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Technical Article

For the Toughest Challenges:
The Great Durability and Low Maintenance Costs of Elastomeric Couplings

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The Great Durability and Low Maintenance Costs of Elastomeric Couplings

Abstract

Under harsh environmental conditions, couplings are exposed to extreme stresses. Conventional products soon reach their limits, causing high maintenance and repair costs. Elastomeric couplings now offer an interesting alternative in many cases. The following report describes the advantages of this type of coupling compared to standard couplings, the carbon-steel gear coupling in particular, and presents the Timken® Quick-Flex® coupling.

Elastomers have long been used as a material for a wide variety of industrial products that need to be both robust and deformable and then resume their original shape later. One of these products is the elastomeric coupling which is particulary suitable for applications prone to especially large numbers of vibrations and shock loads. However, these couplings are not as prevalent yet as one might assume, given their many advantages under the most demanding conditions. These advantages are clearly seen in comparison with what has long been the industry standard, the conventional carbon-steel gear coupling.

Gear Coupling

This grease-lubricated coupling is a proven solution for transmitting forces between two shafts. When deciding whether it is the right solution for a special application, the following points should be considered.

Wear

Sooner or later, many teeth of a gear coupling wear out over time depending on the operating conditions as well as the misalignment or shock load. The metal-to-metal contact of the surfaces also transmits shocks and vibrations over the shaft which can lead to malfunctions in other parts of the system. To assess the remaining lifespan of a gear coupling it has to be disassembled – a very costly and time-consuming procedure with negative effects on production.

Lubrication

A gear coupling must be lubricated to handle misalignments. If it is not adequately lubricated, it will fail prematurely. The regular servicing and grease lead to costs as well as the interruption of operations necessary for the maintenance. Add to this the costs of disposing the old grease – which are five times the purchase cost of the grease.

Replacement

If individual teeth of a gear coupling become worn, they cannot be exchanged. Instead the entire coupling has to be replaced. The replacement is extremely time-consuming and complex, for, in order to access the coupling hubs, all of the related parts such as the motor and/or the gears must be disassembled and stored separately so there is sufficient space to disassemble the hubs. After mounting the new coupling, all of the other components must be reassembled and carefully adjusted as well. The entire process can last eight to ten hours.

Elastomeric Coupling

The following considerations basically apply to all elastomeric couplings, but refer here to the Timken Quick-Flex Couplings. To meet the requirements of specific applications, they are available in different configurations that can be quickly dismounted for maintenance purposes. There are even different configurations of the polyurethane inserts – for standard, high temperature, and very high torque applications.

Wear

With elastomeric couplings no metal-to-metal contact occurs between the surfaces during use - the teeth are engaged through the polyurethane inserts (incidentally, the only part of the coupling that wears over time), simultaneously dampening shocks and vibrations. Since there is no form-fit interlocking, the coupling can shear during extreme torques that are above and beyond their load limit, preventing damage to the gear mechanisms.

Lubrication

Elastomeric couplings require no lubrication and therefore are low-maintenance, very environmentally friendly and have no purchasing or follow-up costs for grease.

Replacement

Once installed, the hubs of an elastomeric coupling never have to be replaced since they do not come in contact. That also means that the motor and/or gears and associated parts never need to be moved again after the initial installation. The hubs require disassembling only if the motor or the gearbox needs replacing. The polyurethane insert itself can be exchanged in just a few minutes without removing the hubs. The cover is simply removed, the insert taken off of both hubs and replaced with a new one. The whole process clearly requires a minimum amount of time and costs considerably less than the complete replacement of a gear coupling.

