DIFFERENT MILL PUMP APPLICATIONS CALL FOR DIFFERENT TYPES OF FLEXIBLE COUPLINGS

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FLEXIBLE COUPLINGS SATISFY CHEMICAL, PULP, HVAC, AND RAW WATER PUMP APPLICATIONS IN THE PULP AND PAPER INDUSTRY.

A BIG PART OF ANY PULP/PAPER OPERATION IS KEEPING A variety of fluids in motion. For the most part, this is done with end-suction centrifugal pumps coupled to electric motors. But while these pumps share the same basic design, the differences among their applications mean they need different types of couplings.

Taking time to make sure you are using the right type of coupling will reward you by extending the life of bearings, bushings and seals, preventing fretted spline shafts, and minimizing noise and vibration—in sum, making both motor and pump work better and last longer, with lower long-term maintenance costs.

Generally, industrial power transmission calls for flexible rather than rigid couplings in order to forgive minor shaft misalignment. Many flexible coupling designs exist because each design has a unique mix of characteristics that makes it right for some applications but wrong for others. This article will look at flexible coupling variations that satisfy four basic areas of pump application common to pulp and paper fluid movement: chemical, pulp, HVAC, and raw water.

Initially, flexible couplings divide into two primary groups: metallic and elastomeric. Metallic types are all-metal designs that gain their flexibility from movement of loosely fitted parts that roll or slide against each other, or from bending of nonmoving metallic parts. Elastomeric types gain flexibility from using resilient, nonmoving, rubber or plastic elements to transmit torque between usually metallic driving/driven hubs. In most cases, metallic couplings will require periodic lubrication and maintenance of seals, while elastomeric couplings do not.

In metallic couplings, the main causes of premature failure of the torque-transmitting element are metal fatigue and wear of parts that roll or slide against each other, both of which result from flexing caused by excessive shaft misalignment or erratic/pulsating/high-inertia loads. In elastomeric couplings, premature breakdown of the torque-transmitting element most often results from excessive heat—either from ambient temperatures or from hysteresis (internal buildup in the elastomer)—or from deterioration due to contact with certain oils or chemicals.

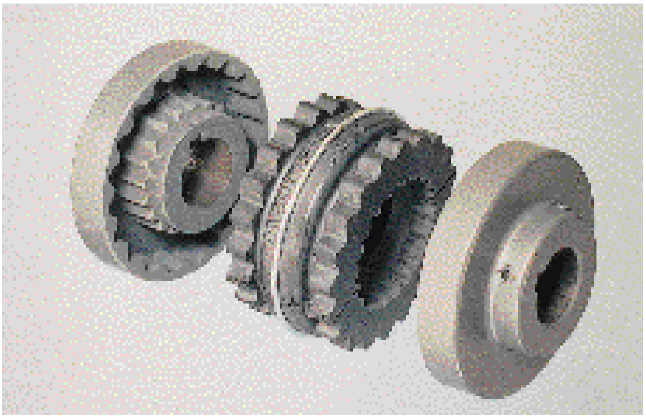
Three of the four main pulp/paper pumping applications generally are candidates for elastomeric couplings, so let us look at that group first.

COMPRESSION VS. SHEAR

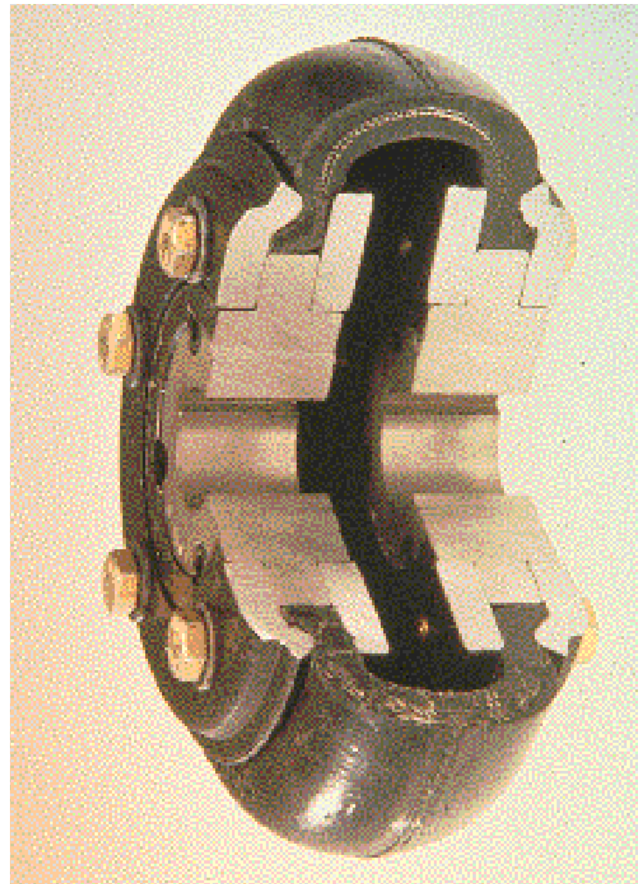
Elastomeric couplings fall into two main categories by the way their elastomeric element transmits torque, i.e., the element is either "in compression" or "in shear."

