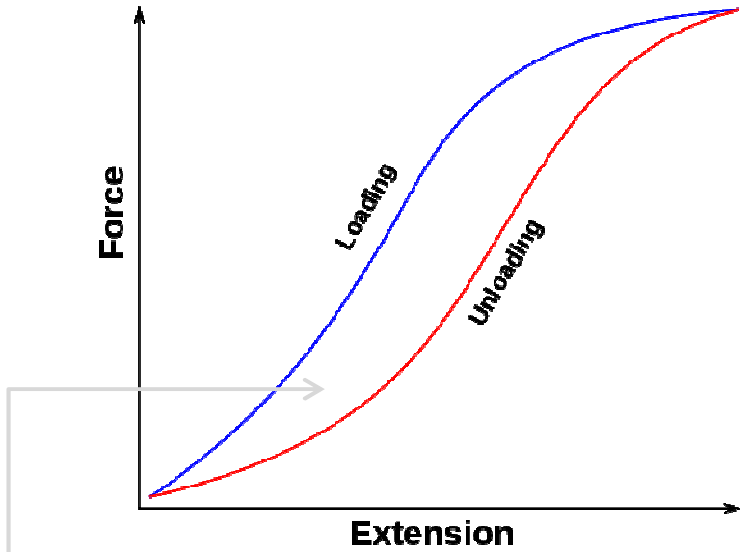
- **The main advantage of torsionally soft couplings over torsionally rigid couplings is that they isolate torque pulses that often arise in a system**. They reduce the impact of the torque pulse by winding up and storing the torque pulse energy in the elastomer. The coupling then releases the energy into the system over a longer period of time at a lower magnitude.

- **The main advantage of torsionally rigid couplings** over torsionally soft couplings is that they are **more power dense** and **can transmit a large**r **torque load**.

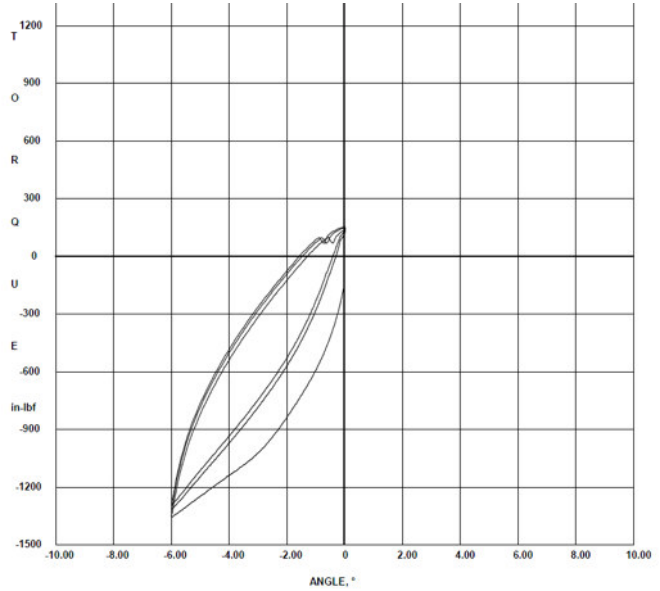
Hysteresis

- Allows elastomeric material to absorb dynamic energy. The energy is in turn lost in heat generation. If heat is able to radiate/ dissipate, dampening will occur without any damage to the coupling. If not, heat will build up internally and the element with fail or melt down.

- Hysteresis is the result of internal friction and the conversion of mechanical energy into heat.