Performance Comparison

If one compares the torque capacities of gear and elastomeric couplings, then striking differences become evident. Based on size and number of teeth, a gear coupling achieves a specific maximum torque rating. On the other hand, a elastomeric coupling of the same size can be designed for various maximum torques by using polymers of different degrees of hardness. That results in great flexibility, since a custom solution is possible for all available coupling sizes. It allows the use of an elastomeric coupling with a small installation clearance since it is designed for the same torques as a gear with a larger clearance. The table compares the maximum torques of common gear couplings up to the largest sizes seen in heavy industry with elastomeric couplings of similar sizes. Contrary to popular belief, the comparison shows that, based on their performance spectrum, elastomeric couplings do not have to be limited to applications in which small coupling sizes are installed. For that reason, this type of coupling is gradually replacing the classical gear coupling, even in applications such as crusher and conveyor drives, hammer mills, separators and other process industry applications.

Gear Coupling	Max. Torque		QF Elastomeric Coupling[1]	Max. Torque		Torque Increase
Size	in. - lb.	kNm	Size	in. - lb.	kNm	QF vs. Gear Coupling (%)
1	9,360	1,058	QF25	12,449	1,407	33
1.5	18,748	2,118	QF50	26,479	2,992	41
2	33,094	3,739	QF100	53,642	6,061	62
2.5	59,270	6,697	QF175	88,257	9,973	49
3	98,152	11,091	QF250	118,930	13,438	21
3.5	153,316	17,324	QF500	219,329	24,794	43
4	246,537	27,857	QF1000	310,466	35,081	26
4.5	337,794	38,169	QF1890	553,982	62,597	64
5	468,322	52,918	QF1890	553,982	62,597	18
5.5	613,125	69,280	QF3150	871,139	98,434	42
6	770,471	87,059	QF3150	871,139	98,434	13
7	1,183,950	133,780	QF10260	1,670,826	188,710	41

Table 1:
Comparison of the maximum torques of gear couplings vs. Timken Quick-Flex (QF) elastomeric couplings.
[1] The data refers to Timken Quick-Flex couplings with a black insert for high torques and a split cover.

Figure 1:
A gear coupling with broken teeth

Figure 2:
The Timken Quick-Flex elastomeric coupling is easy to install and requires no lubrication. With its long service life, it contributes to keeping the overall operating costs low.

Case Study

As indicated in Table 1 on page 4, elastomeric couplings can be used in a variety of industrial applications. One application that comes less readily to mind is the hub drive of an electrically powered excavator shovel frequently found in the coal mining industry. A conventional gear coupling is used for the direct-drive shaft between the electrical high-performance motors and the hoist gearbox that controls the boom raising and lowering the bucket (this achieves a peak performance of about 3000 kW). Because of the high torque, a conventional gear coupling is generally used. This was also the case in the field test in an open pit coal mine described below. The problem: the extreme operating conditions required repeated inspections of the gear coupling. The condition of the teeth, which were often damaged or broken, needed to be checked (Figure 1); the coupling had to be relubricated or replaced completely if it broke down because of a misalignment with the electrically operated excavator shovel. The constant maintenance resulted in frequent downtimes and thus in less than the projected production output.

Solution

To check to see if another type of coupling was better suited to the demanding application, the open pit operator decided on a test run with an elastomeric coupling. Despite a certain skepticism that this coupling would actually produce the same or a better performance than a gear coupling, it was decided to test an aligned Timken Quick-Flex Coupling at the required torque. The initial installation of the coupling, with a Timken engineer lending on-site support went quickly without any trouble as did the start-up and a test run yielding a positive outlook.

Figure 3:
Depending on the application demands, the Quick-Flex elastomeric coupling is available in various covers and polyurethane inserts.

Figure 4:
The polyurethane insert can easily be exchanged without disassembling the hubs.

Results

The elastomeric coupling was installed in March 2012 and is still operating. This is even more impressive since the shovel gearbox failed in September 2012 – coupling hubs and insert were not damaged – and the coupling continues to be fully operational. The manager in charge of the maintenance is convinced that, if this had happened with a gear coupling, the site would have had to replace the entire unit. Since the test run has been a success to date and exceeded all of the operator's expectations, now all of the gear couplings installed in the other shovel excavators are gradually being replaced with Timken Quick-Flex couplings.