

BOLTING SOLUTION DRAMATICALLY REDUCES THE RISK OF HAND INJURIES

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Introduction

Risk of hand injury is very real for operators carrying out conventional bolting operations with power torque tools, reaction arms and backup wrenches. Bolting operations of this type are common today in the installation and maintenance of heavy mining machinery and equipment. Newer solutions have become available that have the potential to dramatically reduce the risk of hand injuries in mining applications.

Mining Applications

Within the scope of mining operations, various types of equipment are used such as tunnel boring machines, bucket wheel excavators, draglines, material handlers, screens, pumps, crushers, continuous miners and longwall systems. Design of these machines typically includes larger diameter bolts for strength and durability. Due to rugged use all machines require frequent maintenance and service which requires the use of heavy industrial bolting tools and methods. Those engaged in bolting operations include technicians working for end-users, equipment manufacturers, general contractors and others who provide services in mining operations. Most all personnel involved with these activities are engaged with use of high power bolting tools and procedures. Training is essential to raise the awareness of bolting safety and to avoid accidents. However improved bolting tools and procedures can play an even more significant role in further improving the safety of all those engaged with bolting in the mining industry.

Safety Concerns

Professionals working in the mining industry are constantly looking for ways to further reduce risk to health and safety. Bolting operations which are fundamental to service and maintenance of mining equipment are often overlooked as a potential area for improvement. Several areas of bolting operations offer potential for improvement in safety and avoiding accidents during equipment maintenance. This paper addresses the safety concerns associated with reaction arms and backup wrenches in conventional bolting applications (Figure 1).

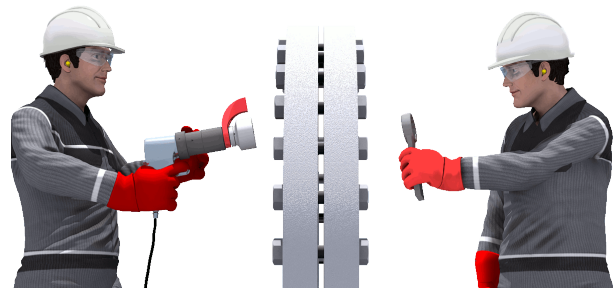


Figure 1 – Conventional Bolting Application

Reaction Arm Pinch Points

In a bolting operation when a power tool is activated a conventional reaction arm creates a very dangerous pinch hazard. These power tools deliver a turning force at a very high energy level with torque often exceeding several hundred or even several thousand foot-pounds. In order to deliver a turning force of this magnitude the reaction forces must brace the tool from turning in the opposite direction.

In conventional bolting applications the reaction forces are braced using external reaction arms that bear against a reaction surface with the full turning force at the specified torque. A particularly insidious aspect of the reaction arm is that it turns slowly. Operators not aware may not even notice it turning. In these applications accidents can and do occur when the operator fails to avoid the pinch point that is created between the reaction arm and the reaction surface (Figure 2).

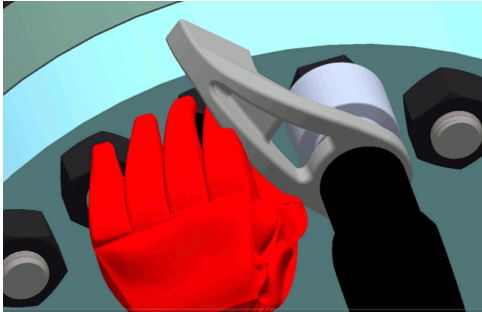


Figure 2 – Reaction Arm Hazard

Backup Wrench Pinch Points

During conventional bolting operations the backup wrench can also create a pinch hazard. The backup wrench must be positioned to brace the back nut from turning. At the start of the bolting operation the backup wrench may move slightly until it is firmly into position. Often the movement is very slight and an unaware operator may not even detect the motion. However this movement creates a very real pinch point between the backup wrench and the bracing surface (Figure 3).

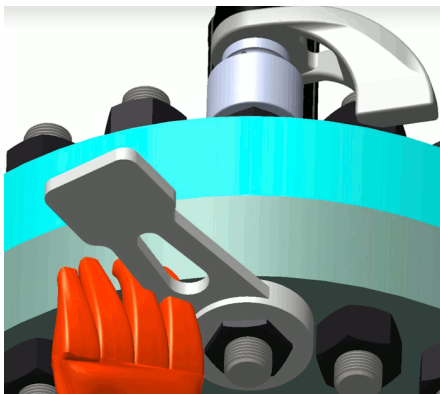


Figure 3 – Backup Wrench Hazard

The turning force in the rear is equal to the force in the front. If the operator fails to keep hands clear of the pinch point between the backup wrench and the bearing surface an injury can occur. An injury occurring on the back side can be just as devastating as one occurring on the front.

Impact

According to the Occupational Safety and Health Administration (OSHA), approximately 27 percent of all workplace injuries occur to the fingers and hands. These figures are even more significant in heavy industry fields where statistics indicate as much as 43 percent of all injuries occur to the hands and fingers of workers. Employees who suffer hand injuries during bolting jobs often do not have a chance to react and protect themselves before the injury occurs. The results can range from broken bones to permanent mutilation, amputation and debilitating injuries.

But the costs of these injuries are not just physical. A single hand injury can cost a business between \$50,000 and \$250,000 in losses, not even taking into account potential liability.

Time is also a factor as injuries can interrupt operations while post injury investigations take place. Often an injury can interrupt work productivity or even shut down the plant.