Region represents the energy dissipated due to material plasticity



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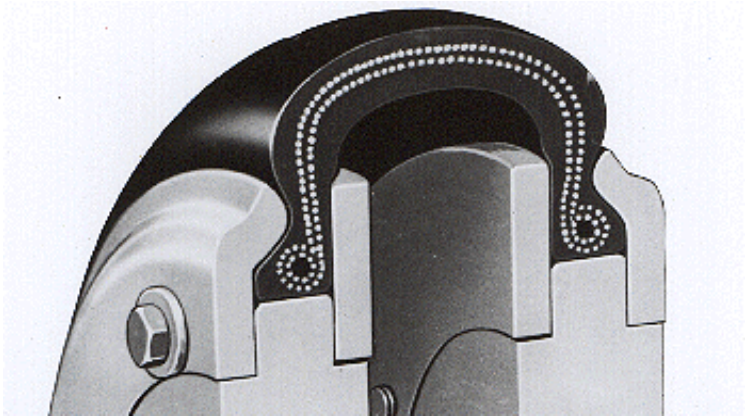
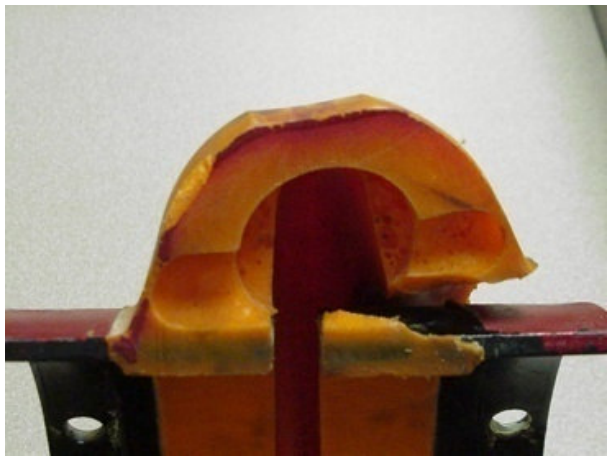
So- Why is this important?

- Example: PARA-FLEX uses a torsionally soft elastomer to absorb vibration and shock loading. The elastomer is reinforced with layers of polyester cord that flexes to accommodate misalignment and works to transmit about 75% of the torque load.
  - The torsionally soft rubber will wind-up during a torque pulse and will release the energy over time at a smaller magnitude in the form of hysteresis.
  - As long as the internal heat created by the hysteresis effect is dissipated, the coupling continue to operate.
  - If misalignment is great or there are excessive torque pulses, eventually hysteresis will take over and the coupling will fail.



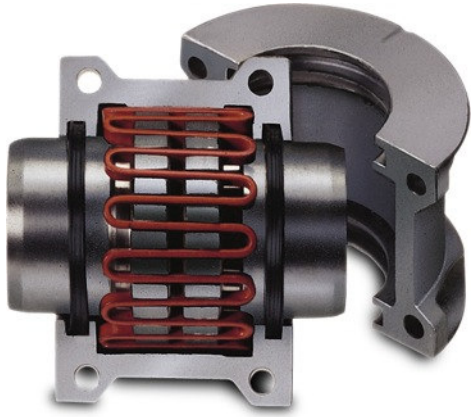
Two Basic Failure Modes for Elastomers

- **Two basic failure modes for elastomers**
  1. They can breakdown due to fatigue from cyclic loading, when hysteresis exceeds its limits. This usually occurs from excessive torque or misalignment.
  2. They can breakdown from environmental factors such as high ambient temperature, ultraviolet light, or chemical contamination.
     - ***Elastomers also have a shelf life, as they will continue to cure until they become hard and brittle.***



Backlash in Couplings

- The amount of free movement between two rotating, mating parts.
- If one half of the coupling is held rigid, and the other half can be rotated a slight amount, then you have some backlash.
- The freedom of movement, or looseness, is the backlash and may be expressed in terms of inches or degrees.
- Gear and grid couplings have some backlash, disc couplings have zero backlash.



Backlash in Couplings

- Backlash can be adjusted on gear couplings to suit a particular application. However, there is a trade off. The less backlash there is in a gear coupling, the less misalignment it can handle. Because of this, there is typically reduced life with reduced backlash couplings.

- Zero backlash couplings are often used in precision location or indexing applications.