When the element is in compression, parts of the driving hub *push* parts of the driven hub. The element *separates* driving from driven parts like a cushion, absorbing some of the torque by being compressed between them.

When the element is in shear, the driving hub *pulls* the driven hub through their mutual connection to the



1. Sleeve couplings



2. Tire couplings

element, which absorbs some of the torque force by being stretched through twisting.

Compression-type couplings generally offer two advantages over shear types. First, because elastomers have higher load capacity in compression than in shear, compression types can transmit higher torque and tolerate greater overload. Second, they offer a greater degree of torsional stiffness, with some designs approaching the positive-displacement stiffness of metallic couplings (i.e., incremental movement of driving shaft produces equal incremental movement of driven shaft).

Shear-type couplings, in turn, offer two general advantages over compression types. First, they accommodate more parallel and angular offset while inducing less reactionary (side) load on bearings. Second, they offer a greater degree of torsional softness, which in some cases provides greater protection against the destructive effects of torsional vibration. Both types have application in pulp and paper mill pumping.

CHEMICAL PUMPS

Designed and built to handle relatively caustic liquids, such as bleaches, washdown chemicals and alum solutions, chemical pumps usually represent relatively expensive types for which *sleeve couplings* (**Fig. 1**) usually are specified. As an example of the element-in-shear category, sleeve couplings are characterized by a tubular elastomeric element molded with serrated flanges at both ends. These flanges mate with serrated sockets molded into the coupling's hubs.

The elastomeric sleeve allows angular misalignment up to 1° and parallel offset up to approximately 0.032 in.

Torsionally soft enough to allow as much as 15° of twist between hubs, sleeve types can absorb moderate torsional vibration. More importantly here, they offer the capability to serve as a "fuse" that protects the system from costly damage under severe shock or overload. Excessive torque on the flanges—from improper startup procedures, for example—simply causes the elastomer to "pop out" or tear, disconnecting the driving and driven hubs.

Sleeves of synthetic rubber (EPDM) are most commonly used for best combination of chemical and temperature resistance for standard service; if higher oil resistance or wider temperature range is needed, sleeves of neoprene or Hytrel® are available.

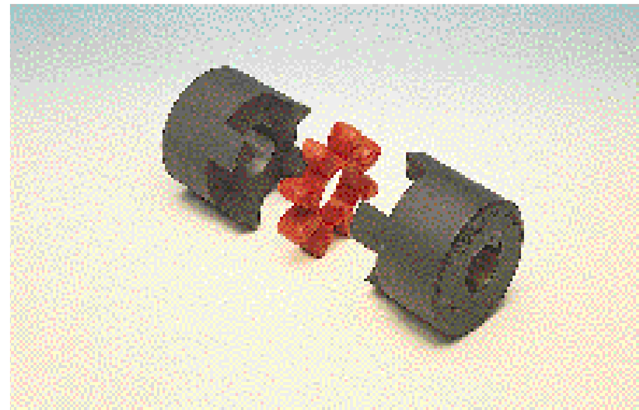
Due to the open-center or hollow configuration of the element, sleeve type couplings easily accommodate installations with very little clearance between shaft ends. For such applications, split sleeves are available for wrap-around installation. Where shaft spacing permits, special hub flanges are available that allow quick "drop-out" replacement without demounting the motor or pump.

