The use of a portable device for the sealing of Nylon 11 (polyamide 11) arson evidence bags

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Introduction

Arosn has a significant impact in the UK and Internationally. With regards to the UK, the cost of deliberate fire started fires is considered to be over £1.3 billion a year (2.12 billion USD). In an average year, these are 3,600 deliberately started fires, 60 injuries and 2 deaths. This results in between 9,000-10,000 samples being analysed across the UK. The collection of arson scene evidence for analysis of volatile compounds must ensure that the evidence is preserved avoiding both loss and contamination (Stairler et al 2007). The containers used are required to contain an array of chemicals potentially utilized to accelerate fires (fire residues and the products generated during combustion). The permeability of the materials used in particular to volatile Organic compounds (VOCs) and the ability to seal the containers is essential to the preservation of this evidence. The containers available, include bags made of a range polymers including laminates of polymers and polymers and metal films, this is supplemented with various designs of cans and jars. Each of these containers has advantages and disadvantages (Redskide et al 1997, Bertin and Ren 2000).

Arson Evidence Bags

Bags made of nylon 11 (also known as Rynite or polyamide 11) are commonly used for collection and preservation of arson evidence in the UK. These are a seamless tubular construction, with one end of this tube often seal by the manufacturer. Nylon 11 is a member of the polyamide group of polymers with the formula [C₆H₉NO]ₙ and a reoccuring structure as seen in figure 1.0.

Figure 1.0 The structure of nylon 11

As a thermoplastic the polyester between 180-185°C, changes the physical properties of the polymer allowing two or more layers to become adhered. The adhesive property arises due to the polar nature of the amide group, which allows strong adhesion of polymers to form multiple hydrogen bonds, including strands from separate layers of the polymer. This generates a seal, which like the body of the tube can retain volatile organic compounds.

Potential benefits

Previous studies have found that of the available techniques the heat seal is the most effective for arson evidence bags (Smyth and Hong-You 2006). In the UK swan neck tyng is the recommended procedure for sealing these bags (Sciencesafe 2009). However it is often impossible to determine whether sealing generated by swan neck tyning or one form of analysis has been conducted. Analysis typically costs £125-150 per sample, therefore as an economic cost to the UK, approximately £1.35 million is spent on analysis of arson scene evidence each year.

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A reduction in headspace volume caused by inappropriate swan neck tyning can alter the profile of the VOC's analysed, as relatively large volumes of accelerant restricted by tyning in a bag may result in a predominance of lower molecular weight volatiles in the headspace (Kattlin et al 2012).

Method

Arson evidence bags were obtained from different forensic suppliers, in which 5 batches were evaluated. All of the bags supplied were from sources which had undergone quality assurance with registration to appropriate ISO Standards. The bags were constructed of nylon 11 and the seals of the bags were single layers, with a 40 µm thickness. These bags were analysed and throughout this study bags were randomly selected from each batch for analysis.

Both unaided observation and microscpic examination x40 magnification using a Nikon, Eclipse E400 POL, were used to inspect the integrity of the heat seals generated.

Heat seals were produced using an impulse heat sealer (Packer PBS-400), powered by the domestic 230 V supply, and to assure porosity a 1000W 12V Pure Sine Wave Power Inverter (Sunsolar Solarrite limited) connected to a 12 v, 45 ah battery (Aptaline).

The strength of seals were tested using the standard drop test from a height of 1.0 m using 1.0 kg sand and tensile strength testing using 10.0 mm sections of seals.

Retention of VOC’s by Heat seals and Swan neck tyning was evaluated by Gas Chromatography-Mass Spectrometry using a Perkin Elmer Clarus 500 quadrupole GC-MS. This was conducted using static headspace analysis of a 100% volume mixture of Petrol and Diesel. Additional analysis was with a Solid Phase Micro Extraction Using a Supelco fused silica fibre coated with a 90 µm film of polydimethylsiloxane.

Results and findings

It was found that the opaque nature of heat seals meant that imperfections were clearly visible without microscopic examination and as such visual examination was capable of rejecting imperfect seals. This visual observation established that four of the five batches of bags, were supplied with some bags with imperfect seals with voids, creases and perforations of bags were observed (figures 2.0 and 3.0).

It was found that the standard drop test method was not able to differentiate between bags with complete and imperfect seal, the exception being bags which were already perforated.

With GC-MS analysis it was found that where seal heat seals were visually examined and deemed to be complete they were capable of retaining VOC’s. These performed equally as well as correctly performed swan neck tyning.

Tensile strength testing was effective and differentiation between bags with complete and perfect seals and allowed variability between batches, in batch and individual bags to be tested. With this was found that of the batches, one was more consistent than the other with a 1.4% (relative standard deviation) compared to the 32.4%.

Visual examination and tensile strength testing conducted on heat sealed bags using the packer PBS-400 showed little variation (percentage relative standard deviation) ranging from 6.5%, to 9.0% on the batches supplied. Addition with the exception of one batch the heat seals produced with the heat sealing were in a greater tensile strength than those present on the bags when supplied. There was no statistical difference between the tests and the domestic 230 V supply of the Power Inverter were used.

Conclusions

This study has found that heat seals can produce seals which are capable of retaining VOC’s. It has been found that these may be made portable by use of a power inverter and an extended battery powerd, and that this has no detrimental effect on the seal generated. This technology provides advantages over the swan neck tyning process commonly adopted in that while it has the same potential to retain evidence, the seals can be quickly and efficiently examined to establish whether the evidence has been generated before leaving the scene, therefore ensuring that potential evidence is not lost.

It has been found that seal produced by some manufacturers are not always complete and so examination should be conducted on these seal also. However the seals generated during this study were more consistent and stronger than those produced by all but one supplier and as such the creation of all seals at the scene may therefore be more reliable.

References