DODGE Gear Coupling Backlash Chart

	Standard Backlash			Reduced Backlash		
Size	**Min (in.)**	**Max (in.)**	**Gap (in.)**	**Min (in.)**	**Max (in.)**	**Gap (in.)**
1	0.003	0.008	0.005	0.003	0.0055	0.0025
1.5	0.004	0.01	0.006	0.004	0.007	0.003
2	0.004	0.01	0.006	0.004	0.007	0.003
2.5	0.004	0.01	0.006	0.004	0.007	0.003

Coupling Grease

- Grease is meant to reduce friction and wear between two bodies in relative motion to one another.
- However, coupling grease is not the same as bearing grease and they should not be interchanged.

  greased couplings:
  - Gear style
  - GRID style

Difference Between Bearing Grease and Coupling Grease – An easy way to improve reliability

Bearing Grease

- **Usually bearing grease will have a low viscosity oil and a high bleed rate to prevent wear and heat cause by rolling friction.**
- **Standard Grease for bearings**
  - NLGI #2
  - Lithium Complex Base
  - 220 cSt @ 40C

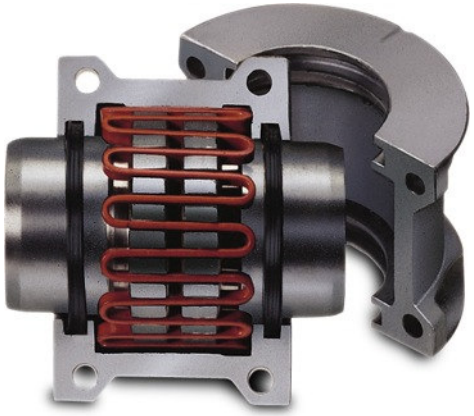
Coupling Grease

- **High Centrifugal force cause bearing grease to separate.**
  - Oil Bleeds out
  - Thickener accumulates
  - Causes Rapid and Excessive wear
- **Coupling Grease Should be highly resistant to separation with EP additives for high pressure.**

Recommended Coupling Greases

Grid Coupling

- NLGI Grade 1 – 3
- Min Base Oil Viscosity 288cSt at 40C
- Complies with AGMA 9001-B97