PULP PUMPS

Cyclic shock loads characterize pulp pumping service because the material typically has a heavy slurry consistency. This makes a different element-in-shear design, the *tire coupling* (**Fig. 2**), more appropriate here.

Named for its resemblance to an auto tire, this design consists of two flanged hubs equipped with clamping plates, which grip the coupling's hollow, ring-shaped ele-

3. Jaw couplings



4.Curved jaw couplings

ment by its inner rims.Furthering the similarity, tire coupling elements usually are rubber derivative elastomers with layers of cord,such as nylon,vulcanized into the tire shape. The tires are split across at one point, enabling assembly to the plates without disturbing the mounting.

Design variations are available,including an inverted tire coupling in which the tire element arcs inward toward the axis,designed for higher rpm service.A third design employs a urethane elastomer bonded to steel sleeves,which are attached to the hubs with radially positioned cap screws.

Tire couplings can damp vibration but are torsionally stiffer than the sleeve coupling. High radial softness accommodates angular misalignment up to 4° and parallel offset up to 1/8 in.Rare among elastomeric couplings is its capability to allow higher amounts of axial (in-out) shaft movement.

HVAC PUMPS

Moving hot or cold water, and characterized by continuous service under steady load and low horsepower, HVAC pumps generally call for *jaw couplings* (**Fig. 3**).

As an example of the element-in-compression type, this design is distinguished by 2–7 axially oriented jaws (thick,stubby protrusions) arranged around the circumference of each hub. Jaws of driving and driven hubs mesh loosely; filling the gaps between them are cushions of elastomeric material, usually molded into a single asterisk-shaped element called a "spider."

One of the jaw coupling's main advantages for continuous-duty service like HVAC is its "failsafe" design. Because driving and driven jaws move in the same plane, if the spider breaks away, the driving jaws automatically advance to contact the driven jaws directly, maintaining operation until the spider can be replaced.

Permanent compressive set is normal as the element ages in service.This is a helpful feature for jaw couplings; when permanent set reduces the element's original thickness by 25%,it provides a visual signal that the element should be replaced. In most applications, where compression is applied to only the spider cushions forward of the driving jaws, spider life can be doubled by advancing the unused trailing cushions into the driving position.

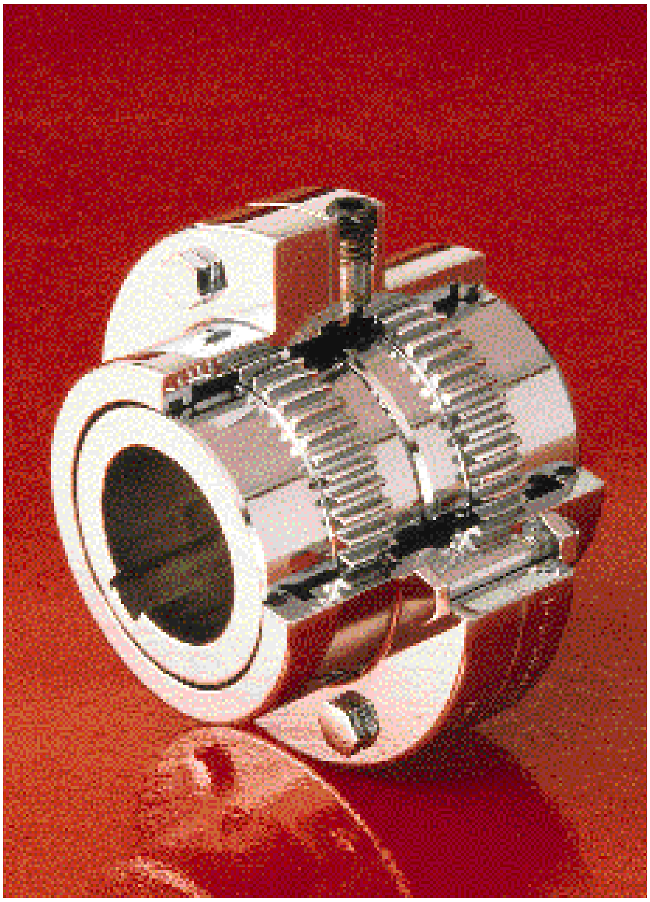
Most jaw coupling designs typically are limited to angular shaft misalignment of 1° and tolerate very little parallel offset. One variation, known as the *curved jaw coupling* (**Fig. 4**), features spiders designed with both radial and axial curvature (crowning), which increases angular movement capability to 1.5° and adds torsional softness.

