

Ensuring Safety in Heavy-Duty Hoists: The Critical Role of Drum Couplings

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Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

Suspended loads remain one of the most significant sources of accidents and fatalities in the steel industry. The risks associated with the failure of lifting equipment, such as hoists used to carry ladles of molten metal, cannot be overstated. According to industry reports — like the World Steel Association’s annual Safety and Health in the Steel Industry report, for instance — incidents involving suspended loads account for a considerable proportion of injuries and deaths in steel mills and associated industrial environments. Ensuring the reliability and safety of hoisting systems is therefore paramount, and drum couplings play a crucial role in this regard.

This article will explore the importance of drum couplings as a safety feature, the superiority of roller-barrel couplings over traditional gear couplings, and the development of these essential components since their invention. Additionally, it discusses the challenges associated with inspecting drum couplings, especially in high-temperature environments, and that there is a new option for continuous condition monitoring.

The Importance of Drum Couplings in Hoists

In heavy-duty hoists, drum couplings are integral to the safe operation of the hoisting mechanism. These couplings transfer torque from the hoist motor to the drum that winds

the wire rope, responsible for lifting and lowering substantial loads such as molten metal ladles. Given the nature of the loads and the critical environments in which these hoists operate, any malfunction in the drum coupling can lead to catastrophic consequences, including the uncontrolled release of the load. This poses a severe risk to both personnel and equipment.

Drum couplings ensure the integrity of the hoisting system by accommodating misalignments between the motor and drum while reliably transmitting the required torque. The safety relevance of these couplings lies in their ability to withstand immense stresses and strains, which are common in heavy-duty hoisting applications. A failure in the drum coupling could lead to load drops, which are particularly dangerous in steel mills where molten metal is handled.

Roller-Barrel Couplings vs. Gear Couplings

Historically, gear couplings were the standard for hoisting applications. However, with the development of roller-barrel couplings, a purpose-built alternative emerged that better addresses the unique demands of hoisting heavy loads in industrial settings. The following points outline the key advantages of roller-barrel couplings over traditional gear couplings.

Comments are welcome.

If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org.

Please include your full name, company name, mailing address and email in all correspondence.

Radial Load Accommodation and Load Distribution

Roller-barrel couplings are specifically designed to accommodate radial loads, which occur when the rope pulls on the rope drum during hoisting. Unlike gear couplings, which are not engineered to handle significant radial loads, roller-barrel couplings distribute these forces more evenly across the coupling components. The barrel-shaped rollers in these couplings ensure that the load is spread out, reducing the concentration of stress on any single point.

In gear couplings, stress tends to concentrate at single contact points on the tooth flanks, particularly once the hardened surface layers are worn off. As the original geometry of the tooth flanks becomes washed out, wear accelerates rapidly, leading to potential failures. The uneven load distribution and stress concentration result in rapid wear and make gear couplings less suitable for heavy-duty hoisting applications. In contrast, the even load distribution in roller-barrel couplings extends their service life and enhances reliability, making them a safer choice for critical hoisting tasks.

Wear Behavior and Resistance

Wear resistance is a critical factor in the performance of couplings used in heavy-duty applications. Roller-barrel couplings are designed with a larger wear allowance — up to 8 mm — compared to the 4 mm allowance typically found in gear couplings; however, the advantage of roller-barrel couplings goes beyond just the wear allowance; it extends to the wear behavior itself.

In roller-barrel couplings, wear occurs in a linear fashion which makes it highly predictable. This predictability allows for precise maintenance planning, ensuring that interventions can be scheduled before wear reaches a critical point. Maintenance becomes a routine and planned activity, minimizing the risk of unexpected failures.

On the other hand, gear couplings exhibit a different wear pattern. Wear starts off slowly in gear couplings but increases exponentially over time as the coupling components degrade. This nonlinear wear behavior makes it challenging to predict when maintenance is needed, leading to a higher risk of unplanned downtime or worse, failures that could result in accidents.

Angular Misalignment Tolerance

Roller-barrel couplings offer superior angular misalignment tolerance compared to gear couplings. While typical gear couplings can handle angular misalignments of around $\pm 0.5^\circ$, the requirements of most heavy-duty applications call for a tolerance of up to $\pm 1.5^\circ$. Roller-barrel couplings, however, can accommodate up to $\pm 2.0^\circ$ of misalignment without inducing significant stress on the coupling components.

