

Dr Christina Baxter, of EmergencyResponseTIPS.com and Hazard3.com, offers helpful advice for first responders

Keeping you safe!

This column aims to provide the hazmat/CBRNE community with operational guidance on the selection and performance of equipment and tactics. In this issue, we focus on inorganic explosive materials and the ongoing interest in their use in improvised explosive devices (IEDs) by terrorist groups. The recent Mujahideen in the West magazine (2022) and the 2023 Al Qaeda video, Inspire, highlight their preparation and especially the use of chlorate based explosives for terrorist operations.

Background

Explosives require a fuel and an oxidiser. A sensitiser may also be necessary. Inorganic explosives are energetic materials that include at least one inorganic oxidiser made of non carbon based compounds although they may be mixed with organic fuels in operational scenarios. The oxidisers in these mixtures are oxygen rich inorganic salts such as nitrates, chlorates, perchlorates or azides.

Nitrate salts are the most common inorganic oxidiser for explosives. For example, ammonium nitrate is used in ammonium nitrate/fuel oil (ANFO) mixtures as a high explosive blasting agent in the mining and construction industries. It was used in the 1995 Oklahoma City bombing. Alternatively, potassium or sodium nitrate are often used with sulphur or charcoal as components of black powder, which is a low explosive.



The azide salts are usually highly sensitive, primary explosives often used in detonators, blasting caps and military munitions. Lead azide is the most common. It is highly sensitive to external stimuli making it a reliable and reproducible initiator for explosions.

These days chlorate salts are generally obsolete in military and industrial applications due to their instability and sensitivity to friction, impact and other chemicals. Historically, they were used in percussion caps, smoke grenades, and pyrotechnics, although people mostly recognise them as the 'pop-it' noisemakers. Perchlorate salts are still used in rocket propellants especially solid propellants, pyrotechnics and others. These chlorate and perchlorate based explosives remain popular with domestic and international terrorist groups as a primary component in IEDs as they are readily accessible.

Process recognition

Inorganic oxidisers can be prepared using improvised methods or purchased and then incorporated into IEDs within illicit facilities, however it is the purchased materials that are the more common. It is imperative that emergency response personnel quickly recognise their manufacture, handling or IED preparation. For safety, immediately, isolate the area and seek the assistance of qualified explosive ordnance disposal or a public safety bomb team.

Illicit laboratories where extraction takes place are most likely to be encountered and are described in detail in terrorist literature. For example, potassium chlorate is contained in match heads and can be extracted using hot water, which is then filtered and crystallised. The indicators for potassium chlorate extraction include used matchsticks with the heads missing and a drying solid residue coloured red to pink from the dye in match heads. Red is the most common colour for safety matches worldwide. A similar method is used to extract potassium perchlorate from sparklers. In this case, the resultant solid residue would be coloured gray to silver.



Illicit laboratories where the oxidisers are synthesised are less frequently encountered. Often heating and cooling sources, reaction vessels, and some type of ventilation are found at these labs along with precursors. For example, in a facility synthesising potassium chlorate, bleach (sodium hypochlorite) and a potassium chloride salt substitute may be found. Chlorine may be accidentally produced during this process. When at these sites always beware of innocuous looking crystalline materials that may be shock and friction sensitive, like lead azide. Do NOT touch. Assess the incident following your response protocols and select the appropriate PPE to protect your respiratory system and skin.



Detection

These materials can often be readily identified on scene. First, screen radiation if it is suspected and choose a suitable sampling technique that considers the hazards, sampling location, detection techniques to be used, and any forensic requirements. Colorimetric kits are most widely used to detect these materials in the field. They are easy to use, often sensitive, but not selective. To account for specificity issues, multiple samples and other detection techniques should be used to rule out cross sensitivities.

Ion mobility spectroscopy (IMS) is commonly used at security checkpoints due to its high sensitivity to organic explosives. Unfortunately, this does not translate to most inorganic explosives due to their low vapour pressure, although volatile nitrates can be detected. Other techniques like capillary electrophoresis have been used to cover this gap, for instance the GreyScan instrument. It is sensitive, detecting explosive residues at nanogram levels.

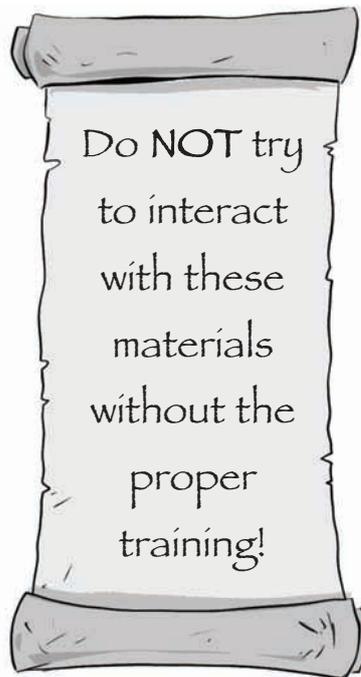
Keeping you safe!

Vibrational spectroscopy is also a valuable technique. Raman spectroscopy is widely used in detecting explosives, but care must be taken when evaluating solid explosives as the laser energy may be enough to detonate the material. This includes the inorganic oxidiser components since it may not be readily apparent that these are not the explosive material. To minimise this threat, always use the smallest amount of material possible for detection and consider reducing the laser power, defocusing the laser, if possible, or utilising raster scanning if available. In addition, using the time delay function on a Raman instrument, mounting it on a robotic platform, or using a standoff capable system, further reduces the potential for accidental initiation and injuring personnel.

There are many instruments commercially available. The Pendar X10 is an example of a standoff system that allows for proximity detection or robotic mounting and utilises raster scanning to minimise the energy used to capture Raman spectra. [See *CBRNe World* 2019-06 for more on Raman spectroscopy.]

Fourier Transform Infrared (FTIR) spectroscopy is also an excellent way to identify explosives in field operations, but it is necessary to take a sample and bring it to the instrument. Small samples are sufficient for FTIR thereby minimising the overall risk, however users should also consider running solid samples without using the anvil to minimise pressure contact. There are many FTIR systems available including from 908 Devices (VipIR, ThreatID, or ProtectIR), Thermo Scientific (Gemini or TruDefender FTX) and Smiths Detection (Hazmat ID Elite), and others allow for FTIR operations without anvil contact. [See *CBRNe World* 2024-05 for more on FTIR.]

Beware of innocuous looking crystalline materials!!



Remember, for a safe and effective response to events involving explosives, secure the immediate area and call for support from the nearest explosives response team. Do NOT try to interact with these materials without the proper training and certifications. Prior coordination and practice between law enforcement, fire, and emergency medical agencies will be critical so everyone is aware of the likely threat agents and their use, and to ensure the successful resolution of these events.

Images are courtesy of Phil Buckenham <https://philbuckenhamart.wixsite.com/philbuckenham>