Understanding Drive Couplings

Most process machinery trains have power transmission couplings. They are used to connect two shafts that turn in the same direction on the same center line. Three different types of couplings can be identified: rigid, flexible and special purpose.

Rigid couplings are used in applications where misalignment is not a factor, where flexibility is not required and where the coupling does not have to absorb shock loads or torque changes.

Rigid couplings connect shafts using bolted flanges, keyed sleeves or ribbed clamps assembled to the shaft ends with keyways. They are primarily used for vertical drive systems such as vertical pumps. Lubrication is not required, however, larger rigid couplings, or those running at high speeds, may require balancing to reduce vibration.

Flexible couplings also connect two rotating shafts. They are designed to dampen vibration, to absorb shock loading and to accommodate axial movement or end float of the shafts, as well as compensate for minor misalignment.

There are three categories of flexible couplings: "mechanically flexible", such as gear and chain couplings, "material flexible", such as disc, spring, diaphragm, elastomeric and bellows, and "combination", such as metallic grid couplings which combine mechanical with material flexibility.

Special-purpose couplings include such devices as mechanically flexible U-joints and constant velocity joints used for automobile applications, magnetic couplings, such as magnet-to-magnet, eddy current couplings, and fluid couplings such as liquid, silicone and shot-filled types. Magnetic and fluid couplings provide no contact between the driver and driven elements. They usually have low maintenance and are capable of absorbing shock loads.

Today, more than 80 styles of flexible couplings are used in approximately 90% of all industrial applications. The most common ones are briefly described in the following paragraphs:

1. Mechanically flexible couplings such as gear and chain couplings, provide a flexible connection by allowing coupling components to move or slide over each other.

Some minor misalignment is accommodated by the clearance between gear teeth or chain and sprocket teeth as the case may be, however shafts should he still aligned as carefully as possible in order to ensure long coupling life.

These coupling types require periodic lubrication using special coupling greases or EP[1] non-channeling greases. The most common form of mechanically flexible couplings, the gear coupling shown in Figure 1, even when using a continuously oil lubricated design, has been largely abandoned by the Hydrocarbon Processing Industries (HCPI) wherever feasible due to their unacceptable maintenance load. Approximately 75% of gear or chain coupling failures are caused by misalignment and improper or insufficient lubrication during long operating periods without maintenance shut-downs common in these industries.

2. Material flexible couplings, as the name suggests, provide flexibility by incorporating elements that bend and flex. The flexing materials providing the connection between the driver and the driven component include laminated discs, bellows, diaphragms and elastomeric materials that may include rubber or

[1] Extreme Pressure

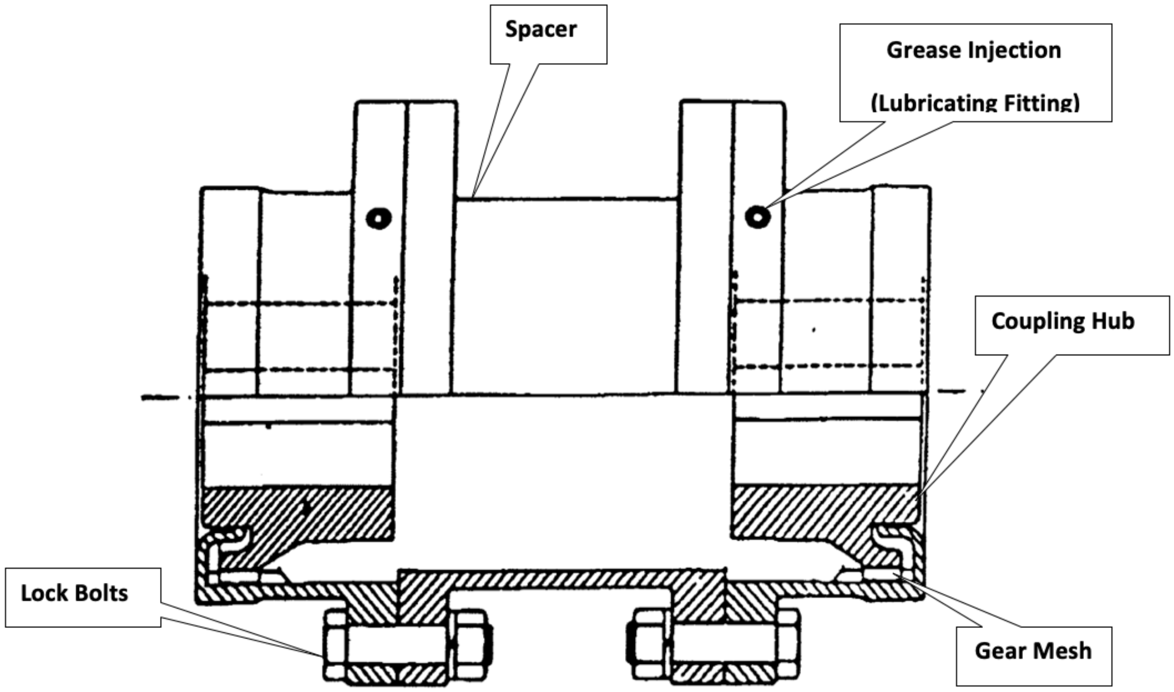

Figure 1. Gear coupling**.**

plastics, such as neoprene and urethane.