Figure 1

Critical hot metal cranes demand a drum coupling to ensure safety. By utilizing hardened barrel rollers to ensure reliable, positive-lock force transmission. Their rugged design, complete with sealed housing and high-strength bolts, protects against particle ingress, provides secure fastening, and enables efficient torque transfer to the rope drum. External monitoring of wear and axial position is possible, eliminating the need for disassembly.



This higher tolerance reduces the likelihood of failure due to misalignment, which is a common issue in heavy-duty hoisting applications where maintaining precise alignment is challenging. The ability to accommodate greater misalignment further contributes to the safety and longevity of roller-barrel couplings.

Development and Evolution of Drum Couplings

Drum couplings have undergone significant evolution since their initial development. Gear couplings were once the industry standard, valued for their ability to handle large torques. However, the limitations of gear couplings in terms of misalignment tolerance, radial load accommodation, and wear resistance led to the development of roller-barrel couplings in the 1960s, when an accident on a ladle crane led to the development of barrel-roller drum couplings.

The drum coupling designs have addressed the shortcomings of traditional gear couplings, providing

Figure 2

Drum couplings use hardened barrel rollers to transmit force through positive locking. The robust design, including sealed housing and high-strength bolts, ensures protection against particle ingress, secure fastening, and efficient torque transmission to the rope drum. Wear and axial position can be monitored externally without dismantling the coupling.



Figure 3

Barrel-type drum couplings, designed to handle the immense radial forces involved in lifting heavy loads, excel where other couplings risk catastrophic failure. These couplings use hardened barrel rollers to transmit force through positive locking. Their robust design — including sealed housing and high-strength bolts — ensures protection against particle ingress, secure fastening, and efficient torque transmission to the rope drum. Additionally, wear and axial position can be monitored externally without the need to dismantle the coupling.



a more robust and reliable solution for heavy-duty hoisting applications. Over the decades, these couplings have been refined with advanced materials, precision manufacturing techniques, and innovative features such as wear indicators and electronic wear monitoring systems.

Today, drum couplings represent the state-of-the-art in this application, offering unmatched performance, safety and durability. The ongoing development of these couplings has been driven by the increasing demands of industrial applications, where safety and reliability are paramount.

Inspection Challenges in High-Temperature Environments

Despite their critical role in hoisting systems, drum couplings pose significant challenges in terms of inspection and maintenance. These components are often installed in locations that are difficult to access, such as under the hot roof above the shop floor in steel mills. The extreme temperatures and confined spaces make regular inspections challenging, increasing the risk of undetected wear or damage.

In such harsh environments, drum couplings are exposed to elevated temperatures, dust, and other contaminants that can accelerate wear and tear. Traditional inspection methods require manual access, often necessitating downtime and exposing personnel to hazardous conditions. To mitigate these risks, manufacturers have developed advanced inspection technologies, including visual wear indicators and electronic wear monitoring systems.

Continuous Condition Monitoring

A newer, advanced option for coupling wear monitoring is continuous condition monitoring systems. Continuous condition monitoring systems, like the LifeMonitor system from Malmedie, can enable around-the-clock monitoring of coupling wear and provide precise data on the condition of the coupling. Continuous monitoring systems allow operators to track wear patterns over time, predict maintenance needs and prevent unexpected failures that could result in dangerous situations.

Continuous condition monitoring systems can transmit data through various communication protocols and integrate into existing control systems so data can be viewed remotely, which is particularly beneficial in environments where accessing the coupling is difficult or hazardous, such as under the hot roof of a steel mill. These systems can be used in new installation or be retrofitted to existing couplings, making them an attractive option for facilities looking to enhance their safety and monitoring capabilities without the need for complete system overhauls.

Conclusion

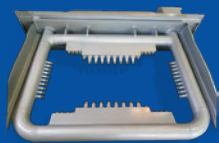
Drum couplings are a critical safety feature in heavy-duty hoists, particularly in applications such as ladle or process cranes where reliability and precision are paramount. The evolution of drum coupling technology, from traditional gear couplings to advanced roller-barrel designs, has significantly improved the safety and performance of hoisting systems. Roller-barrel couplings are purpose-built to accommodate radial loads, offer superior load distribution, and feature highly predictable wear behavior, making them the preferred choice for demanding industrial environments.

However, the challenges associated with inspecting drum couplings, especially in high-temperature environments, cannot be overlooked. Manufacturers have responded to these challenges by developing innovative wear detection technologies, which can offer continuous wear monitoring, remote data accessibility, and retrofitting capabilities. As drum coupling technology continues to evolve, the focus on safety, reliability and ease of maintenance will remain at the forefront, ensuring that these essential components continue to meet the demands of modern industrial applications. ♦

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