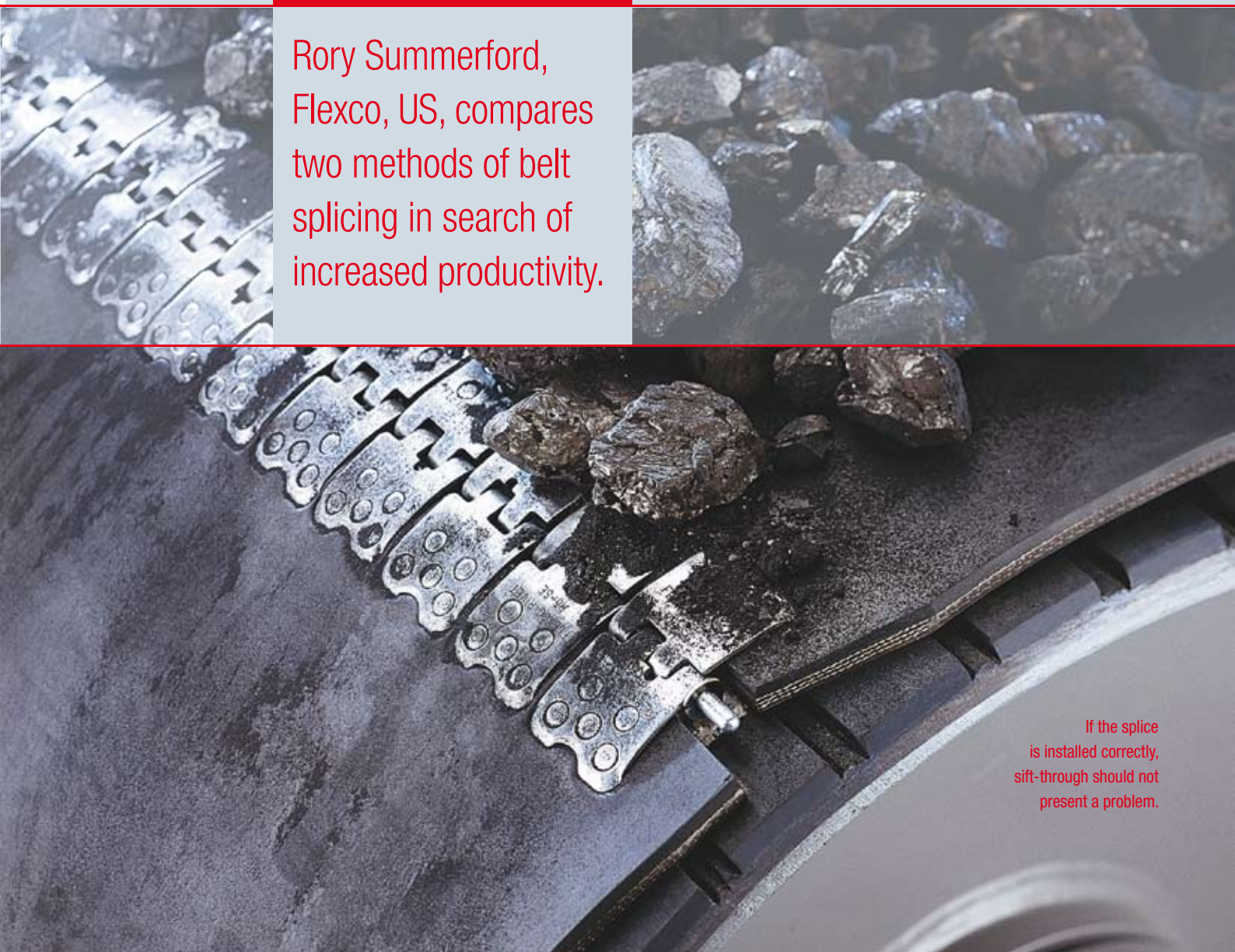
MECHANICAL SPLICING VS VULCANISING

Rory Summerford, Flexco, US, compares two methods of belt splicing in search of increased productivity.

Although the global coal market remains relatively stable amid a global economic downturn, coal mining operations still need to do everything they can to improve operating efficiencies and reduce costs. At the heart of a mine is its conveyer system – an excellent first checkpoint when seeking to optimise productivity.

A critical area of importance on any conveyor system is the splice, and in most coal mining applications, there are two preferred types of splicing methods: mechanical splicing, which joins belt ends by metal hinges or plates; and vulcanised splicing, which joins belt ends through heat and/or chemicals.