Gear Coupling

- NLGI Grade 0- 1
- Must Comply with AGMA 9001-B97

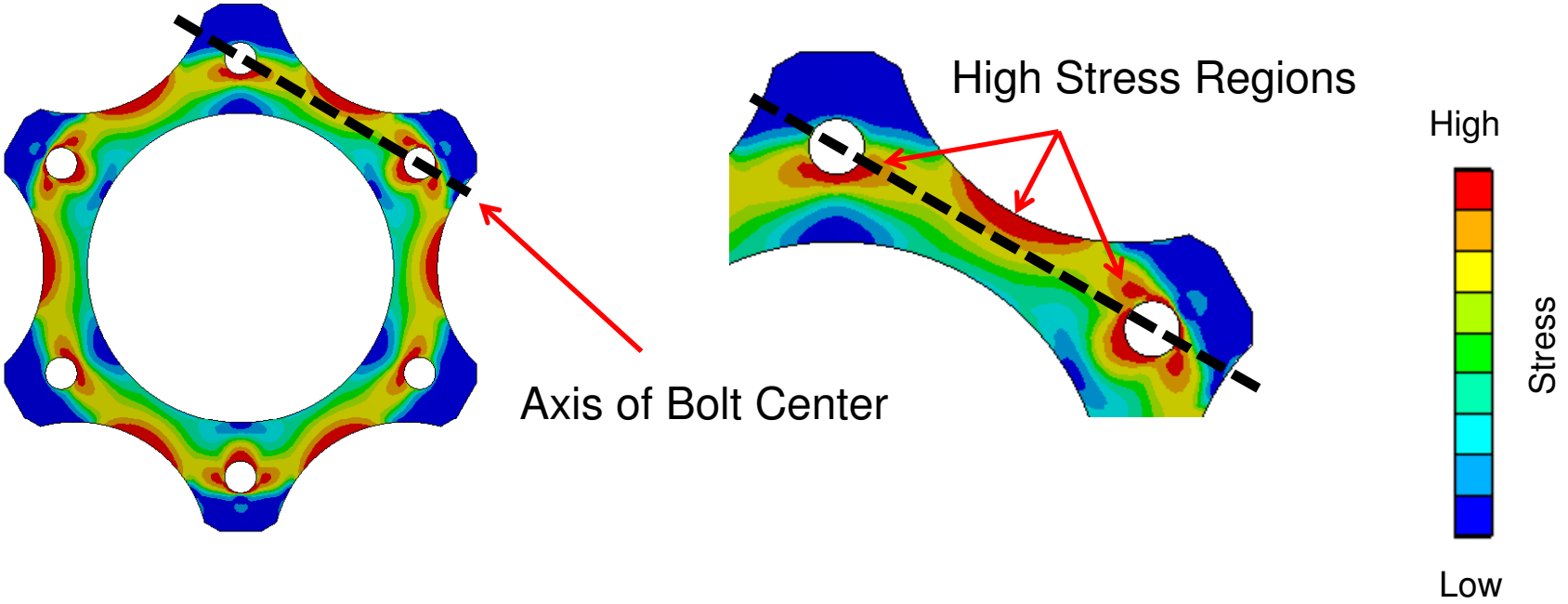
WARNING: Over Greasing

- **It is possible to over grease the Grid and Gear Couplings.**
  - Appling too much grease can create a hydraulically locked condition inside the housing. This will cause extreme pressure on the teeth and cause drastic wear.
  - Usually fails within hours
  - A coupling that has failed from over greasing will have one side showing signs of extreme wear and the other side looking brand new.

Improving Reliability & Productivity- by using new technology

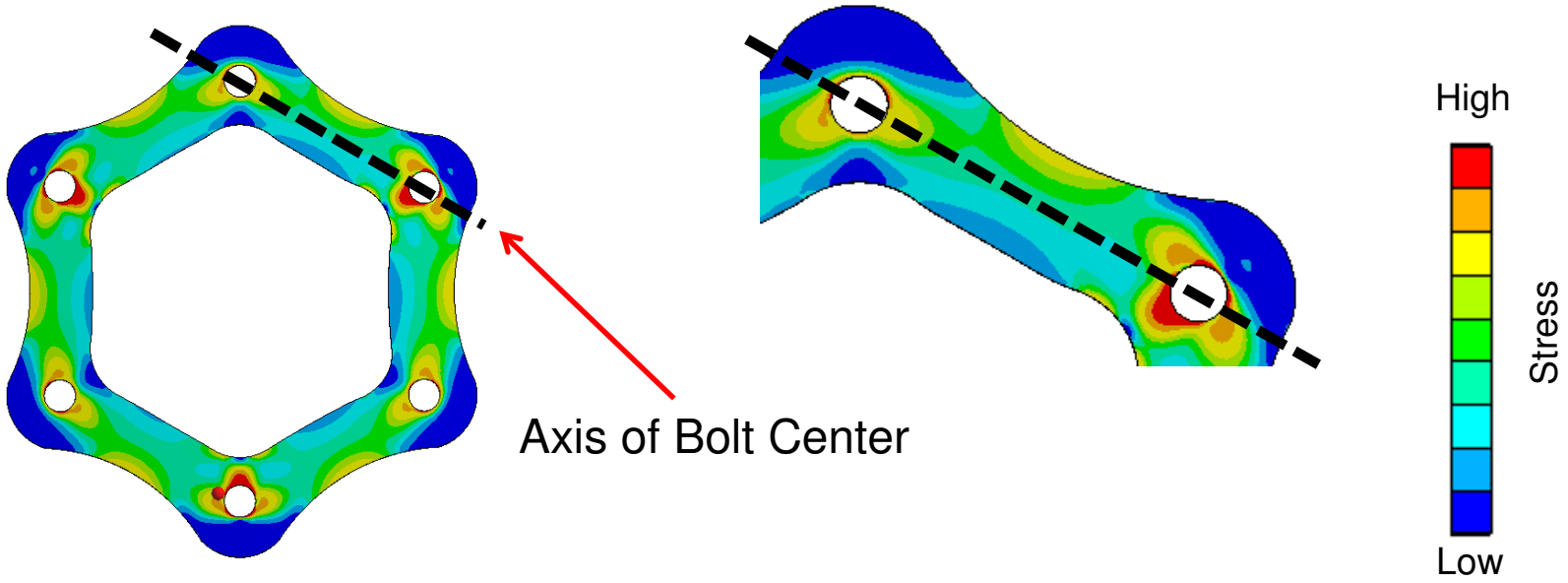
- **Example: New design of disk coupling**
  - No lubrication required
  - Power dense
  - Flexible yet metallic
  - “Downsizing” may apply
  - Newer disk pack engineering designed last longer
  - Higher ratings than previous designs

