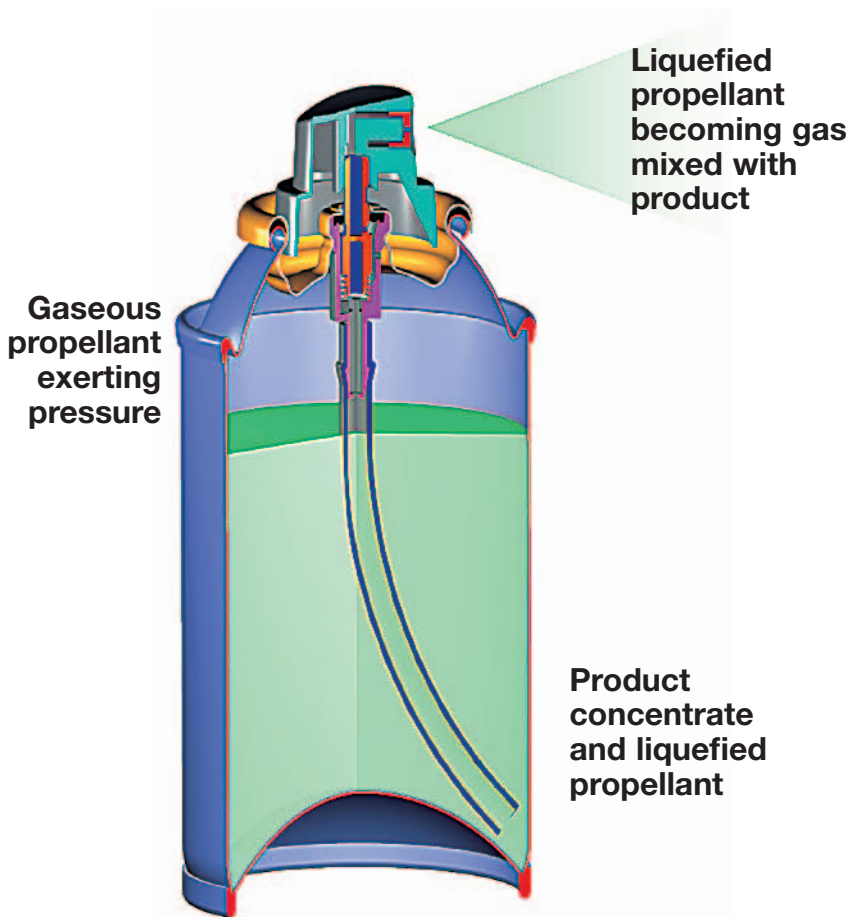


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AEROSOL SMOKE DETECTOR TESTERS

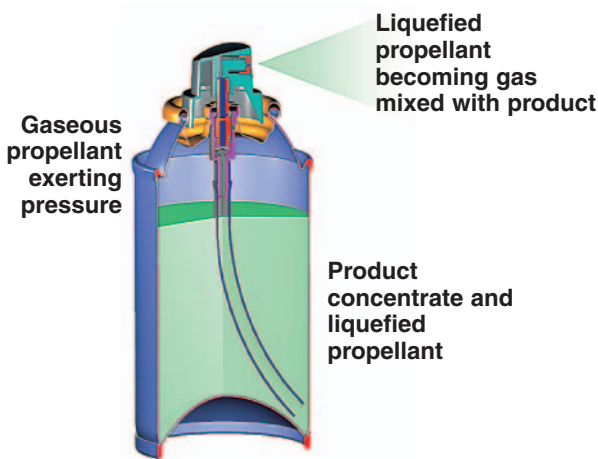
by Stewart Pepper, Technical Director



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AEROSOL SMOKE DETECTOR TESTERS

Stewart Pepper, Technical Director of No Climb Products, explains the basic principles and discusses the functional and safety issues which need to be considered.



The concept of aerosol smoke detector testers was invented and first filed as a patent application in Switzerland in 1969 by Cerberus AG.

Codes and standards around the world require functional tests to confirm that smoke can enter the detection chamber of point type smoke detectors. This can be done by generating simulated smoke or by the use of suitable aerosols. Aerosol smoke detector testers are widely accepted as the popular method of performing such tests because they are quick, simple and controllable. The substance used for the test must not cause damage to, nor affect the subsequent performance of, the detector. Environmental and health and safety issues must also not be forgotten.

Basic principles of aerosol detectors

The scientific term 'aerosol' refers to small particles suspended in a gas but, in

everyday usage, it refers more often to the pressurised containers that we know and use in so many of our activities. Aerosol canisters contain two essential components: the propellant and the active ingredient. The propellant's two main jobs are:

- a) to create pressure within the canister to push out the active ingredient, and
- b) to help break up the liquid droplets and make a fine spray.