Understanding the pros and cons of each splicing method is extremely important when making an educated decision on which splicing method to use. What are the environmental factors that might affect the splice? Are workers up against time constraints? What are the costs associated with long conveyor downtimes? These are just some of the



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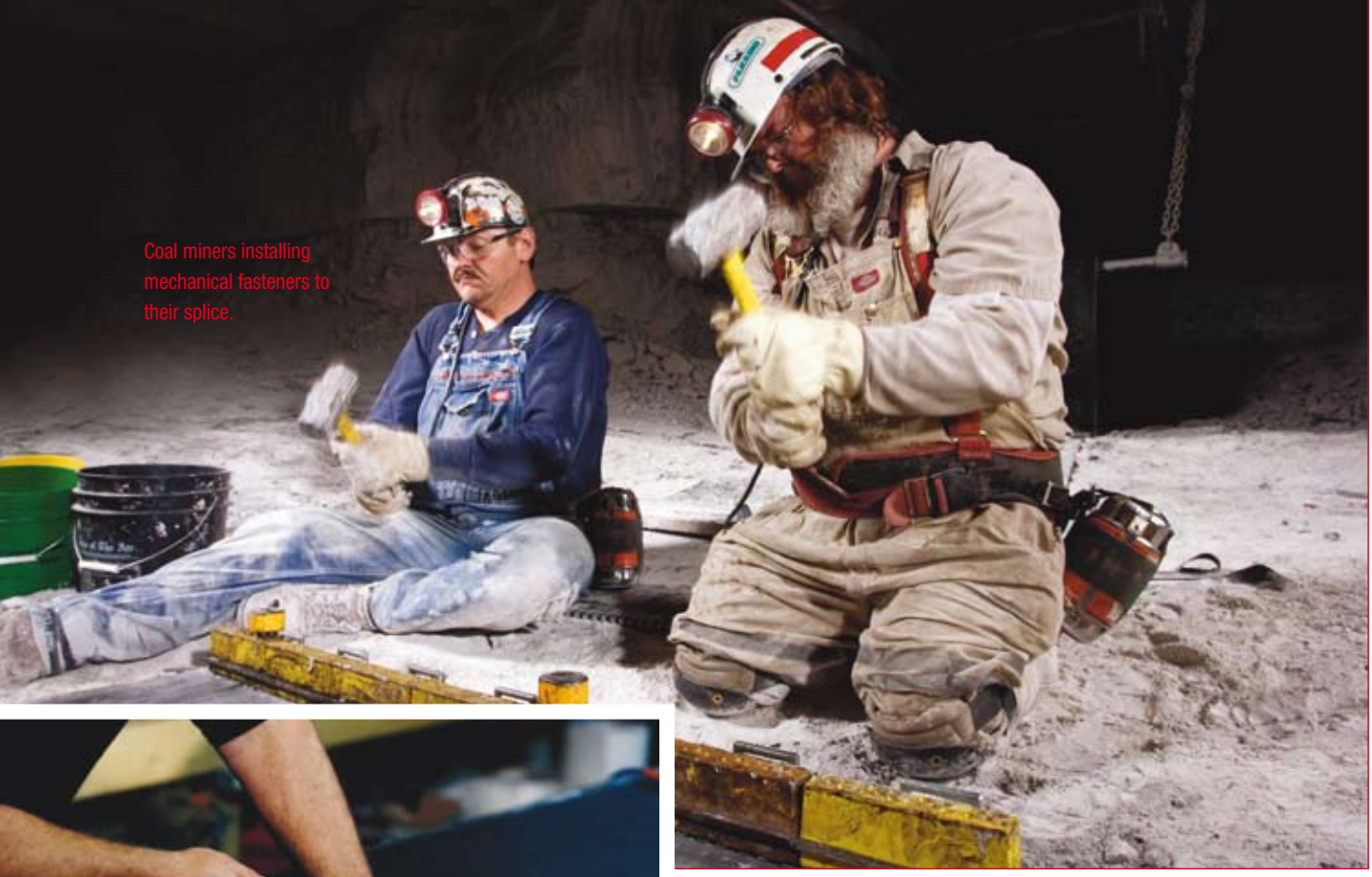

Coal miners installing mechanical fasteners to their splice.

The vulcanisation process requires a skilled expert, specialised tools and a clean, moisture-free work environment.

questions to ask when choosing between mechanical fastening and vulcanisation.

The vulcanisation process

Vulcanisation is an involved procedure that, if done correctly by an expert, can offer a smooth splice with minimal risk of snagging, tearing and other harmful wear to the belt. There are several different types of vulcanised splices, including stepped splices, finger splices and overlap splices, and two types of vulcanising processes, hot and cold. Each process requires unique tools and an intimate knowledge of the rubber bonding process.

