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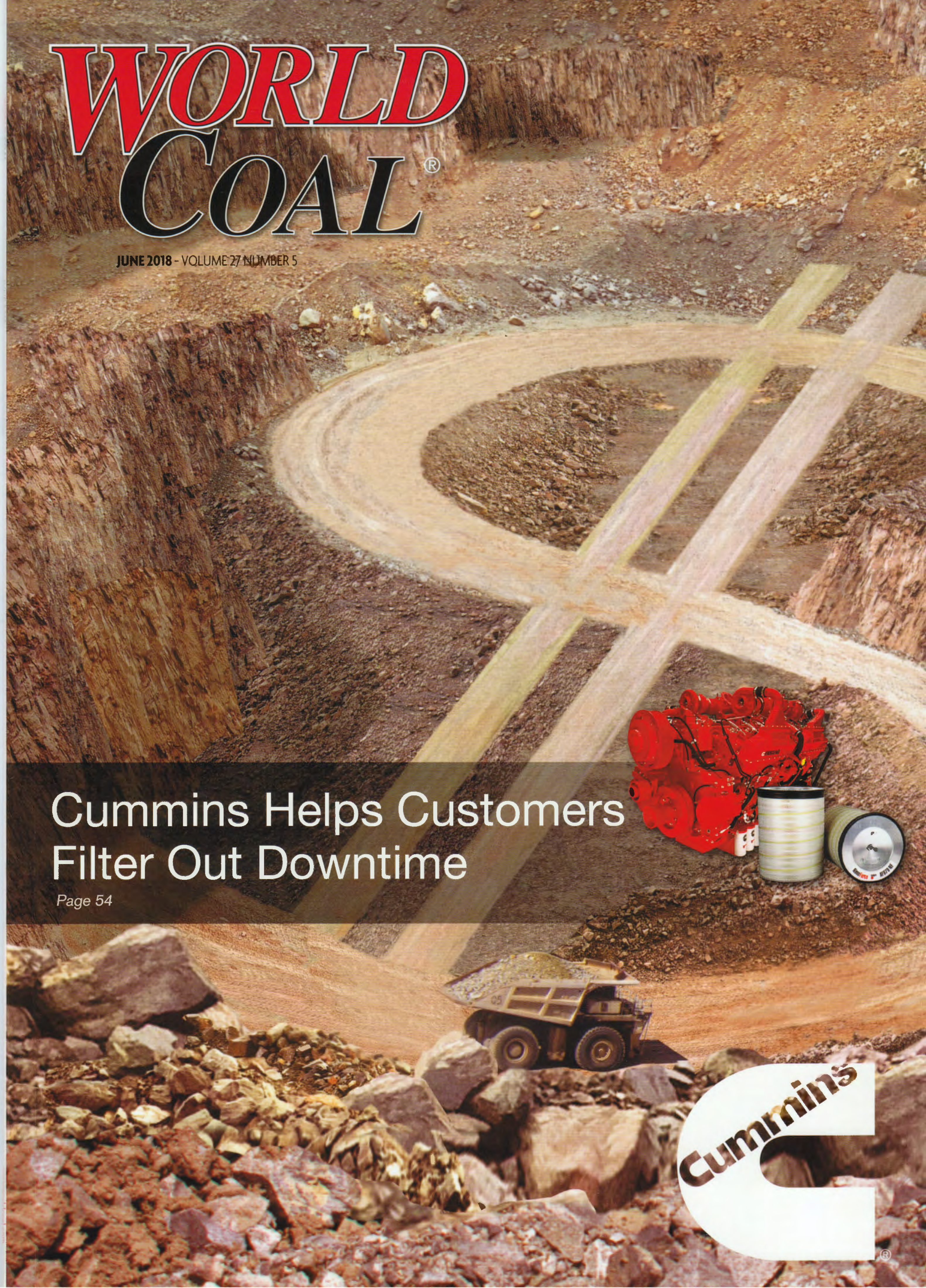

Cummins Helps Customers Filter Out Downtime

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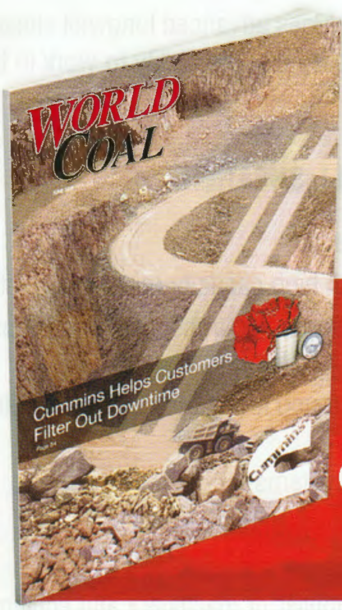

This month's front cover

"Smarter maintenance practices mean a big increase in profit for mining operations. That's why Cummins is working with mining customers around the globe on holistic maintenance plans that lead to longer intervals and more strategic scheduling of service events. The winning combination of Cummins expertise, customer collaboration and the newest filtration technologies in the industry increases mining customers' uptime, productivity and profits. Learn more on p.54."

