Baldor•Dodge Elastomeric Couplings: Elastomeric Coupling Basics

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When selecting an elastomeric coupling for an application, the designer must consider the following information to choose a coupling capable of providing adequate torque and long life.

1. Type of driver and driven equipment.
2. Horsepower (nominal and max. HP) and coupling speed (nominal, min., and max. RPM).
3. Frequency of starts, shock loads, reversing loads, overloads.
4. Constant or variable torque application.
5. Peak torques.
6. Ambient conditions (operating temperatures, corrosive or non-corrosive environments).
7. Expected operational misalignments.
8. Special requirements for application.
9. Shaft diameters and keyseats of driver and driven shafts.
10. Shaft attachment (tapered bushings, clearance fits, interference fits, and tapered fits).
11. Torsional vibration considerations.
12. Appropriate service factor for application.

There are generally two primary methods of selecting couplings. The HP/100 RPM method is probably the most popular selection method. Coupling manufacturers publish HP/100 RPM ratings to help designers select an appropriate coupling for an application. The HP/100 RPM rating is a measure of a coupling's horsepower capacity for every 100 revolutions per minute. Simply divide the coupling's HP/100 RPM rating by 100 and multiply the result by the coupling's operating RPM to determine the coupling's horsepower capacity. The following equation can be used to select a coupling based on its HP/100 RPM rating.

HP/100 RPM = (HP) x 100 x S.F. / (RPM) (Formula #1)

Where,

HP = Motor Horsepower

S.F. = Service Factor

RPM = Coupling Speed

Many technical individuals such as engineers and designers prefer the torque method since power transmission system designs are based on torque, speed, and horsepower. Coupling manufacturers generally publish torque ratings in addition to HP/100 RPM ratings. The torque rating is a measure of a coupling's ability to transfer torque from the drive shaft to the driven shaft. The following equation can be used to select a coupling based on its torque rating.

T = (HP) x 63025 x S.F. / (RPM) (Formula #2)

Where,

T = Torque (in-lbs)

HP = Motor Horsepower

S.F. = Service Factor

RPM = Coupling Speed

Elastomeric couplings consist of rubber or plastic elements to connect two shafts, transmit torque, and accommodate misalignment. Except for periodic inspections of the element, elastomeric couplings are generally maintenance free since they require no lubrication. This benefit allows them to be used for hidden or out of the way applications where periodic lubrication would be difficult to manage or neglected. The savings from reduced maintenance can equate to lower operating costs. Coupling failures caused by inadequate or improper lubrication can result in costly downtime. Elastomeric couplings virtually eliminate the possibility of lubrication failures that tend to be unpredictable and catastrophic.

Most elastomeric compounds used in coupling elements can be sensitive to various chemicals and hostile environments. Each compound reacts negatively or positively when exposed to various chemicals, but the designer can avoid problems by selecting an elastomeric element that is inert to the surroundings where it will be applied.

Elastomeric couplings have the ability to cushion shock loads and dampen vibration due to the resilient nature of the elastomeric compounds. Most elastomers can absorb small quantities of energy during each torque pulse. The elastomer then releases this energy as heat. This phenomenon is known as hysteresis. This feature makes them suitable for applications where high torsional shock loads are frequent such as steel mill tables and primary crushers. The designer may need to perform a torsional analysis on a system to determine the dampening effects of elastomeric couplings on applications involving vibratory torques, such as reciprocating pumps, reciprocating compressors, and hammer mills. Before beginning a torsional analysis of a system, the designer must be familiar with the following terms.

Baldor•Dodge publishes torsional stiffness data for all elastomeric couplings to help the customer assess the danger of over service-factoring or selecting a coupling that is too stiff for the application. Each time the coupling size increases the torsional stiffness essentially doubles. If the customer needs a torsionally soft coupling but chooses a service factor greater than recommended for an application, the customer may be choosing a coupling that is too stiff for the application. A coupling's stiffness can be used to determine the torsional displacement or wind-up.

Coupling wind-up is the amount of rotation in degrees that occurs when torque is applied to the coupling. The amount of wind-up depends on the coupling's torsional stiffness and the magnitude of the applied torque. The following equation can be used to determine wind-up.

Wind-up (Degrees) = Torque (Lbs.-In) / Torsional Stiffness (Lbs.-In/Degrees) (Formula #3)

Couplings can generally be classified as either torsionally rigid or torsionally soft. Torsionally rigid couplings generally consist of a metallic flex element to transmit torque and accommodate misalignment. They are usually power dense couplings, which refers to a coupling's ability to transmit large torques in a relatively small package. Disc and Gear style couplings represent examples of torsionally rigid couplings.

Torsionally soft couplings generally consist of an elastomeric element to transmit torque and accommodate misalignment. Torsionally soft couplings have a major advantage over torsionally rigid couplings since they can reduce or isolate torque pulses that often arise in mechanical power transmission systems. The coupling reduces the torque pulse by winding-up and storing the torque pulse energy within the coupling element. The coupling element then releases the energy to the system over a longer period of time at a lower magnitude than torsionally rigid couplings. The customer can have smoother running, longer lasting drive components and equipment when torque pulses are reduced.

Creep is the progressive wind-up in elastomeric couplings when the element is exposed to high temperatures and high wind-up angles for extensive periods of time. The Baldor•Dodge PARA-FLEX couplings are constructed with reinforcing cords that help to minimize their susceptibility to creep. As the coupling is wound, the cords lock up to prevent further undesired wind-up.

Reaction loads in elastomeric couplings depends upon material, stiffness, and internal construction. The Baldor•Dodge PARA-FLEX coupling achieves its torque carrying capabilities by using a relatively soft base elastomer with multiple layers of polyester reinforcement to transmit torque. The polyester cords carry the load and limit the element's wind-up. When the Baldor•Dodge PARA-FLEX element misaligns in the angular, axial, or parallel direction, the tensile cords flex to accommodate the misalignment. The flexing action of the tensile cords produce relatively low misalignment stiffnesses and low reaction loads. Other coupling manufacturers use an unreinforced, high stiffness elastomer to obtain a torsional stiffness comparable to the Baldor•Dodge PARA-FLEX coupling. The high stiffness elastomer produces high misalignment stiffnesses and high bearing reaction loads.

Generally, elastomeric couplings fail due to age distress or overload. Cracks or tears located on the element's surface reveal signs of normal age distress. This feature provides visual warning of impending failure so the customer can plan replacement of the element before it actually fails. Shock load or overload failures will show a different crack or tear pattern. The cracks or tears will appear as jagged separations of the rubber. The cracks in a Baldor•Dodge PARA-FLEX coupling will generally be 45° relative to the shaft centerline since the layers of polyester are positioned approximately 45° relative to the shaft centerline. Couplings that fail in this manner may have been undersized, or, if properly sized, probably protected the balance of the drive from a jam load or torsional overload.

Figure #1: Torsional Overload Failures

Elastomeric couplings with reinforcement cording, such as the Baldor•Dodge PARA-FLEX, can absorb substantial amounts of torsional shock. At times, the amplitude and/or frequency of the torsional shocks are more than the coupling element can absorb. Element failure results from heat generated in the rubber due to extreme rapid flexing of the rubber. For extreme cases, torsional failures have easily recognizable signs. The rubber will have melted and become shiny black and sticky. If the coupling has reinforcement, the cord ends will be exposed and extremely fuzzy. Less severe cases are difficult to identify and can easily be mistaken for overload or age distress.