Longer Life, Improved Reliability



- **Competitive disc geometry – single scalloped design**
  - Unevenly distributed material along “axis of bolt center”
    - Creates high stress areas in the disc during operation
    - Decreases misalignment capability
    - Decreases torque ratings

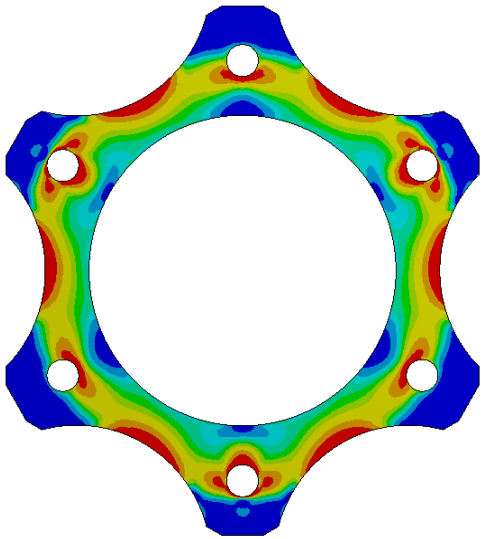
Longer Life, Improved Reliability

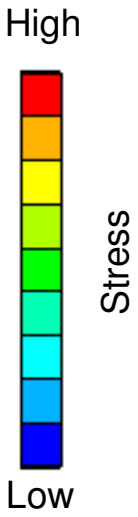


- **New Disc Geometry – dual scalloped design**
  - Evenly distributes material along “axis of bolt center”
    - Minimizes high stress regions
    - Industry leading torque capacity and misalignment capabilities
      - 2 times torque capacity of leading competitor
      - 2-3 times misalignment capabilities of leading competitor

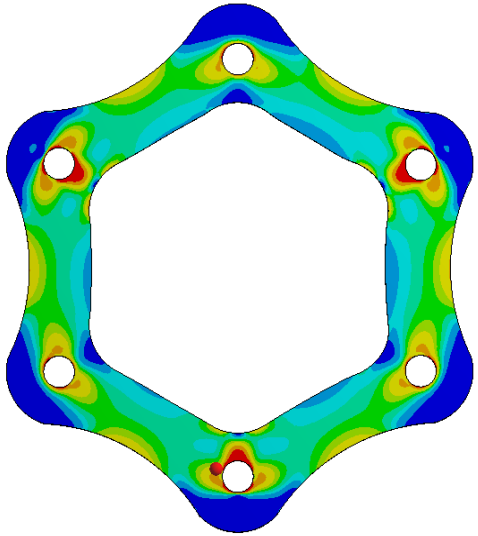
Longer Life, Improved Reliability

Typical Disc Geometry





New Disc Geometry



- **New Disc Coupling geometry results in:**
  - Longer life
  - Improved reliability
- **Detailed disc geometry analysis "white paper" available**

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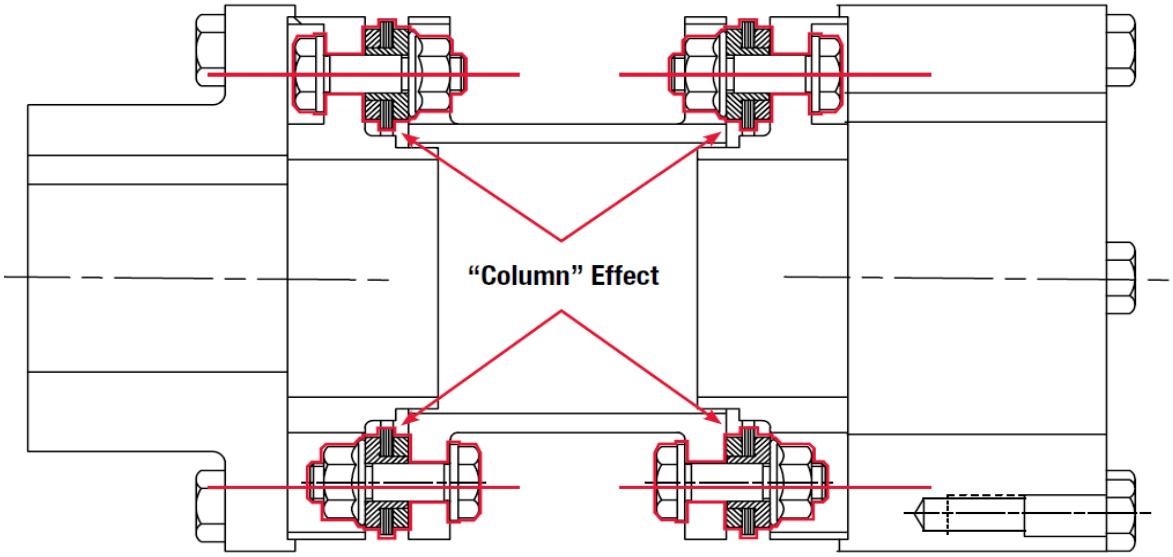
Longer Life, Improved Reliability