Spiders are available in several different materials to suit different applications,but those made of nitrile butadiene rubber (NBR)—sometimes called Buna N—are the most economical and widely used standard.

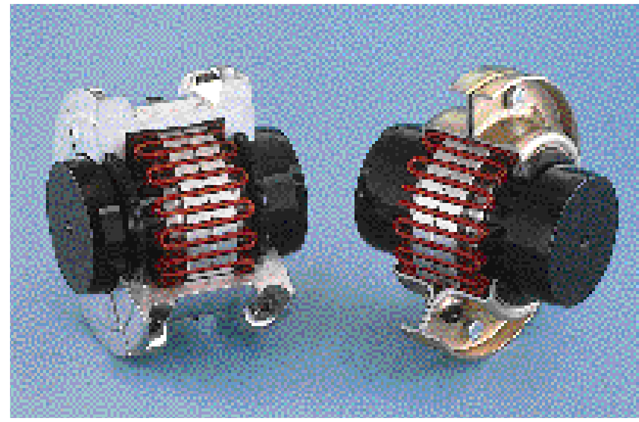
RAW WATER PUMPS

Due to the high volumes involved in moving raw water, the need for larger pumps and high horsepower motors usually calls for metallic couplings of the gear or grid type, in which torque is transmitted across separate metal elements that push against each other. As the most economical alternatives per horsepower of capacity, these designs offer high torque-to-outside-diameter ratios. They accommodate angular misalignment up to 1°, but allow little parallel misalignment, and have relatively high torsional stiffness.

Gear couplings (**Fig. 5**) consist of two shaft-mounted hubs with gear teeth around their external circumferences. Both hubs are enclosed within a common connecting sleeve that has gear teeth around its internal circumference,which mate with the hubs'teeth.Some gear designs have crowned (slightly rounded) teeth that permit greater angular misalignment capability;some have a variable crown that reduces tooth stress and maintains torque-handling capability as misalignment increases. Continuous teeth along the length of the sleeve allow generous tolerance for axial (in/out) shaft movement.In



5. Gear couplings



6. Grid couplings

lower torque ranges, nylon sleeves can eliminate the need for lubrication and provide quieter operation; higher torque and/or rpm ranges can be achieved with special models having heat-treated teeth.

Grid couplings (**Fig. 6**) are the only metallic type to offer moderate torsional shock/vibration damping capacity. This design employs a spring steel grid preformed to snake back-and-forth between two shaft-mounted hubs, nesting in slots formed around the external circumference of each hub. The beam effect of this grid as it spans the gap between the two hubs gives this design its resilience. The grid also permits minor axial shaft movement, but movement that significantly shortens the gap between hubs and reduces grid resilience. A common sleeve encloses both hubs and grids.

CONFIRMING SELECTION

In many cases, the type of coupling currently in place is there because that is what has always been there, but that doesn't necessarily mean it is what ought to be there. Reviewing the application to confirm the right type of flexible coupling requires profiling the following factors:

- Real horsepower and/or torque requirements of the *driven* side of the system, rather than the rated horsepower of the motor (note the range of variable torque resulting from cyclical or erratic loading, "worst-case" startup loading, and the amount of any start-stop activity common during normal operation).
- Driven-system inertia values in relation to prime-mover inertia (equipment vendors can supply inertia data).
- Vibration, both linear and torsional (experienced vendors or consultants can help you evaluate vibration).
- Shaft-to-shaft misalignment — note degree of angular offset (where shafts are not parallel) and amount of parallel offset (distance between shaft axis centers if shafts are parallel but not axially aligned); also note whether driving/driven units are or could be sharing the same base-plate.
- Axial (in/out) shaft movement, BE distance (Between Ends of driving and driven shafts), and any other space-related limitations.
- Ambient conditions (mainly temperature range and chemical/oil exposure).

With this information, experienced coupling vendors can guide you to the type of flexible coupling that best suits your application. **TJ**

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