The active ingredient (often a blend) is dependent on the application, and is the 'wanted' product from the can (e.g. the synthetic smoke particles). Put together in a canister, which is designed to contain the pressure of the propellant, they are regulated and dispensed by a valve and actuator combination. The valve and actuator determine the rate and type of spray pattern as well as providing a heavy influence on the particle characteristics (themselves also a function of the chemical ingredients).

Aerosol smoke detector testers produce a fine mist of particles, providing sizes and characteristics comparable to various types of smoke. Ideally, they also provide a mix of particles optimised to activate quickly both optical and ionisation smoke detectors.

Selection of the correct chemicals for use within these products is of paramount importance since there is a need to balance the often conflicting requirements of environmental and health and safety regulations, (non) flammability, low cost and, most importantly, compatibility with the components from which detectors are manufactured.

Technological Issues and Design Criteria Particulate

The particle size, particle distribution and particle lifetime of the purposely-

generated aerosol particles play a crucial role in the responses – and clearing times – of the detectors on which they are used. Ionisation detectors are more sensitive to smoke particles between 0.01 and 1 micron and photoelectric (optical) between 1 and 10 microns. A universal test product therefore needs to be producing particles to cover a range of particle sizes (0.01 – 10µm). Other characteristics of the aerosol particles are also crucial for activation of the detector.

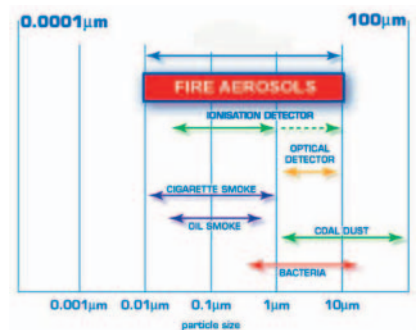


Figure 1. Particle sizes

By simulating these characteristics the aerosol canister simulates not just 'smoke' but probably a wider spectrum of smokes than is produced by tests using certain 'real smokes' (the characteristics of which will depend on what substance is being burned under what conditions). As such, 'aerosol testing' can be argued to be a more rounded test than using 'real smoke'. It is certainly one that meets the core requirement of a test to: "confirm(s) that smoke can enter the detector chamber and produce a fire alarm signal (e.g. by use of apparatus that

generates simulated smoke or suitable aerosols around the detector)" BS 5839-1:2002 45.4 (d).

Clearing time

A thorough test of the system will seek to ensure that the horns / bells / sirens will be activated by each detector individually, Both BS 5839 and NFPA 72, for example, require the checking of both smoke entry to the sensing chamber **and** an alarm response. This means the panel being automatically or manually re-set after each test (which cannot be done until the detector is clear of smoke). Clearing time is therefore almost as important as activation time (not to mention probably being more heavily influenced by the test media).

Ideally smoke detectors will respond in the fastest time (as allowed by circuitry design) and the test aerosol will clear (dissipate) in the shortest time to allow the detector to be reset. A product whose particulate dissipates very quickly either needs more spray (to remain long enough for time delayed detectors) or must be contained within an aerosol dispenser. Longer lasting sprays (where less spray is required) have the disadvantage that they take longer to clear (so delaying re-set) and, often, a greater propensity for residue and contamination.

Use of a dispenser enables an aerosol with quick clearing time to be used on detectors that require longer particle presence.

Residue and Contamination

Over the years there have been concerns about using aerosol canisters, because of the residues that can be left through their (mis)use. These residues have the potential for attracting dirt, dust and other contaminants and therefore ultimately affecting the detector performance.

Residue can be left by many things in addition to aerosols ('real' smoke being one of the worst offenders) and this is a key issue – particularly when it is so avoidable.

Particles from aerosol smoke detector testers are created, in liquid form, by the break-up of the chemical constituents as they pass through the aerosol valve and actuator. As volatile liquid particles travel through the air larger particles diminish in size, so that an aerosol spray canister designed to project a long distance or remain for a period without dissipating, may need to start by producing larger particles. Larger particles are also somewhat desirable in hand held applications on account of their ability to travel further in the air due to their additional momentum. Unfortunately, the larger the size of the particle and the higher their momentum, the more likely it is that particles will impact a surface and then form a residue. Depending on the chemicals involved, this residue may be volatile or non-volatile.

Residue volatility is heavily influenced by the use of oil or non-volatile active

ingredient. Whilst excellent at meeting the demand for 'longer lifetime' particles, oily or non-volatile ingredients can result in the formation of a film of residue over the detector surfaces and / or are more likely to be left as deposits capable of attracting dust, dirt and moisture. Even if a residue is not apparent immediately there is the danger of oil based or non-volatile ingredients having a cumulative effect over time.

