The identification of petroleum residues in arsons

Report title: The Identification of Petroleum Residues in Arsons
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This grant provided partial support for Dr Thatcher to undertake research leading to a Ph.D. in Chemical Engineering from the University of Melbourne. His summary of this research follows:

Although the damage to buildings and property caused by fire is costing the Australian community about $100 million a year, the investigation of arson remains one of the neglected areas of forensic science. Most fires that are maliciously lit are ignited with the assistance of flammable liquids such as petrol and lighting kerosene-the so-called accelerants. These and other fuels derived from petroleum are those most commonly used by arsonists and for this reason this research was concerned only with such liquid fuels.

The scientific investigation of fires suspected to be the result of arson has suffered from severe limitations and, as a result, it has often not been possible to determine whether a fire has been deliberately lit or, moreover, to produce enough convincing scientific evidence to prosecute a suspected arsonist and secure his conviction.

Remarkable though it may be, most fires do not destroy all traces of the accelerants used, even when a conflagration has occurred. In particular, traces of polynuclear aromatic hydrocarbons that are present in all petroleum products in very small amounts or that may be formed when these products are burnt, often remain in unburnt fuel at the source of the fire or are deposited in soots on the relatively cold surfaces of fittings, such as windows, that escape complete destruction.

This research has concentrated on two major areas of arson investigation where at present the scientific limitations result in the non-detection of some arsons. As a consequence charges are not laid in these cases.

These two areas are (i) the comparing of accelerant residues found at arson scenes with fuels suspected of being the source of these residues (in order to provide incriminating evidence) and (ii) the solving of large or confusing fires by examining the soot deposits mentioned above.

To resolve these problems the polynuclear aromatic hydrocarbons in the fuels were quantitatively determined and the polynuclear aromatic hydrocarbons associated with the soots formed by burning the fuels were also identified.

It was found that each fuel and solvent of different origin did not contain the same relative amounts of particular polynuclear aromatic hydrocarbons and that the fuels could be distinguished by the ratios of the concentrations of these compounds.

When the fuels and solvents were burnt it was found that most of the polynuclear aromatic hydrocarbons appeared in the soot extract regardless of the type of fuel burnt but, significantly, others only appeared in the soots formed by burning aliphatic fuels.

These results were used to postulate pathways leading to the formation of soot and associated polynuclear aromatic hydrocarbons and also to explain the different ratios of certain structural isomers which were in the soots, depending on the degree of aliphaticity and aromaticity of the fuels. The fluoranthene/pyrene ratio in the soots was particularly important in interpreting the chemical nature of the fuel burnt.

Materials which are commonly used in the building, furnishing, decorating and packaging industries were also burnt to investigate the effect that compounds formed in these flames would have on the interpretation of the results obtained from soots taken from suspected arson scenes. It was established that these substances could be identified by the presence of heterocyclic polynuclear aromatic hydrocarbons and phthalates in their soots.

Experiments were then carried out on some of the fuels to investigate the effect of a restricted air supply on the types and amounts of polynuclear aromatic hydrocarbons formed in flames. These experiments were done because occasionally arsons occur in situations where the fire burns with a very limited supply of air as a result of doors and windows having been left closed either inadvertently or to prevent early detection of the fire.

Finally fire scenes were attended and investigated by orthodox procedures. If the cause of the fire was successfully determined by a scene examination and subsequent conventional laboratory tests, a soot sample was taken and analysed to determine the validity of the new technique.

Since the results obtained by the new technique confirmed the conclusions drawn on the basis of orthodox procedures in most cases, there is every reason to believe that this novel method could be used not only to obtain corroborative evidence but also in its own right as a method for establishing the cause of fire.