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Clean conveyor systems, good firefighting capabilities and ongoing maintenance are the best defence against fires, explain **Dan Marshall and Todd Swinderman, Martin Engineering, USA.**

FIGHTING FIRE

A fire is one of the worst catastrophes in any manufacturing facility, but operations involving large conveyor networks are at particular risk of large-scale fire events and the hazards they pose to worker safety and company profitability. There are a number of underlying reasons. First, the nature of bulk material conveying generates dust that can serve as fire fuel and even an explosion hazard, and controlling fugitive material in these operations is an ongoing challenge. Second, conveyors are notoriously under-maintained; they are often huge, complex structures that are only serviced when a component fails. As such, a seized idler or mistracking belt can create sufficient frictional heat to cause ignition.

In addition, the size and speed of modern conveyors presents the ability to spread even a modest fire outbreak over great distances in a very short time frame. Complicating matters further is the fact that conveyor fires are typically difficult to fight. The belt is a long structure, often easily ignited itself, and a fire can spread along this extended route with frightening speed. If it is not spotted in time, burning material can even be transferred from one conveyor to another. The belt path will often run around or through a variety of enclosures and structures, all of which carry the risk of ignition, where the fire can be very difficult to extinguish. Inclined conveyors can develop a flue-like effect that intensifies the air flow, feeding the blaze and magnifying the damage. In many operations, elevated conveyor systems can also prevent easy access, presenting additional firefighting obstacles.

In underground applications, the danger is far more acute. Statistical data reveals that up to 70% of fires in underground coal mines occur in excavations equipped with belt conveyors.[1] With enough friction and heat, many conveyor belt constructions are capable of self-sustained fire propagation, whether they are made from natural materials, synthetics, or a combination of the two. Once ignited, they tend to produce a thick, black smoke resembling a tyre fire, which is often a far worse risk to personnel than the flames themselves. Smoke and heat can quickly travel through shafts, limiting visibility, access and escape, and it can take days to completely extinguish the event. If a burning belt should split under tension, the burning ends can fly apart, leading to multiple fires at different locations, as well as the splatter of burning rubber.

Causes of belt fires

Although heat caused by friction is the principal trigger of conveyor fires, there can be several underlying causes. Seized components, such as rollers, brakes or bearings, are a common source, often exacerbated by fugitive material that acts as an abrasive. Carryback on pulleys can also cause belt slip, creating friction between the two. Static electricity can also trigger an event, particularly when significant amounts of airborne dust are present. It has been estimated that frictional and static ignitions may account for up to 40% of all belt fires (Figure 1).

Other causes are less predictable, such as overheated motors, electrical fires, incidental ignition of surrounding spillage and foreign material entering the cargo stream producing sparks. These sudden ignitions can be spontaneous and, in some cases, leave little trace as to the trigger for the fire. With the addition of factors such as wind and other flammable agents near the conveyor, fires

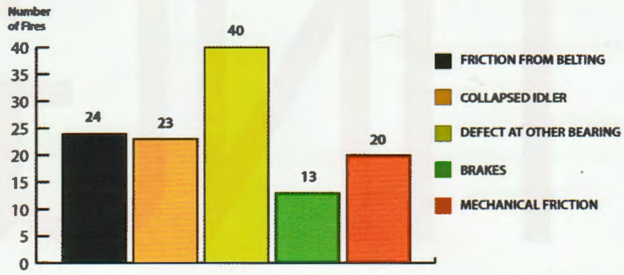

Figure 1. Number and causes of belt fires from 1986 - 1991. Reported in the HSE topic report, 'Safe Use of Belt Conveyors in Mines'.

