Thermal Monitoring for Early-Warning Fire Detection

Overview
Large-scale laundry facilities face a multitude of fire risks. Combustible fabrics, the possible presence of flammable or reactive contaminants, and unmonitored or uncontrolled heating of laundry piles all increase the potential for spontaneous combustion.

Spontaneous combustion depends on the following conditions:
1. Availability of a fuel source
2. Availability of an oxidizing agent
3. Availability of a heat source

The linens themselves – particularly materials with high cotton content – provide a readily-available fuel source. Cotton materials begin to oxidize when surface temperatures reach 95°C. If the heat due to oxidation is not permitted to dissipate, the material may continue to heat until the point of ignition, resulting in a spontaneous fire. When cleaning and petroleum products, or natural fats and oils are added to the mix, the potential for spontaneous combustion increases[1]. It is not difficult to imagine how piles of soiled laundry left in the sun, or exposed to heat sources inside a laundry facility can become potential sites for spontaneous ignition, particularly if the soiled linens have been exposed to flammable or reactive substances. Due to the inherent risks, a multi-tiered fire prevention, detection, and response plan is needed.

FLIR integration partner Movitherm (Irvine, CA) was approached by an industry-leading linen and uniform supply company to design and deploy a thermal monitoring system. The intent of the monitoring was to track the critical temperatures at key processing locations in their laundry facility, and generate warnings and alarms when temperatures exceeded expected limits.

It is important to note that the system discussed in this application note was not designed to replace existing fire detection and response protocols – it is never expedient to rely on one system, or even one type of system, when human lives are potentially at risk. Rather, the system was designed to function as an early warning system – detecting areas in the facility where runaway oxidation and early ignition may be starting to occur. By providing advance warning earlier on pathway to ignition, costly, and potentially life-threatening fires can be averted before they are permitted to start and spread.

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System Implementation

Figure 1: System Overview

To address the specific domain challenges, MoviTHERM adopted a distributed, multi-camera network topology based on nine FLIR A310 cameras and three (3) MIO-8 multichannel intelligent I/O controllers. A block diagram of system components is depicted in Figure 1. The digital output channels of the three MIO-8 units are connected to industrial (audible) alarm annunciators and warning lights. These early-warning devices alert workers in the immediate proximity of the potential danger, enabling workers to start corrective action or evacuate to safety, depending on the severity of the risk. Viking Industrial auto-dialers are also integrated into the system, and configured for both a warning response and a critical alarm response. The lower-level alarm alerts plant managers (by telephone) when warning temperatures have been reached. The higher-level alarm automatically telephones dedicated fire response crews if critical temperatures have been detected.

Installation Details

The nine FLIR A310 cameras are divided into three sub-groups. Each sub-group monitors a separate inspection zone inside the facility.

Zone 1 employs four cameras, and monitors the critical incoming loads. The incoming loads typically present the greatest fire risk, as the unprocessed laundry can contain a wide range of unknown contaminants. At this stage, unsorted linens can be susceptible to chemical reactions, which can result in spontaneous combustion.

The remaining 5 cameras are divided between Zones 2 and 3. Zones 2 and 3 monitor areas in the facility where bags of partially processed laundry can remain stationary for extended periods. These are locations where oxidization monitoring can provide early warning of a potential hazard. Zones 2 uses three cameras and Zone 3 uses two cameras.
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All of the camera images are routed to the monitoring station. A FLIR NVR (Network Video Recorder) records and archives the live video streams, providing a live record of any events that occur. The live camera images are also displayed on a video monitor for continuous, real-time viewing by facility personnel. (See Figure 2.)

Key Components of the Monitoring System

The monitoring system functions as a stand-alone alarm system. It monitors, records, and alarms without any dependence on an external PC or PLC. The key component that enables this capability is the MoviTHERM MIO (Intelligent I/O) module, as shown in Figure 3.

As indicated previously, nine FLIR A310 cameras (as depicted in Figure 4) generate the thermal images used for the analysis. Specific regions of interest (ROIs) can be defined in each camera scene so the system can respond to unexpected temperature anomalies while at the same time, ignoring features that are expected to be out-of-range under normal operating conditions.

The installation also incorporates a Digital Network Video Record (NVR) to record and archive the live video streams from the cameras. (See Figure 5.)
When events occur – either warning or alarm events – the NVR is a useful tool for reviewing and investigating the event. Given the dynamic nature of an industrial laundry facility, a wide range of equipment and personnel can pass through the camera field-of-view on any given day. The archived video footage provides a useful way to determine whether events are false alarms, due to normal operational variability, or if they are legitimate alerts that require further action.

The NVR also provides a video monitor output. This permits live camera streams to be displayed on a video display monitor. The NVR live video capability alleviates the need for a dedicated monitoring PC. Furthermore, using the built-in Internet connectivity, employees and managers can to log into the system at any time to view live streams or pre-recorded events. Powered by the FLIR Cloud technology (and a free FLIR software app), users can access the system using a smart phone, tablet or PC from any location.

**MIO Configuration Interface**

The MIO intelligent I/O modules are configured using a standard web browser. The browser-based configuration utility, depicted in Figure 6, enables quick set-up and configuration changes.

A separate configuration line is provided for each Analog (4-20mA) and Digital output line on the MIO device. The user begins by selecting one of the connected cameras from the Camera pull-down menu. After selecting the camera, a Command (or response action) is defined using the pull down menu as shown in Figure 6. The final step is to select a pre-defined Region of Interest from the available regions for the selected camera.

The MIO can be configured for a wide range of behaviors, from passing temperature values in the selected Region of Interest to one of the 4-20mA outputs, to changing digital output values based on internal alarm conditions generated by the FLIR A310 cameras.

The MIO offers a number of different strategies for generating useful I/O responses.

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**Conclusion**

As this application note illustrates, networked FLIR A310 cameras, in combination with MoviTHERM MIO Intelligent I/O modules can provide a simple and effective “first response” industrial fire monitoring system. The MIO units offer multiple analog and digital outputs, which can easily be configured to drive standard, off-the-shelf alarms and auto-dialers. Adding the FLIR NVR video recorder to the system adds image archiving, and a real-time monitoring option to the mix. Best of all, this configuration is more cost-effective than any traditional PC-based hardware and software monitoring solution!

**Sources**

“Spontaneous Ignition Fires in Laundries – The dangerous and Often Misunderstood Contributing Factors” – Everett, Jim (National Fire Code Contributor)


MovITHERM

advanced thermography solutions

15540 Rockfield Blvd, Suite C-110
Irvine, CA 92618

Phone: (949) 699-6600
Fax: (949) 699-6601
E-mail: info@movitherm.com
http://movitherm.com