Isaac Papier
VP Industry Relations
Honeywell Life Safety
3825 Ohio Avenue
St. Charles, IL 60174
(630) 377-6580
isaac.papier@systemsensor.com

Jeffrey M. Klein
Business Line Leader
System Sensor
3825 Ohio Avenue
St. Charles, IL 60174
(630) 377-6580
jeff.klein@systemsensor.com

Todd Alford
Senior Product Manager
System Sensor
3825 Ohio Avenue
St. Charles, IL 60174
(630) 377-6580
todd.alford@systemsensor.com

New Advances in Multi-Criteria Smoke Detection Better Counter Nuisance Alarms

False and Nuisance Alarms

Despite marked improvements in the reliability of alarm and detection systems, false alarms remain a significant issue for the fire protection industry. False alarms represent one out of every ten calls in the U.S. and U.S. fire departments responded to 2.1 million false alarm calls in 2004 [1]. According to Michael Karter, in the 2006 update to this study "Over the 1988-2006 period, the number of system malfunctions increased every year from 1988 to 1999 and increased an overall 63.7 percent from 550,500 in 1988 to 901,500 in 1999, changed little in 2000, and decreased 18.4 percent to 721,000 by the end of 2006"[2]. While this is a marked improvement, the fact remains – false alarms are still a significant issue for our industry. The financial implications can be significant when a false alarm occurs. The evacuation of a hospital or a financial institution can cost thousands of dollars per minute and many jurisdictions are beginning to levy fines for multiple false alarm visits.

Material Factors

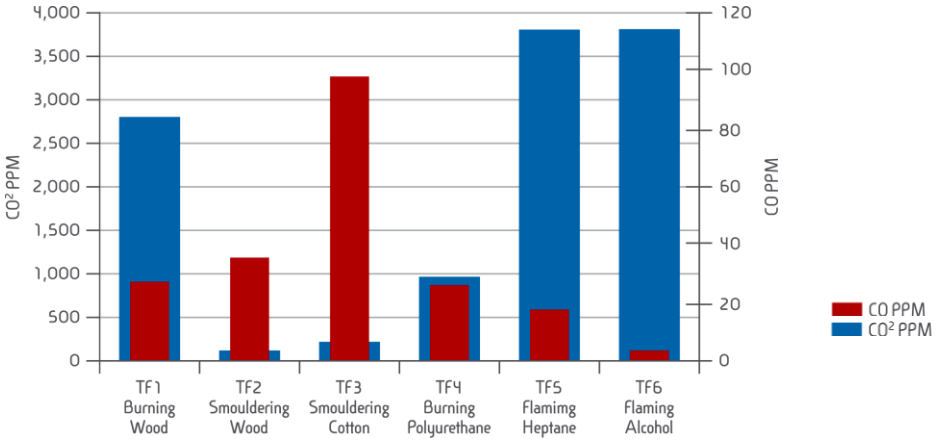
Over the last 20-30 years, a transition from natural to man-made materials has changed the way fires develop and spread. New construction and furnishings materials such as nylon, orlon, polyesters, etc. create new challenges for smoke detection. Detector response characteristics at the incipient stage of fires from these new materials are similar to that of natural materials. However, due to the more rapid acceleration of fire seen with the man-made materials, escape time has been dramatically reduced, as evidenced in the two Dunes studies sponsored by NIST[3]. One solution is to make the detectors more sensitive, but this invariably leads to more false alarms. This also conditions users to become complacent about fire alarms and in many cases, ignore them altogether – a classic "boy who cried wolf" scenario.

