The use of detectors in modern fire protection

The final decade of the twentieth century saw many significant changes in the theory and practice of active fire protection. One of the most interesting changes was the growing acceptance of detectors that use more than one type of technology to detect fire. These detectors are generally known as multi-sensor detectors, not to be confused with multi-criteria detectors, and, at this point, it is perhaps useful to clarify the terminology and eliminate some of the confusion that exists.

By Rowland Davies, Marketing Manager, Apollo Fire Detectors.

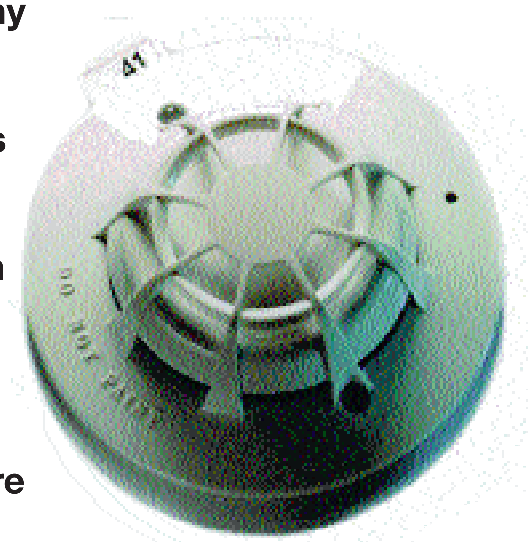

Photo: The Apollo Discovery multi-sensor detector.

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Multi-sensor detectors incorporate two or more sensors of different types - ionisation smoke, optical smoke, heat, CO - and process the signals to produce one output on which the decision fire/no fire is based.

The majority of multi-sensor detectors have micro-processors in the detector head to carry out this processing.

Multi-criteria detectors use one sensor but combine different measurements to produce an output. Thus the rate of increase of smoke in the environment might be combined with a maximum measured level to produce the output from which a decision is made.

Experience would suggest that most manufacturers of fire detectors have chosen to develop multi-sensor detectors first and that there is sufficient knowledge of their performance, both in the fire test laboratory and in live fire protection systems, to be able to discuss them with confidence.

Why develop multi-sensors?

The driving force behind the development of multi-sensor detectors was the perceived shortcomings of ionisation detectors combined with the growing influence of the green lobby in a number of European countries.

By the late 1980s the characteristics of ionisation and optical smoke detectors were well established and advantages and disadvantages appreciated by fire protection engineers. Ionisation detectors were by far the most widely used, but their sensitivity to small-particle smoke meant that they tended to produce more false alarms than optical detectors. Optical detectors, on the other hand, although recognised in standards and in practice as good general purpose detectors, were not sensitive enough to small-particle smoke as to be adopted without reservation as substitutes for ionisation detectors. It seemed that a gap had opened up – a gap that could not be ignored, since heat detectors did not offer the degree of protection afforded by smoke detectors.

The issue of ionisation detectors was also influenced by environmentalists, who saw the radioactive foil in these detectors as a hazard which should be eliminated as soon as possible. If elimination was not immediately possible, then the storage, transportation and use of ionisation detectors should be controlled by government agencies.

Detectors using radioactive foils had been developed and modified over the years with a view to eliminating erstwhile high levels of radioactivity and had attained the OECD standards of less than 1µCi (microcurie) by the early 1980s.

This activity, which is contained inside the detector, is less than that of a colour television set. Nonetheless, because of fears of radiation, regulations by various governments on the circulation and storage of ionisation detectors became increasingly restrictive, making designers and installers of fire protection equipment less willing to use them, even though their effectiveness

multi-sensor

in detecting fires was undisputed.

Sensor combinations

Multi-sensor detectors are invariably a combination of a heat and at least one type of smoke sensor.

Detectors which combine more than one smoke sensor are treated by the regulating bodies as smoke detectors having more than one type of sensor.

Multi-sensor detectors that incorporate CO sensing as well are planned .

The argument for fire detectors with two smoke sensors (ionisation, optical) and a heat sensing element is that they offer the best of both worlds, as far as smoke detection is concerned, i.e, the detection of large particle smoke with the optical chamber and the detection of small particle smoke with the ionisation chamber.

The argument for multi-sensor detectors with one smoke sensor (optical) and a heat sensing element is that the optical-heat combination performs, in practice, as well as an ionisation sensor, thus making the ionisation sensor redundant.

Discovery multi-sensor detector

Whatever the merits of multi-sensor detectors with ionisation smoke chambers as well as optical chambers, it is obvious that the inclusion of the ionisation sensor means that the detectors are subject to the same regulations of storage, transport and usage as simple ionisation detectors.

Mode of operation

In single-sensor detectors a signal is generated which corresponds to the amount of smoke or heat present around the detector. If the signal increases conventional detectors change to the alarm state at a pre-set threshold while analogue detectors transmit the signal for processing either within the detector or in the control panel.

A multi-sensor detector has two or three signal inputs and these are processed in the detector using an algorithm written by the manufacturer for that particular type of detector and its associated equipment.

Different operating modes may be offered for particular environments. The range of modes and the method of selecting a mode will differ from one manufacturer to another. As an example, the Apollo Discovery multi-sensor has five operating modes that are selected by the system designer or commissioning engineer via the control panel. This detector has an optical smoke sensor and a heat sensor, and the detector can be selected to operate as a smoke detector only, a heat detector only or as one of three combinations of both. If one of these three combinations has been selected, the signals from each are considered in relation to the other, for instance, the smoke detector can become more sensitive if the heat detector reports an increase in heat.