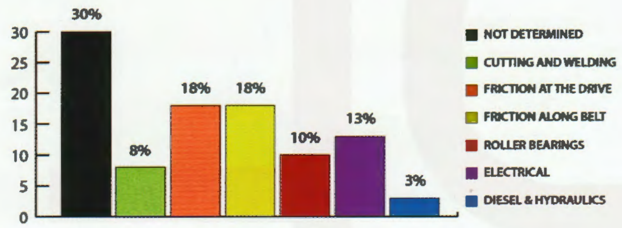

Figure 2. Causes of belt fires as reported in the 2008 Verakis and Hockenberry presentation,'Conveyor Belt Entry Fire Hazards and Control'.

can spread quickly, leaving little evidence of their true source (Figure 2).

To create a fire there must be three elements: oxygen, heat, and fuel (aka, 'the fire triangle'). One factor that makes conveyor fires so hazardous is that the belt itself can be the fuel. According to a study of belt fires conducted by the National Institute for Occupational Safety and Health, any of the standard neoprene, PVC, chloroprene and BELT-approved SBR belts can ignite.[2] Although some belts were hard to extinguish and burned completely, while others ignited quickly and went out on their own (self-extinguishing), the conclusion is that there is no non-flammable belt, particularly when accompanied by a combustible material.[3]

Friction

What leads to friction can often be sourced back to either the discharge zone or the loading zone, or both. Inadequate belt cleaning in the discharge zone can lead to dust and carryback on the return side of the belt, causing a fouled tail pulley to run under a stalled belt, which creates tremendous heat. A fouled tail pulley can also cause the belt to enter the loading zone unevenly. As a result, cargo dropped from the transfer chute can settle on one side of the belt, causing the belt to drift further and come in contact with the structure or fixed components, resulting in high temperatures caused by friction that can ignite a fire.

Dust emissions of any kind (combustible or noncombustible) originating from the loading or discharge zones have a tendency to foul rolling components, leading to failure of the seals, contamination in the bearings, and eventually causing the roller to seize. A rolling component can also stall if impact or cargo weight causes the bearings to collapse. Continuous frictional contact with a seized idler or the roller face can cause a loaded belt to exceed safe operational temperatures. It can also potentially result in extreme wear on the belt, degrading the main fire-retardant layer and exposing the heat-sensitive materials found in the belt's inner construction.

Belt testing for friction

Tests have been developed to study the resistance of conveyor belts to ignition, glowing, or sparking when under intense friction conditions. The 'Drum Friction Test' uses a sample of conveyor belt suitably mounted around a drum that rotates at a specified speed and belt tension. This allows testers to simulate the conditions of a stalled belt in contact with a fast rotating drive pulley, or a belt passing over a seized idler. The desired results are as follows:

- The belt should resist catching fire due to friction.
- The belt should be difficult to ignite with an open flame.
- An ignited belt should not propagate a fire.

The test measures different specified tensions for a given time period until the belt breaks. The presence, or absence, of flame or glow is noted and the temperature of the drive drum is measured. Conducted in either still air and/or in moving air depending on conditions, in most standards, the belt or the belt debris emitted from the drum rotation must not catch fire during a specified test duration.

Although the sample may break, or remain intact depending on the test standard, testers must specify the maximum temperature the drum reaches during the testing. For example, testers for coal mine applications set the maximum drum temperature to approximately 325°C, which is below the ignition temperature of coal dust. However, some standards allow drum temperatures of up to 400°C for nonflammable cargos.

Controlling fugitive material

Fugitive material control and regular cleaning of spillage are imperative. Without proper belt cleaning, chute sealing, and belt tracking, spillage that collects around the loading/discharge areas and along the belt path, can damage moving components, restrict access by fire crews, and potentially act as fuel.

Dust control is extremely important when handling combustible substances, and it is recommended, instead of just taking into account the fire triangle, operators consider the 'Dust Explosion Pentagon'. Examples of highly combustible materials include:

- Coal – a carbon-based, highly flammable material that burns at high heat, with dust that is easily ignited by a spark.
- Petcoke – a carbon-rich derivative of oil processing used as a coal alternative for power generation, among other applications. In dense concentrations, the dust is combustible with a high energy spark.
- Cellulose – a naturally occurring polymer found in wood, paper and grains; dust readily ignites.