New Detection Technologies Combat New Material Technologies

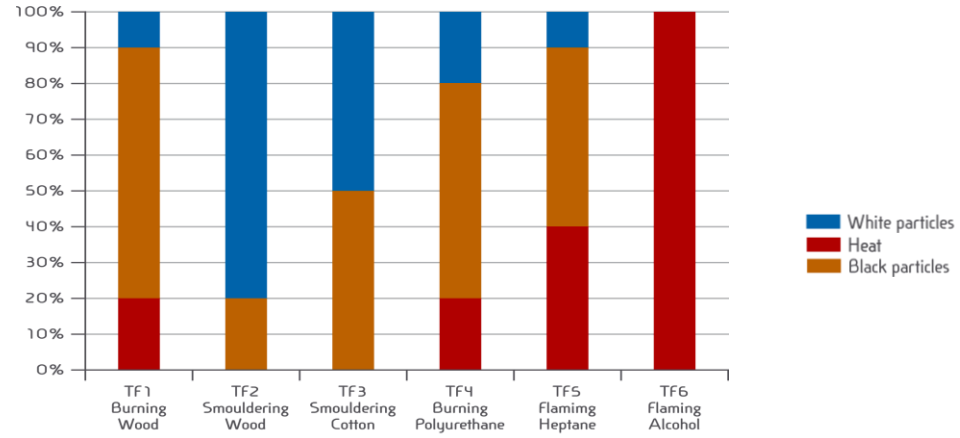
Advancements in smoke detection involve the use of multiple sensing elements in the form of a multi-criteria smoke detector. In such a device, the individual sensing elements work cooperatively to make the alarm decision based on consideration of multiple fire products, not just particulate or heat. At the same time, the information is used to make the system more resistant to nuisance alarms. The advent of such devices may eventually lead to performance based designs with a unique mix of devices tailored specifically to the facility being protected. Further, each device may be configured to respond appropriately to the specific environment in each area of an installation. This will allow for additional protection against false alarms while improving the responsiveness of the detector, and thus, the overall system.

Multi-Criteria Detection

A number of multi-criteria devices are becoming available with a variety of sensors and features to improve both the fire detection and the nuisance rejection capability. All fires have three elements in common: they produce carbon monoxide, they produce heat and they produce particulate matter (smoke). However, the proportions and timing for each element depend on the type of fire. As identified in the graphs below, the same fires produce markedly different levels of CO, smoke and heat. In Graph 1, it can be seen that a smoldering cotton fire produces significant CO, while flaming alcohol produces very little measurable CO. However, when looking at the particulate and heat from these same two fires, it is apparent that particulate sensing is much more applicable to a smoldering cotton fire than to flaming alcohol, which would be better suited to heat detection. Ideally, one device would provide adequate sensing for all fire types in various conditions, without being prone to nuisance alarms .



Graph 1: Concentration of CO and CO_2 for common fire types



Graph 2: Concentration of white particles, black particles and heat for common fire types

Using combinations of sensors in an intelligent way leads to multi-criteria detection. These devices offer greater capability and intelligence than conventional products and have the potential to drive the next significant improvement in eliminating nuisance alarms – while improving fire detection accuracy. A detector that can sense each of these elements is able to

provide a more accurate fire decision and discern a nuisance condition. An additional benefit derived from this cooperative detection is the potential to accelerate the response when multiple sensors detect common fire elements. This allows such devices to operate at low sensitivity in normal operation, but to become much more sensitive as conditions change. One such device combines classic photo-thermal detection with electrochemical carbon monoxide sensing and infrared sensing. With microprocessor controlled algorithms and communication among the sensors, the device can provide a new level of accuracy in fire detection. The addition of an infrared sensor, combined with on-board intelligence, allows the device to look beyond the comparatively small sensing chamber and out into the covered space to respond to flame signatures. At the same time, the algorithms and cooperative detection prevent nuisance alarms from common conditions such, as candles, welding flash, and cooking flames.

Such devices are the first foray into an "artificial intelligence" means of fire detection. It is realistic to anticipate a future when fire detection devices move beyond simple algorithmic-based decision making. They will one day be able to actually analyze the products of combustion and adjust their sensitivities to achieve a near Early Warning type response, without the current risk of false alarms generated by common environmental nuisances.

Applications

Such devices are ideal for facilities or specific areas within facilities with mission critical applications, such as:

- Medical facilities
- Financial trading centers
- Computer server rooms

Or areas prone to nuisance alarms, such as:

- Hotel rooms (shower steam and in-room smoking)
- Boiler rooms (particulates from combustion equipment)
- Dormitories (shower steam or other nuisances)
- Performance theatres (stage smoke)
- Near commercial kitchens (airborne particulates from cooking)

Building owners or facilities managers who are responsible for coordinating emergency response procedures (such as in a medical facility) should have particular interest in applying these new technologies. Specifying Engineers and Architects should also be interested in these technologies to enhance the performance and protection they provide to their customers.

Summary

Intelligent fire detection has progressed significantly in the last 25 years [4,5]. Multi-criteria detection represents the next opportunity to improve the accuracy and reliability of fire detection. Such devices allow for methods to:

- Respond to the broadest range of fire types
- Respond quickly and accurately to true fire conditions
- More accurately reject nuisance alarms

References

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