No Climb no longer uses oil based ingredients in its newer aerosol products, focussing instead on those that are much more volatile. These, more volatile, ingredients are much better as they leave far less long term residue and have a shorter particle lifetime (much quicker detector clearing and re-set times).

Using them in conjunction with a dispenser enables them to be contained and controlled both from the residue and particle lifetime standpoint.

Silicon

Highly volatile ingredients (at the other end of the extreme) are not, however, without their problems either. One group of commonly used highly volatile ingredients that can cause problems are derived from silicon. This substance has a 'sticking power' and, when used in an aerosol, 'sticks' on the item being tested / sprayed, even if apparently volatile. The surface of the item then becomes slippery, not allowing anything to adhere to it. This can cause problems in a variety of instances – most obviously 'clean air' environments, areas where paint is to be applied, and places where there is any mechanical equipment. If in doubt, users need to contact the manufacturer of the aerosol product and check for the presence of silicon.

Plastic and Component Compatibility

Stress cracking is (the premature) cracking and embrittlement (of a plastic) due to the simultaneous action of stress and strain. It may be caused or accentuated by contact with certain chemicals. Damage caused to the detector under test is, obviously, a serious issue. Most plastics, including those used in fire detectors, have limited chemical resistance.

The SOLO aerosol smoke detector tester development project included what is almost certainly the most in depth plastic compatibility tests undertaken in this area to date. Within these tests, different samples of different plastic material types commonly used in the manufacture of smoke detectors were sprayed under 'conditions of abuse' with samples of different aerosol test products. Tested also were materials used in the construction of the SOLO dispenser. The plastics were then examined under a Scanning Electron Microscope (SEM).

Under the powerful magnification of the SEM it was / is immediately apparent that at least one of the aerosol products tested

(some of which had been approved by third party test houses) caused stress cracking to plastics. As time passed, the stress cracks increased (see photo below). The SOLO Detector Tester aerosol and previous products from No Climb did not, however, show any signs of such plastic incompatibility.

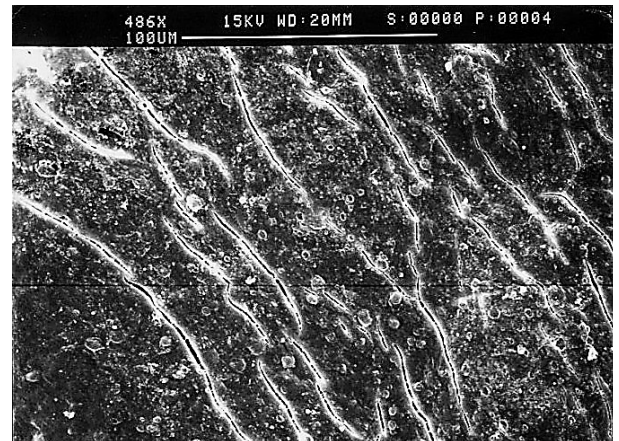


Photo: Stress cracking of plastics.

Even though it is not always possible for the naked eye to see this type of damage (and may even be unknown to the manufacturer of the aerosol) it can affect the long-term durability and structural reliability of the detector.

Environmental & Health and Safety Issues

International differences

Users of pressurised aerosol products must be confident that safety considerations have been fully reviewed and met. Worryingly, what is suitable for one country or trading bloc may prove unsuitable / unacceptable or in contravention of norms and standards for / in another. SOLO products have been developed and certified with regard to appropriate regulations for flammability, product labelling, packaging, pressure and transportation across the world.

Environment & Flammability

Historically, manufacturers of aerosol smoke testers used CFC's in their products up until (and for a while after) 1987 when their use in such manufacture was outlawed under the Montreal Protocol. Since then, the choice of chemical propellants has been between:

- 1) HFC's – expensive but non-flammable, and
- 2) hydrocarbons such as propane or butane – cheap but flammable.

Smoke detector test aerosols filled with flammable propellants present a greater hazard than non-flammable ones. Spraying flammable contents at sources of ignition (such as live electrical circuits found in detectors) can be exceedingly dangerous (as controlled tests at No Climb have shown). In the event of a fire or explosion, flammable aerosols constitute a

For the manufacturer, approving a smoke aerosol tester can help assure the user that the test product is compatible for use on their own products, and also ensures that their clients have a good test product.

considerably greater risk to safety. Non-flammable, environmentally friendly propellants are more expensive than flammable alternatives but many of us in the life safety / fire detection industry feel it is better to use a non-flammable product, even if more expensive, than a cheap flammable alternative.

Pressure

The internal pressure of an aerosol product and its suitability for its canister are key issues in a good and safe product. The pressure depends not just on the propellant and the other ingredients but also outside influences such as ambient temperature and atmospheric pressure. Internal pressure can change very significantly when any of these influences changes. The ability for the finished product to safely withstand pressure changes depends wholly on the components used in manufacture and their relative ratings. Two canisters may look identical but use very different pressure rating capacities. At elevated temperatures one could fail. Users should satisfy themselves that the aerosol product they elect to use day-in day-out meets national guidelines such as the EEC Council directives and BAMA guidelines in the UK. Not all products available in today's UK and European market meet such requirements.