Generally speaking, these coupling types require little maintenance other than alignment checks. Their service life is limited by the fatigue limit of the flexing material itself - see Figures 2 and 3.

3. Combination mechanical/material flexible couplings include grid couplings that are compact units capable of transmitting high torques at speeds of up to 6,000 rpm. The construction of this type of coupling coupling consists of two flanged hubs, each with specially designed grooved slots cut axially on the outer edges of the flanges. The flanges are connected by using a serpentine spring grid that fits the grooved slots. The flexibility of this grid provides torsional resilience, can provide periodic lubrication using good quality coupling grease in the areas of the grooved slots and serpentine spring.

While this coupling is still very popular in other industries, North American HCPI have all but discontinued the use of these couplings, again, due to their high maintenance intensity.

Why couplings still fail. Couplings fail for several reasons. The primary causes are improper selection for the particular application, excessive misalignment, harsh environmental or operating conditions

Figure 2. Disk pack coupling (Thomas).

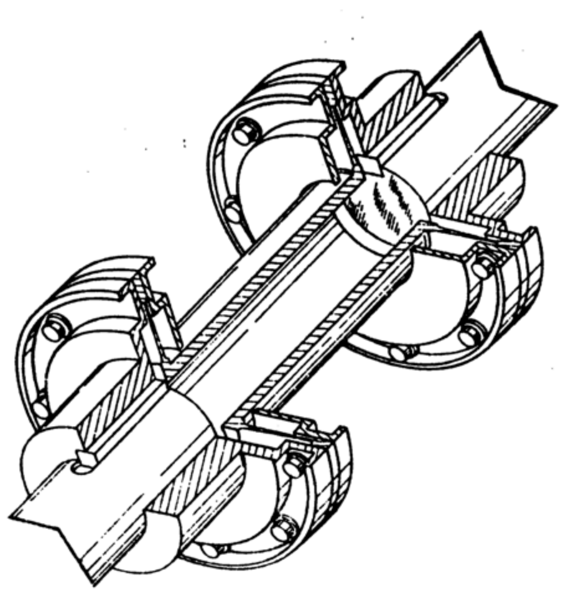

Figure 3. Diaphragm coupling (Bendix).

and excessive speeds or loads. With lubricated couplings, there is the additional cause of improper, inadequate or insufficient lubrication, often brought on by neglect.

Application issues: Table 1 compares the salient features of three coupling types most often applied in the HCPI.

	Disk Pack	Diaphragm	Gear
Speed Capability	High	High	High
Power to Weight Ratio	Medium	Medium	High
Lubrication Needed	No	No	Yes
Misalignment Capability	Medium	High	Medium
Inherent Balance	Good	Very Good	Good
Overall Diameter	Low	High	Low
Failure Mode	Sudden	Sudden	Progressive
Overhung Moment	Medium	Medium	Very Low
Pulse Generation - Misaligned	Medium	Low	Medium
Capacity for Axial Movement	Low	Medium	High
Resistance to Sudden Axial Movement	High	Medium	High

Table 1. Comparing couplings used in the HCPI.

Alignment issues: There is a perception that flexible couplings can accommodate a large parallel offset and/or angular shaft misalignment. This is incorrect. Depending upon the coupling type, flexible couplings can only accommodate from 1/4 degree to about 2-1/2 degrees of misalignment. High-speed, high-load applications require much closer tolerances. In an earlier column we dealt with coupling alignment tolerances and issues in detail[2]

Indications of misalignment include the following:

- Noise at the coupling
- Disintegrated rubber particles, slivers from laminations or lubricant near or directly below the coupling guard, depending upon coupling type
- Process fluid and/or oil leakage from driven or drive shaft – or both shafts

[2] See PL&G Technology June 2004

- Premature shaft, shaft key or component failures
- Premature or frequent bearing failures – one or both machines
- "Soft foot" condition at footing of one or both machines
- High operating temperatures at or near the coupling
- Broken or constant loosening (vibration loosening) of bolts on one or both machines
- High vibration conditions, usually at both machines
- Cracked or broken foundation, particularly at or near the foundation bolts
- Continuing or intermittent leaks at pipe joints caused by pipe strain
- High energy consumption
- No compensation for vertical, horizontal and or axial thermal growth at either the driven machine or the driver during initial alignment procedure
- Settling of the machine or its foundation after installation

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References:

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