- **Factory assembled disc pack**
  - Creates a “column” effect
  - Tight tolerance bushings
  - Correct torque at install
  - Prevents bolt shearing
  - Prevents excessive wear
- **Benefits**
  - Higher torque ratings
  - Higher misalignment
  - Longer life



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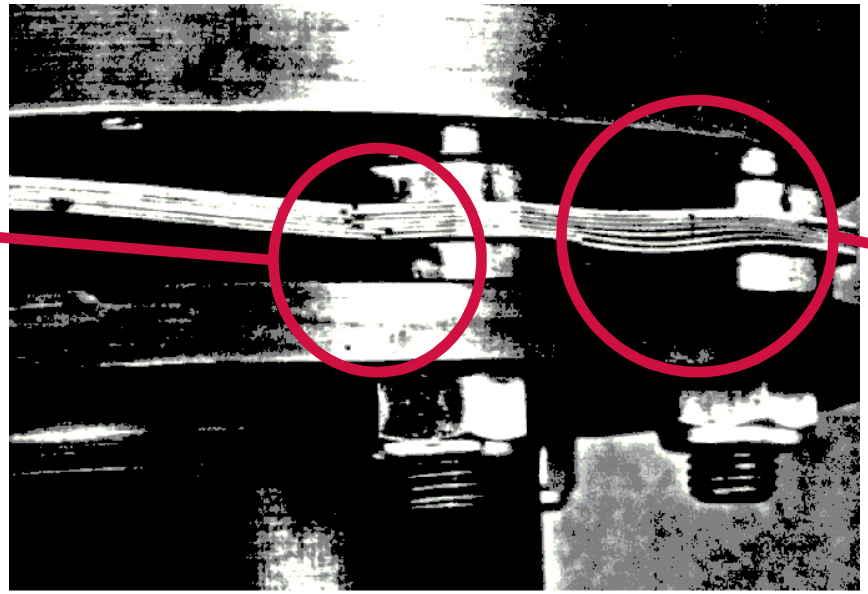
Increased Productivity

- **Inspection without disassembly**
- **Strobe light inspection during operation**

Cracked disc next to the bolt is due to misalignment



"S" condition results from torque overload in the application

Reduced Total Cost

- **Large hubs**
  - Utilize one or two large hubs
  - Situations where bore size dictates the coupling size
  - Potential to downsize 1 or 2 sizes

Impact of Misalignment on Reliability

		New Disc Coupling	Old design-industry typ.
Coupling Size		165	0230
Rated Disc Torque	(in-lbs)	17,700	19,520
Application Torque*	(in-lbs)	7,602	7,602
Reactionary Moment at 1/2 Degree Misalignment	(in-lbs)	97	130
Resultant Radial Load - Motor Bearing	(in-lbs)	2765	3705
Resultant Radial Load - Pump Bearing	(in-lbs)	2959	3965
Dynamic Capacity of Bearing	(lbs)	22,000	22,000
L10 Life of Motor Bearing	(hrs)	4706	1,955

240% increase in motor bearing L10 life

*ECP84407T-4 Baldor Motor
200 HP, 1785 RPM, 2.0 SF

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Thank You!

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