Application Note

Flame Detection for Recycling Facilities and Zombie Batteries

Introduction

Lithium-ion (Li-ion) batteries are now widely used in a wide range of applications, ranging from portable handheld devices through to energy storage in peak shaving plants, and uninterruptable power supply systems, etc.

Compared to lead batteries, the energy density of Li-ion batteries is close to 300% higher and can sustain up to twenty times as many charging cycles. These batteries are also more environmentally friendly and are practically maintenance-free.

This type of battery does however, present a considerable fire hazard. If a Li-ion battery is damaged, short-circuited or exposed to high temperatures, a reaction can occur resulting in a rapid and extreme temperature rise, causing the battery to catch fire. This fire can quickly escalate, via a chain reaction, to nearby materials, or other batteries in storage applications, potentially leading to widespread damage and revenue loss.

Figure 1 The tipping floor, image courtesy of Fike taken as a snapshot from the video feed of a FLS-IR3-HD

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The waste transfer station and Zombie batteries

A survey released in May 2020 looking at the characteristics of fires caused by batteries in electrical and electronic equipment (WEEE) showed that "the average cost of all incidents in 2018 was estimated at EUR 190 k (USD 250 k), which can represent a significant burden for an individual company. The most severe fires occurring at respondents' facilities in the last four years gave rise to an average reported cost of damages of EUR 1.3 million (USD 1.5 million).[1]"

The main area of interest requiring detection is the waste transfer station and these come in many forms. A waste transfer station is a light industrial facility where solid waste is temporarily staged during its eventual journey to be recycled, landfill, or waste-to-energy facility.

Vehicles are unloaded at the main transfer building. Solid waste may be dropped onto the "tipping" floor, into a pit, or immediately onto another vehicle.

At some transfer stations space is provided for the public to drop off green waste or other approved recyclables. Materials are usually segregated by the public and dropped into large skips; with the content of the skips being compacted by site operators.

