

# FEELING

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**Richard Gagg, AMETEK Land,** discusses infrared line scanning as a technique that can be applied to detect early stages of spontaneous heating and combustion for coal moving on belt conveyor systems.

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**B**elt conveyor systems have been around since the early 1900s and remain a key component in modern coal transportation because of their efficiency, cost and proven reliability. The ability of belt conveyor systems to move large quantities of materials continuously has made them invaluable in mines and storage areas and at transportation hubs, such as port facilities and train terminals. Conveyors are also widely used within solid-fuel-fired power production facilities. With all of the advantages of belt conveyors comes a requirement for continuous remote monitoring. Unlike most other modes of transportation, belt conveyors function without a 'driver' and little attention is given to the conveyor, which is looked upon as automatic and continuous.

The advantages of belt conveyors can also be their weakness. This is particularly true when transporting reactive combustible materials that are used as fuels. A hot inclusion in

that material can be quickly transported and spread throughout a facility, causing potential belt fires, storage pile fires and mill explosions.

Sub-bituminous coals, such as Powder River Basin (PRB) coal from Wyoming and Montana in the US, are in high demand because it offers a combination of low cost and low sulfur content, however, handling this coal requires special care and safeguards to reduce the risk of fires.

Compared with bituminous coal, sub-bituminous coal, such as PRB, is less densely packed. That porosity means the coal contains more oxygen compounds, such as water and CO. This combination can set the scene for spontaneous combustion events. In another example, PRB can be blended with conventional coal, which seems to result in an even more volatile material.

Handling and maintenance practices that were previously adequate for bituminous coals are unacceptable and dangerous

when switching over to sub-bituminous coals. In the case of conveyor transport of these coals, it is highly desirable to detect any hot inclusions that may at a later stage cause a fire in or around the belt, or in a final storage area or mill.

## Detection

Detecting hot inclusions in coal on a moving conveyor is not easy to achieve. There is no single way of detecting 100%

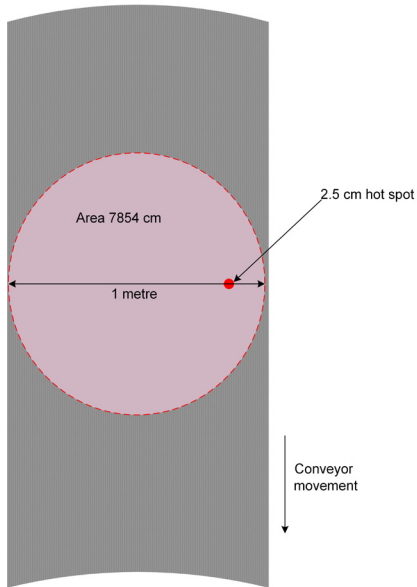


Figure 1. Single spot thermometer using a 100 cm wide belt.

of possible inclusions under all circumstances. Many sites use temperature measuring devices that detect a developing belt fire, but, at that stage, it is too late. The challenge is to preventatively detect hot items that may later cause a fire.

In the past, some users would install a single infrared thermometer above the belt to view the coal as it passed below. To some, this may have seemed to have worked, but, in practice, the sensor was unable to detect small hot items that went unnoticed.

For example, if a single infrared thermometer was viewing the full width of a 100 cm-wide conveyor, the target spot would be that of a 100 cm dia. circle with an area of 7854 cm². If a hot spot 2.5 cm in dia. were to pass by, it would occupy an area of just 5 cm². If the average temperature of the target spot was 30°C and the hot spot was 120°C, a thermometer viewing that area would read a little less than 30.1°C. In other words, it would be incapable of detecting the hot spot. If the belt were wider, the infrared thermometer would be even less sensitive (Figure 1).

Since the early 1990s, industrial infrared line scanners have been able to measure temperatures down to 20°C or lower. Line scanners use an extremely

fast response speed detector. The detector's field of view is scanned rapidly by using a rotating mirror in a similar way as a bar code scanner in a supermarket. An 80° angle scanned view looks out of the scanner enclosure through a durable sapphire window. During each scan the detector samples 1000 small temperature points.

In the same 100 cm-wide conveyor belt example, the scanner samples a row of 1000 temperature spots, each with a spot size of 1.2 cm and is capable of detecting small hot objects (Figure 2). In the example given above, a 1.2 cm dia. hot spot with a temperature of 120°C will register the correct temperature of 120°C and trip an alarm so protective actions will occur.

The line scanner scans a line of 1000 points 100 times each second so 100 000 data points are measured each second.

The line scanner system continuously evaluates the temperature samples. Should one exceed a customer selected high-temperature set point a high-speed alarm is triggered.