As such, companies that have employees or contractors that perform heavy bolting work frequently find themselves in a cycle of putting employees at risk while paying out high insurance premiums. But in doing so, they are not addressing the primary issue at hand – hands and fingers are put into harm's way.

Reaction & Backup Washer System

A new washer system has been designed to fundamentally reposition the reaction forces so that they are braced by the washers. This shift of mechanical forces provides many functional advantages while also addressing the fundamental need to improve safety and reduce the risk of hand accidents. The washer solution reduces the risk of hand injuries by completely eliminating pinch points and by shield any moving parts from exposure to the operator's hands.

Reaction Washer

The Reaction Washer is a hardened steel washer providing a smooth side used as a bearing surface for the turning element (nut or bolt head), a knurled side to constrain washer rotation against the structural surface and a reaction surface for constraining the reaction forces of a calibrated torque wrench during tightening (Figure 4).



Figure 4 – Reaction Washer

Reaction Washers are assembled on the turning side of the joint between the structural surface and the turning element. The Reaction Washer knurled side faces the structural surface and the smooth side faces the turning element. In setting up the bolting operation the initial snug-tight step will firmly affix the washer between the turning element and structural surface so that the washer will remain fixed and will not turn (Figure 5).

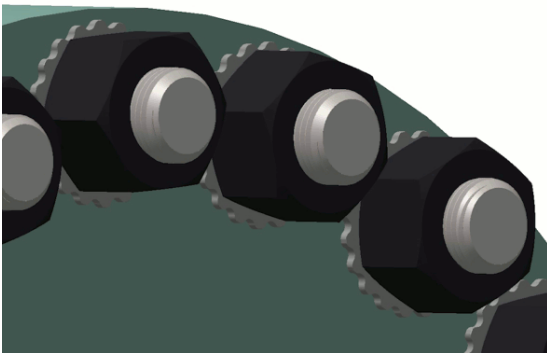


Figure 5 – Reaction Washer Installation

The power torque wrench used with the reaction washer typically has a dual socket driver. This driver consists of an inner socket to rotate the bolt head or nut and an outer socket engaging the reaction surface of the stationary Reaction Washer. During tightening the reaction surface engages with the driver to constrain the reaction turning force of the torque wrench as it fully tightens the bolt. The outer socket is essentially an enclosed shield completely eliminating hand exposure to any turning elements and reaction forces. There is no reaction arm or pinch hazard with this approach (Figure 6 & 7).



Figure 6 – Bolting Tool with Reaction Washer Driver



Figure 7 – Reaction Washer Driver Engagement

Backup Washer

The Backup Washer is a circular hardened steel washer used in bolted joints on the non-turning side of the fastener to prevent turning of the back-nut. The Backup Washer has knurls on both sides of the washer. The Backup Washer is assembled with knurled surfaces facing both the nut and the structural surface (Figure 8). Once the joint is snug-tightened, the Backup Washer is firmly affixed between the back-nut and the structural surface. The Backup Washer knurls prevent the back-nut from turning thus eliminating the need for a backup wrench. By eliminating the backup wrench the bolting operation is significantly simplified resulting in improved workforce efficiency and elimination of a significant safety hazard associated with the backup wrench.

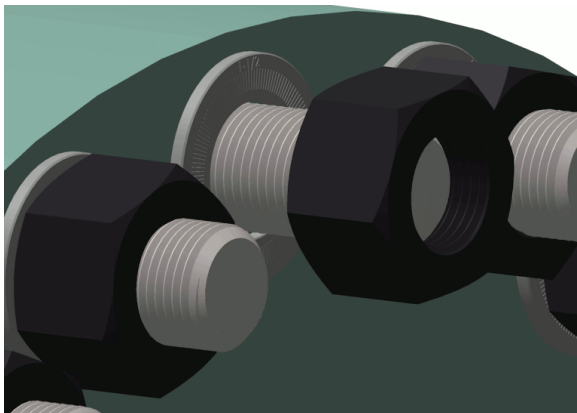


Figure 8 – Backup Washer

Complete Solution

While either washer may be used independently from the other, a complete solution uses both reaction and backup washers to entirely eliminate the need for a reaction arm on a torque wrench, as well as the need for a backup wrench on the application's backside. This solution removes the main hazard of industrial bolting and can essentially eliminate the risk of hand accidents when the technology is used correctly (Figure 9).

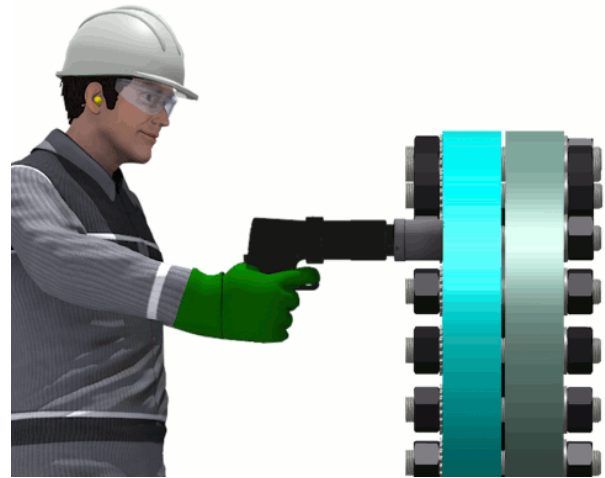


Figure 9 – Complete Solution with Reaction Washer, Backup Washer and No Pinch Points

Conclusion

The innovative washer system provides a much safer environment for workers while offering the potential to dramatically reduce or even eliminate the risk of hand injuries during bolting. This solution should be considered for all mining operations requiring heavy industrial bolting activities.