Toxicity

Even worse, some aerosol test products have been known to contain toxic chemicals that can potentially damage the user who is testing the detectors! Potentially toxic chemicals such as phthalate esters, (which are suspected carcinogens) and / or teratogens (capable of causing birth defects or testicular damage) have been found in aerosol smoke test products available in the world today. Users should check the manufacturers Material Safety Data Sheet (MSDS) for the product to ensure that it is fit for purpose and, if in any doubt, ask specific questions of the manufacturer.

Approvals

Approvals come in many guises. In terms of aerosol smoke detector testers, two obvious approvals stand out as being of importance. Firstly, approvals by third party certification bodies and secondly, approvals by detector manufacturers.

Third party approvals are useful for the end user in determining overall safety of product, lack of adverse affect on the detector under test, and compliance with statutory regulations. However since there are few countries whose legislation requires a test product of this type to have third party approval, few have test regimes for

this sort of product (an exception being Underwriters Laboratories of the US, against whose test regime SOLO aerosol smoke detector tester has been approved). However, a third party approval should only be a starting point in terms of making a decision on which product to use to test the system.

The role of detector manufacturer endorsement of aerosols (or any test product) can be critical in selecting the correct tester. Both in the UK and elsewhere in the world, standards that call for smoke entry testing also state that the manufacturer should approve the test method used. For the manufacturer, approving a smoke aerosol tester can help assure the user that the test product is compatible for use on their own products, and also ensures that their clients have a good test product that will enhance the integrity and lifetime of the system.

Within this approval and endorsement process, obviously, plastics and electronic compatibility, as discussed earlier, are crucial.

Packaging and labelling

It is more difficult for users to ensure that the product they intend to use meets with safety approvals (including flammability, leakage, fill pressure, toxicity, appropriate labelling and packaging) since the

requirements and regulations differ by market (and, it has to be said, policing of the system can be 'thin on the ground'). In some markets, for example, there is nothing to prevent a manufacturer making available a large canister (which looks like good value for money) but putting only a

fraction of what one might expect inside. Weight does not assist the user either because, in the case of aerosols, some propellants are much heavier than others. The European Prescribed Quantities Directive (EPQD) discourages the possibility of only half-filling a large canister with product in an attempt to mislead the consumer over the size. Users can identify products which conform to the EPQD because they are marked with an 'e' symbol on the canister. In addition users should look to see that the canister is marked with a reverse epsilon. This mark means that the product does not fall short of the nominal minimum quantity for the can size under the European

Aerosols Directive. These marks are not a total guarantee but, if they are present, they should go along way to convince the user that some thought at least has been put into the safety and labelling accuracy of the product.

Cost

The words 'cheap' or 'cheaper' have negative connotations for good reason. The issues outlined in this article should have gone some way to showing that the unit / item cost of a smoke aerosol canister in isolation can be dangerously misleading and to rely on it is short-sighted.

The true cost of an aerosol is very difficult to calculate and is a function of a wide number of factors. The price paid for the canister is only the start and users should begin by looking at the 'minimum contents' of the canister (not the canister size). Here, it is the volume (not weight) which is important since the specific gravity of different chemicals differs widely. More important still is the number of tests that can be obtained. This, in turn, depends on the method of use, the number of sprays required, the duration of each spray, the chemical mix of the product, the rate of product discharge from the can, the make, model and condition of the detector under test, the ambient temperature, relative humidity, airflow and canister temperature when conducting the test and the system configuration – amongst others!

At the same time, calculations of cost per test should take account of whether the aerosol can be relied on to activate all makes and models of detector. Failure to activate a particular detector when it should have done so, means time and money wasted. Finally in the regrettable situation that some aerosols cause damage to the detector, this too must be taken into account.

Conclusion

Production of smoke detector testers has become increasingly commoditised over recent years but we should never be fooled into thinking cheap products are necessarily good products. A fire alarm system is designed to protect life (as well as last a number of years). Any product used to test it needs to enhance its life and dependability, not shorten or detract from it. Detector test aerosols need to be compatible with the plastics from which detectors are manufactured – let alone not harm the user or the environment. Incompatibility can cause stress cracking or affect detector sensitivity, harming the very system under test. A good smoke detector test product is not one that simply sets common detectors into alarm and which is available at low cost. A good product is one that accommodates the test requirements of increasingly sophisticated fire alarm systems, is well supported and meets the many and diverse health, safety and compatibility requirements about which a satisfied user never should need to worry.