Significant amounts of dust can collect on the walls of the loading zone chute. If a foreign metal object is accidentally introduced into the enclosed area, a spark can potentially create an explosion. Additionally, common maintenance within the chute, such as removal of the wear liner using a cutting torch, often requires confined space entry by workers. If the inside of

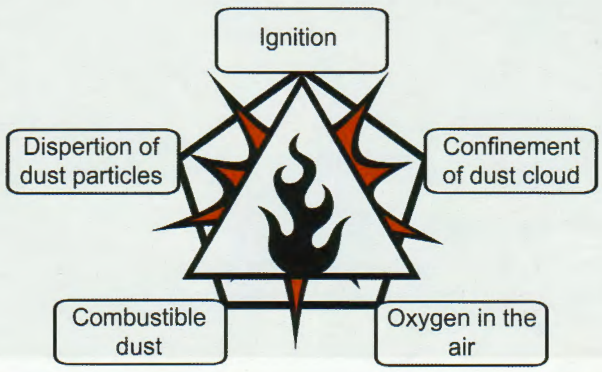

Figure 3. Dust explosion pentagon.

the chute is not adequately cleaned, this task could pose a serious hazard.

Think like an inspector

When examining conveyor equipment, one should approach the task with the same critical mindset as an inspector from OSHA, MSHA, or the local fire department. Prior to concentrating on specific components of the conveyor, safety professionals recommend a holistic view of the system, taking into account the combustibility of the material being conveyed and how the areas around the conveyor could be impacted. The following should also be assessed:

- Spillage levels and cleaning schedules.
- The conveyor's proximity to work stations.
- How the conveyor design (enclosures, narrow walkways etc.) could create a hazard for employees.
- Safe storage of flammable liquids.
- Compliant signage.

Finally, take a common sense look at the current state of fire suppression apparatus. Conveyor designs are ever-evolving and often retrofitted with new equipment based upon changes in production and volume. In older facilities, fire suppression systems were most likely designed for the conveyor that was in place years, if not decades, prior and may no longer be effective in the event of a fire on the current system.

Considerations for conveyor fire prevention

Often, the potential return on investment (ROI) for prevention equipment is not recognised until managers are inspecting burnt rubble and negotiating with insurance adjustors. However, safety-minded operators understand that the same equipment they would implement for increased efficiency, such as belt cleaners and impact cradles, can also help prevent fires.

Impact cradles and support cradles help reduce fugitive material by providing a flat, stable belt surface that facilitates effective sealing.

Transfer chute design is a critical element of fugitive material control, with sufficient settling zones and confinement. New raised chute designs also allow for external wear liners that eliminate the need for confined space entry or torch removal. When paired with improved skirt seal designs, fugitive spillage and dust emissions are drastically reduced, which protects rolling equipment from fouling and seizure. The decrease in spillage mitigates the collection of potential fuel around the conveyor and requires considerably less labour for cleanup.

Modern belt trackers with troughed idlers or gripping return idlers are so sensitive that they detect mistracking the moment it happens and correct the belt path immediately, significantly reducing the chance of a friction fire due to belt drift. This also reduces spillage along the belt path from uneven cargo loads.

A heavy-duty belt cleaner system, featuring modern primary and secondary cleaners with an effective tensioner, increases the volume of discharge and limits the amount of carryback and fugitive dust. Along with limiting spillage, tail pulley health is improved and there is less fouling of rolling components.

Conclusion

Improving the fire retardance of its belting is just one of the ways that an operation can reduce the risk of conveyor fires. The development of fire-retardant conveyor belting has made an important contribution to safety, but even fire-retardant belts can burn in the presence of another fuel. These potential fire hazards can only be minimised through high standards of conveyor installation, maintenance and cleanliness.

Operators should regularly contain airborne dust at transfer points and remove accumulated dust from beams, pipes, conduits, equipment and fixtures; and minimise spillage from belts. Damaged rollers must be identified so that they can be replaced as soon as possible before the damage leads to frictional heating that can result in a fire. Operators should use flame resistant grease and other lubricants. Fire detection and suppression systems and equipment must be tested in accordance to industry and regulatory standards.

Conveyor belt alignment is also an essential prerequisite to belt safety. Belts must be aligned and trained to prevent frictional heating where the belt rubs against the conveyor structure. Another significant fire-prevention measure is control of 'hot work' permits and procedures (for employees and outside contractors), and restrictions on the placement of flammable liquids and gases.

It is incumbent upon employers to protect workers from one of the most potentially hazardous pieces of mechanical equipment at any facility: conveyors. Knowing the risks of fire, facilitating periodic inspections, and striving to implement the steps and equipment needed for a safer workplace should be the goal of every operation.

Experience has shown that clean conveyor systems, good firefighting capabilities, and ongoing maintenance form the best defence against fire. WC

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