For both hot and cold vulcanisation, the belt must be disassembled and each belt end prepared according to that particular belt's splicing recommendation. Proper belt preparation is crucial to ensure that the finished splice will hold and perform to its published tensile ratings.

With hot vulcanisation, splices are heated and cured under pressure with a vulcanising press. This process takes several hours. If a belt is retensioned and used before the splice is bonded and completely cooled, the splice will be ineffective and may come apart completely, causing additional downtime.

Cold vulcanisation does not employ a vulcanising press, but rather uses a bonding agent that causes a chemical reaction to splice the two belt ends together.

When vulcanising, several factors must be taken into account to ensure a high-quality splice. Firstly, a vulcanised splice must be performed by an expert who is skilled and trained for the procedure and who has a thorough knowledge of solvents, bonding materials and other cover and fill materials.

Secondly, the process requires a specific temperature, compression and dwell time of the equipment, in addition to a virtually moisture free work area.

Thirdly, some types of belts may not allow for vulcanisation at all. If a belt is old, dirty or unevenly worn, vulcanisation is not a good option, because it will not always cure evenly, which can result in a weaker splice.

The entire process for the vulcanised splicing of a 24 in. belt will take about 6 – 11 hours, depending on working conditions. Wider belts may take longer. And because vulcanisation often requires time for a specialised vulcanising crew and equipment to be brought onsite, mining operations can be shut down for half a day or more.

Ultimately, vulcanisation may cost thousands of dollars per splice, considering material and labour – and that is before considering the cost of downtime required to make the splice.

To summarise, use vulcanised splicing in the following circumstances:

- The clean belt is clean and free of contaminating agents, such as oil, sand and material fines.
- The belt is compatible with the adhesive of choice.
- The belt is new or without excessive wear.
- The procedure is performed by a trusted, certified vulcaniser.
- The work environment is at an optimal temperature and moisture level.
- There is easy access to the area that needs splicing and plenty of room to work.

- There is enough downtime available to allow for a properly installed vulcanised splice.

An alternative: mechanical fasteners

The speed and simplicity of mechanical splice installation represents major advantages over the vulcanisation process. Depending on belt width and thickness, most mechanical splices can be finished in less than one hour and are installed by an in house crew with portable, easy-to-use installation tools. In the event that an unexpected splice is required, it is thus not necessary to wait for professional assistance. Additionally, mechanical splices can be made in restrictive environments, with no special regard for space, temperature, moisture or contaminants.

Mechanical splicing also offers reduced belt waste and visibility of splice condition, both of which can significantly reduce costs. Because vulcanised splices often require consumption from 8 to 10 ft of belt length, conveyers may not have enough 'take up' if more than one splice is necessary over time.

And, because a mechanical splice is visible, wear and deterioration is visibly apparent and can be taken care of before a complete belt failure. Vulcanised splices, in contrast, typically deteriorate from the inside out due to poor adhesion. The first sign of wear comes too late for any preventive measure, resulting in longer downtime.

Mechanical splicing and mining applications

As with vulcanisation, there are several types of mechanical fasteners, each created for use with different belt widths, lengths, thicknesses, speeds, tensions and cleaners. Identifying the correct fastener for the application is essential to ensuring maximum splice life and performance. Mechanical fasteners are available in two types – hinged and solid plate – and with a variety of attachment methods, including rivets, bolts and staples.

For mining applications, rivet hinged fasteners allow for the greatest versatility. Rivet hinged fasteners combine top and bottom fastener plates, which are joined at one end by two wide hinge loops. Each pair of plates

A mechanical splice can usually be installed in less than 60 minutes.

sandwiches the belt end and is secured to the belt with a staggered pattern of rivets. The rivets penetrate the belt without damaging or weakening the belt carcass because they slip between the load-bearing carcass fibers. The rivets are installed in a staggered pattern to provide maximum resistance to pull-out and to distribute splice tension evenly across the width of the belt.

No matter what the belt condition, mechanical fasteners are a good choice for both new and older, worn belts. Rivet hinged fasteners can be used on belts ranging from 1/8 in. to 1 in. (3 – 25 mm) with pulley diameters from 9 in. to 42 in. (230 – 1050 mm). Concerns about comparable vulcanised splice strength can also be dismissed: rivet hinged fasteners have a long history of service on belts, with mechanical fastener ratings of up to 2000 P.I.W (350 kN/m).