Some line scanners require a PC and software to achieve this functionality. Other hotspot detection scanners are much easier to implement and operate because they use a small processor unit that is simple to configure without relying on an operator with software skills. These line scanner systems are typically connected into safety systems that may actuate a diverter or inerting system depending on where in the process the measurement is made.

It is worth noting that all infrared temperature devices need to see the surface of the hot object. If the hot object is covered by 30 cm of coal, it will not be seen unless there are cracks or fissures through the upper layer. Hot gases can convect upwards through cracks and affect the surface temperature of the coal above. The line scanner's extremely tight optics allow it to view through narrow cracks and its very-high thermal sensitivity enhances temperature detection.

It is important to understand that infrared detectors are not 'x-ray eyes'. If someone says their infrared device can see through coal, it simply is not true.

In many cases, the end-user or installer will position a line scanner at a

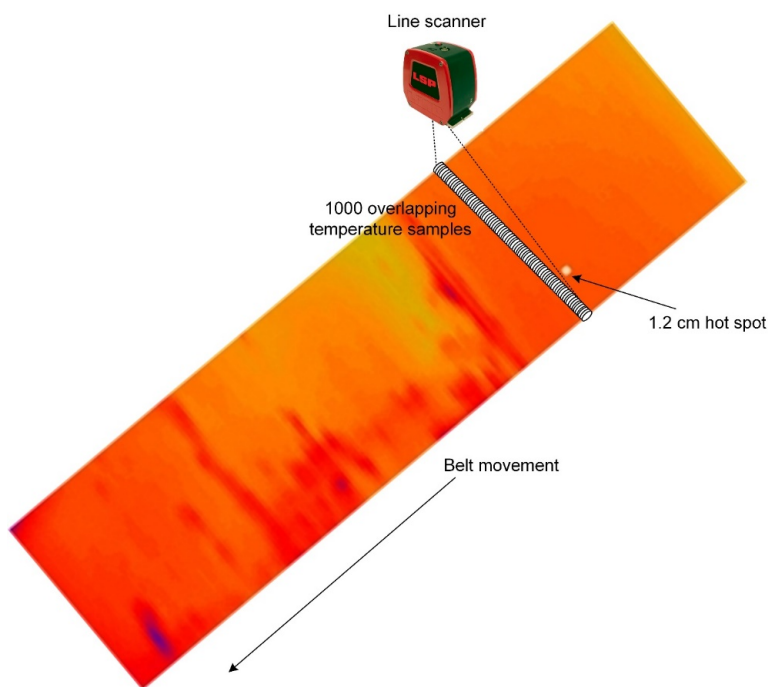


Figure 2. Line scanner above the belt scanning for hot spots.

transfer point or chute where coal is falling. Such a location has the advantage that the falling coal separates, and the curtain becomes partially transparent. This helps with detecting hot inclusions that may have previously been covered below the surface.

If conveyors are covered or in enclosed spaces, users must carefully select a suitable line scanner that is specifically designed and certified for use in a hazardous atmosphere location.

It is important not to set high alarms too low. While this gives better sensitivity to hot objects, it may also be a cause of false alarms. In planning an installation, users should understand the ambient temperature levels that occur within the scanned scene over the course of the year. This will allow the user to configure alarm set points for each unique situation and to consider how to cool or heat equipment to deal with climate extremes.

Line scanners typically require an unobscured view of the process and, for that reason, are supplied with air purge

systems to ensure that their optics are kept clear of dust. If suitable local sources of compressed air are unavailable, a vendor can easily provide a self-contained blower unit. The protection window on a line scanner should ideally be flat and flush with its surroundings to provide no place for dust to collect. Some line scanners have extremely durable windows made from materials such as sapphire, which resist acids, solvents and are very difficult to scratch.

The installation of a line scanner system is very simple. They are compact and usually only require one cable and one air connection. A typical sensor will work in ambient temperatures up to 60°C, (140°F) without requiring cooling.

Systems usually feature two high-speed alarms, which can be set for process spot high alarm and sensor ambient temperature alarm. In addition, the system should include a fast response 4-20 mA output signal, which is linear with temperature over the range of 20 – 250°C (68 – 482°F).

An infrared line scanner is an important preventative system that can detect small hot objects as they pass by. The scanner is just one of the tools available to provide a multi-line defence against hot inclusions that can cause problems. If areas are enclosed, then CO monitoring should be employed to provide an excellent second line of defence.

Unfortunately, there have been several incidents since the wide spread conversion to sub-bituminous coals. With the increasing use of these pyrophoric fuels, additional safeguards and revised operating and maintenance methods have changed from desired things and become necessities. Infrared scanning detection systems are an important part of this defence.

These detection systems minimise the possibility of such incidents and facilities damage, prevent lost production time, and can significantly lower insurance rates.

With these detection systems in place, a plant can reap all the benefits that these new coal types offer. <sup>W</sup>C