Manufacturers will supply guidance on which mode to choose or they may make

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Figure 1. Overheated plastic (POM)

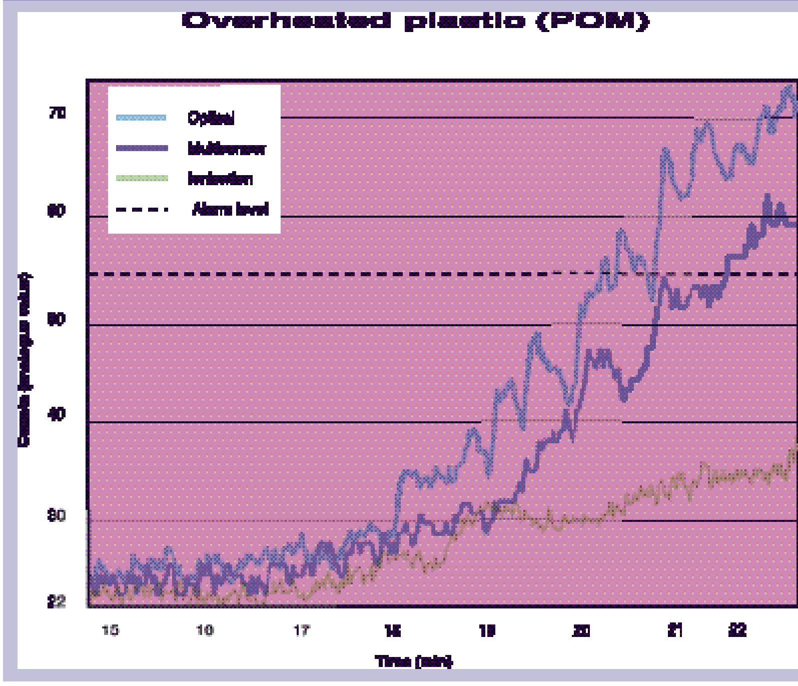
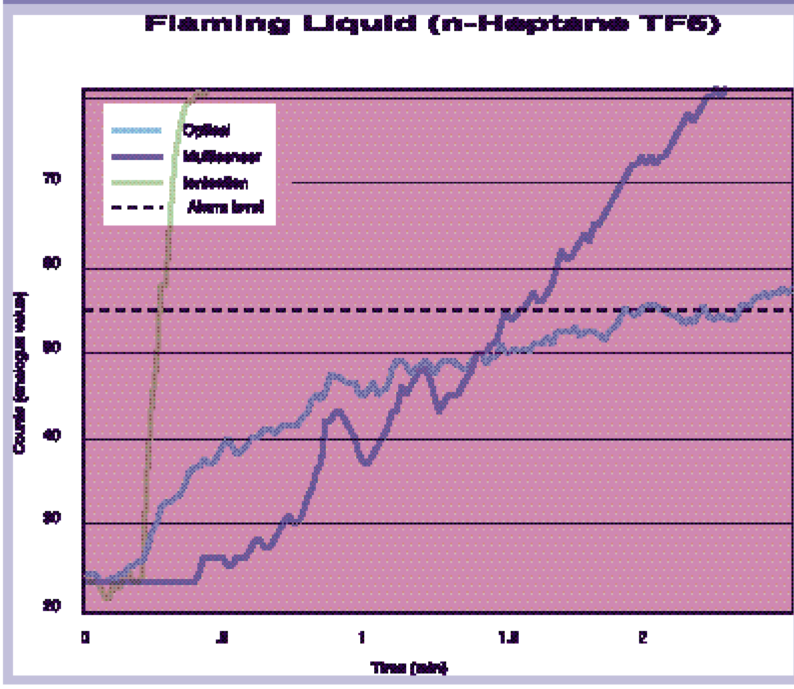


Figure 2. Flaming Liquid (n-Heptane TF6)



engineers available who will programme the detector appropriately.

Performance of multi-sensor detectors

The performance of multi-sensor detectors is obviously of paramount importance. If we say that we are seeking enhanced performance, we mean that we want continued reliable detection of real fires with increased resistance to false alarms.

Tests were carried out at the EN54 fire test laboratory at Apollo's factory in Havant. The graphs show two typical fires: one is overheating with large particle smoke (figure 1), the other is a flaming fire with small particle smoke (figure 2). These two fires represent opposite extremes of the test fire scale.

The smouldering fire is detected initially by the optical detector, which reaches the alarm level in just under 21 minutes. The multi-detector sensor, however, requires only one minute longer to reach the same level. The ionisation detector, by contrast, fails to reach the alarm level in the time available for the test.

At the other end of the scale is the n-heptane fire. The ionisation detector needs only 15 seconds to reach the alarm level. The multi-sensor detector takes about 1min 30secs to reach the alarm level, but the optical detector only just manages to reach alarm in the time allotted for the test. Note that the response of the ionisation detector is such that it is easy to understand why ionisation detectors can give false alarms.

Taken together, it will be seen that the multi-sensor detector is the only one that performs satisfactorily at both ends of the fire scale.

As far as the increased resistance to false alarms goes, the author is unaware of any publication which documents a controlled experiment to determine whether or not multi-sensor detectors reduce the rate of false alarms. There is, however, anecdotal evidence that systems which have had a tendency to false alarms with single-sensor detectors have shown significant reductions in the false alarm rate, once multi-sensor detectors have been installed instead. This is, of course, exactly what the theory would predict, since multi-sensor detectors avoid the sensitivity extremes of both ionisation and optical detectors.

Conclusion

There are no apparent disadvantages in the multi-sensor detector.

They perform well; they use known and proven technology and they can be confidently retro-fitted where ionisation detectors are no longer tolerated or permitted.

Moreover, they can be expanded in future to include the new CO sensors that are emerging.

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