Because hinged fasteners can easily be separated by removing the hinge pin, these designs are essential in mining applications where belts must frequently be removed, extended or shortened. In addition, hinged fasteners also provide several installation benefits to mining applications. The hinged fastening system permits separate halves of the belt to be pre-spliced, requiring only the hinge pin to be inserted at the job site. If belts of different thicknesses must be joined, hinged fasteners can often satisfy this need by allowing two different fastener halves to be joined by a hinge pin acceptable to both.

Mechanical fasteners are installed quickly and easily, onsite, with in house maintenance crews, usually in less than 60 minutes. The mechanical splice installation tools are easily transported to the job site and offer splice installers versatility in installation methods. Depending on the mine's available power source, mechanically attached rivet hinged splices can be installed with as little as a basic installation tool and hammer, or with a modified installation tool and choice of electric, air or powder actuated power source.

Mechanical fasteners can also be countersunk during the installation process so that the fastener plates are flush with the belt's cover, which eliminates interference with tight-fitting scrapers, skirtboards, and other conveyor components. Countersinking also strengthens the fastener-to-belt attachment by positioning the plates closer to the belt's load bearing carcass fibers. The belt strength remains intact as only a portion of the top cover material is removed, while the belt's vital carcass fabric is left intact.

Besides virtually eliminating fastener rip-outs, rivet hinged splicing cuts downtime by giving maintenance crews more freedom in deciding when to replace a splice. Any splice damage or wear and tear is very visible on a mechanical splice and operators can finish a shift even with a few plates missing and not worry about belt failure.

Vulcanisation vs mechanical fastening: common misconceptions

Every splicing method has its limitations and it is essential to get the facts before deciding how to splice a belt. Some of

Hinged fasteners can easily be separated by removing the hinge pin - essential in mining operations where belts are frequently removed.

the most common misconceptions include the following.

Mechanical fasteners cannot be used with higher tension belts (i.e. over 800 P.I.W.).

Synthetic belts and improved fastener designs have resulted in mechanical fasteners that are compatible with belt tension ratings of up to 2000 P.I.W.

With mechanical fasteners, sift-through of carried materials is a problem.

To prevent leakage and sift-through, vulcanised belts are ideal. However, when all things are considered, mechanical fastening may be preferable. If the splice is done properly, sift-through should not present a problem. Solid-plate splices can be sift-proof, and, if filler materials are used with a hinged fastener only minimal sifting should occur.

Mechanical fasteners are noisy, incompatible with belt cleaners and scrapers and generally damaging to the belt.

If mechanical splices are properly installed, maintained and countersunk by skiving the belt, there should be no problem with noise or damage to the belt or cleaner.

All belts can be vulcanised

Old and/or worn fabric belts are not well-suited to vulcanisation because the belt layers are weaker and will become brittle when heat is applied. Older rubber belts are also poor candidates for vulcanising, as the bondable properties of rubber deteriorate over time. Finally, vulcanising requires additional belt length, so operations with little take-up simply may not have enough belt to vulcanise.

You can vulcanise anytime, anywhere

Only clean, dry and relatively warm conditions are suitable for vulcanising. Chemical residue, excessive moisture and extreme temperatures can interfere with the curing of the adhesives and cause nicks and/or bubbles. These conditions, in turn, weaken the strength of the splice. In addition, vulcanising can be extremely difficult in areas that are not easily accessible.

Vulcanisation does not mean a lot of downtime

In fact, vulcanisation requires the shut down of the belt for a substantial amount of time – much longer than a mechanical splice would require. Not only do the chemicals take several hours to cure, but a vulcanized splice is also at the mercy of the vulcaniser's schedule.

Vulcanisation does not compromise belt strength.

Vulcanising actually robs the belt of an entire ply of strength – even more if not done properly. Mechanical fastening on the other hand, does not compromise the belt's integrity.

Inspecting a vulcanised splice is easy

The early signs of adhesion breakdown in a vulcanised splice are nearly invisible to the naked eye. Often, operators are not even aware that a vulcanised splice is experiencing problems until it fails – a catastrophic event that requires the immediate shut down of the line.

Conclusion

Conveyor belt and belt splice damage will always be a fact of life in most material-handling applications. Consequently, operations and maintenance personnel should have a thorough understanding of the available splicing and repair alternatives and how each method can affect the productivity and cost-effectiveness of operations.

New designs, materials, and processes are making mechanical splicing better than ever and incorporating mechanical belt fasteners into a splicing routine can provide numerous benefits for output and bottom line. In most applications, especially coal mining, mechanical splices offer the flexibility, economy and speed to keep material and labour costs down and avoid expensive downtime situations. WC