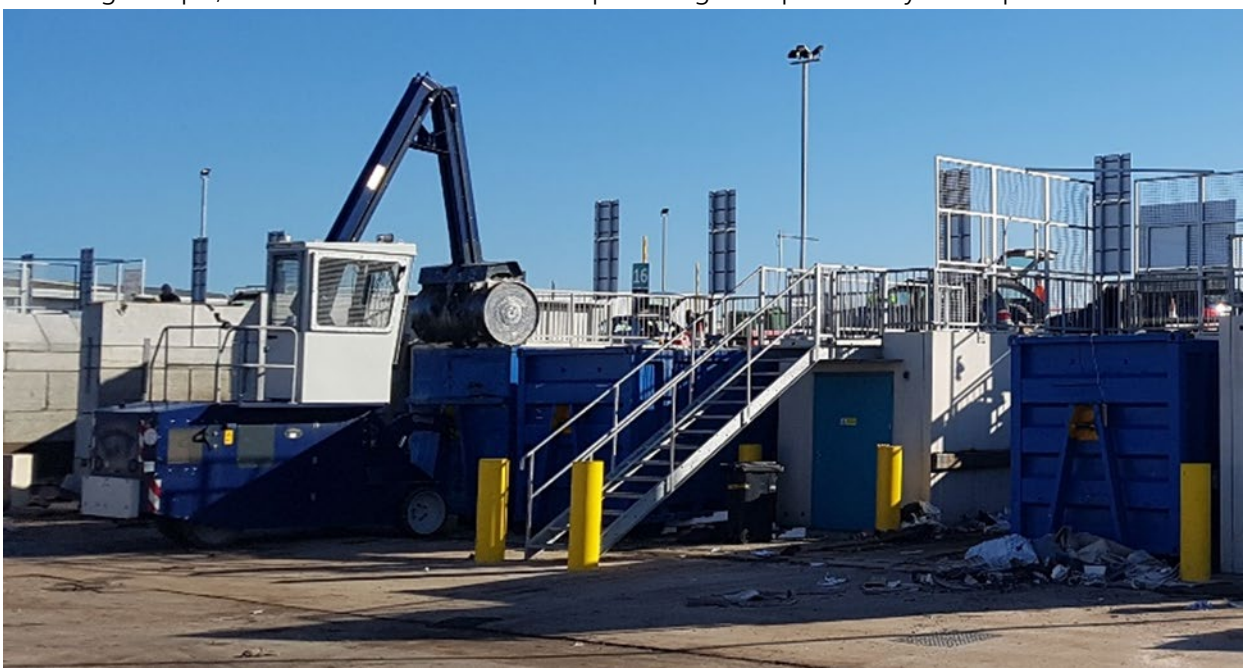

Figure 2 Skips for segregated materials and machinery to compact the content

Recycling centres have seen a huge increase in fires recently due to the disposal of Li-ion batteries[2,3]. These so called "Zombie" batteries are usually relatively small but become damaged when disposed of in general waste or recycling. Batteries discarded in this manner regularly become damaged during the collection or processing of the materials.

Many fires happen on the concrete "tipping floor" because the wheel loaders, used to move the waste materials about, damage the batteries which eventually causes them to catch fire. In some cases, fire escalation leads to incidents requiring dozens of firefighters[4] to attend and people living near the facility may have to be evacuated. In waste-to-energy plants, the waste material is the process fuel and so power generation may need to be shutdown leading to a loss in revenue.

Detecting fires in waste transfer stations

Fire detection in recycling facilities is not straightforward as the areas to cover tend to be outdoors or in large volume buildings with high ceilings that may be open on at least one side. These factors mean that conventional smoke and heat detection would be ineffective.

We also need to consider that fires can occur anywhere within, deep inside a pile of refuse or at the surface. Deep-seated fires can smoulder and spread internally, causing a hot spot that may spread to the surface where smoke, heat or flame can be detected. Smouldering fires move through the pile and may not be detected until the fire reaches the surface.

There are few standards concerning the detection and suppression of fires in waste facilities other-than that of hazardous waste. It is therefore important to understand the type of waste being deposited on the tipping floor to recommend the most appropriate fire detection technology.

One potential approach uses thermal radiometry cameras to measure the external temperature of an object based on the radiant energy detected. The camera then displays the temperature as an image with different colors representing different temperatures. Thermal cameras can trigger an alarm when a predetermined temperature has been reached.

The alarm mechanism for a thermal radiometry camera is relatively rudimentary, as any temperature that exceeds the setpoint generates an alarm. This means that false alarms are a common problem, particularly when there are vehicles in its field of view, for example due to the exhausts of refuse trucks or wheel loaders. It is important to highlight that there are no fire standards for listing or approval of thermal radiometry cameras, and they can only be connected to a fire alarm panel by special approval of the local authority having jurisdiction.

Optical flame detectors, on the other hand, are designed for the harshest of environments and can cover large areas and they must be certified to international fire detection performance standards like FM3260 and EN54-10.

The most common types of industrial flame detectors are UV-IR and IR3. UV-IR detectors tend to be less expensive than IR3 detectors, but they tend to be less sensitive, meaning more detectors may be needed to protect an area, and they can be easily blinded by airborne contamination, like dust. IR3 detectors on the other hand can detect fires at long distances are more resilient to optical contamination

Figure 3FlameSpec IR3-HD

The FlameSpec IR3 is good choice for such an application. The unit's high sensitivity and fast response means that fires can be detected when they are small and extinguished rapidly. The unit operates in all weather and light conditions with highest immunity to false alarms.

For added peace of mind the FlameSpec IR3-HD can be used to remotely view activities onsite, these units also have high speed onboard recording of fire events both leading up to and after the event. This capability is invaluable for post incident investigation.

Conclusion

We have seen that Li ion batteries are posing a significant issue at waste recycling facilities. Each fire has been estimated to cost the site operator an average of EUR 191k (USD 230k). Rapid fire detection is key to minimising damage at these facilities, triple IR flame detection presents a unique set of benefits in this regard.

References

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