Unit-5: Cases Involving Arson and Explosives

[Chemistry of fire. Collection and preservation of arson evidence. Analysis of fire debris. Analysis of ignitable liquid residue. Scientific investigation and evaluation of clue materials. Information from smoke staining.
Classification of explosives - low explosives and high explosives. Synthesis and characteristics of TNT, PETN and RDX. Mechanism of Explosion process. Blast waves. Searching the scene of explosion. Post blast residue collection and analysis.]

Chemistry of fire

Fire is the rapid oxidation process with release of heat, light, and various reaction products.

1. **Fuel** can be any combustible material in any state of matter-solid, liquid, or gas such as furniture, paper, kerosene, diesel, petrol, alcohol, turpentine oil, etc.
2. **Oxygen** is available from the atmosphere.
3. **Heat** is the energy necessary to increase the temperature of the fuel to a point where sufficient vapors are given off for ignition to occur.

Flammable liquids are those that have a flash point below 100^0F.

Combustible liquids are those that have a flash point above 100^0F

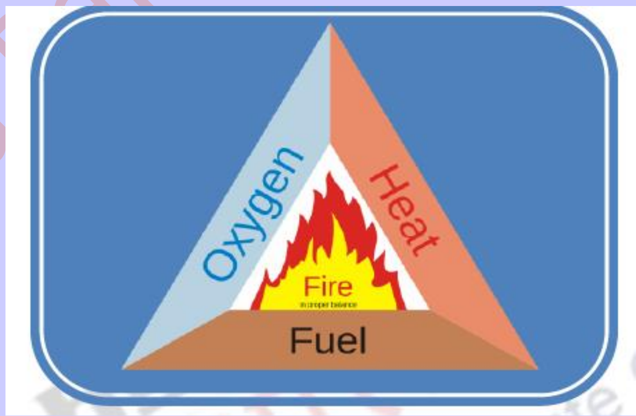


Figure1 is a Fire Triangle that represents the 3 elements needed for fire to occur: Heat, fuel and oxygen are all essential elements for a fire to occur.

Types of Fire:

(a) CLASS "A" FIRES

A class "A" fire can involve any material that has a burning ember or leaves an ash. Some examples of class "A" fires are wood, paper, or pulp. The adopted method for quenching fire of class "A" is to remove the heat. Water is considered to be most common agent, but other agents such as foam and dry chemical can be effectively used.

CLASS "B" FIRES

A class "B" fire involves flammable liquid or gas. Familiar examples would be gasoline, oil, propane, and natural gas. A variety of fire extinguishing agents is used on flammable liquid fires employing all theories of fire extinguishment. Which agent is best to use is dependent upon the circumstances involved. Flammable liquids do not ignite in their liquid state; rather it is the vapors being generated by these liquids that ignite. The mixture of oxygen and flammable vapors in proper proportion needs only an ignition source to start the combustion process.

CLASS "C" FIRES

Class "C" fires involve live electrical equipment and require the use of an extinguishing agent and/or extinguisher that will not conduct electricity back to the fire fighter(s). Electricity is an energy source and an ignition source, but by itself will not burn. Instead, the live electrical equipment may serve as a source of ignition for a class "A "fire such as insulation or packing, or a class "B" fire.

CLASS "D" FIRES

Class "D" fires involve exotic metals such as titanium, zirconium, magnesium, and sodium. These fires require special agents such as dry powders and special application techniques. The extinguishing agents and techniques used on "A", "B", or "C" fires will not work on class "D" fires, nor will the agents and techniques used for class "D" fires work on any other classification of fire. Many common agents like water will actually react to burning metals and increase the intensity of the fire in a violent manner.

Table 1.

Class/Classificationoffires	**Example**
Class"A"	Solid materials: paper, wood, lumber, cloth
Class"B"	Flammable liquids: oils, paints, grease, gases
Class "C"	Electric:faultyfuseboxes,frayedwires,over-loaded electrical outlets
Class "D".	combustiblemetals

Arson

Arson is the crime of intentionally and maliciously setting fire to buildings, wild land areas, vehicles or other property with the intent to cause damage. Arson often involves fire deliberately set to the property of another or to one's own property so as to collect insurance compensation. Arson is also called incendiary fire.

Motives for Arson:
(i) Revenge: Personal or professional vendetta
(ii) Vandalism: Crime of opportunity
(iii) Profit: Monetary gain by claiming insurance

(iv) Crime Concealment: Destroying evidence to cover another crime
(v) Excitement: Sense of power or seeking recognition
(vi) Extremism: Social protests against governments or corporations

Collection and preservation of arson evidence

Proper evidence collection and chain of custody are the responsibility of the scene investigator or a designated evidence technician who selects and assembles all evidence collection equipment and materials.

As evidence is identified, the investigator may work with a photographer and/or a schematic artist. The investigator is responsible for proper documentation of evidence prior to collection, maintaining an evidence log and numbering system, packaging and preserving all evidence collected, and maintaining custody at the fire scene and during transportation to a properly secure storage area. The investigator is also responsible for arranging for laboratory analysis requests and transmitting evidence to the laboratory.

Evidence Containers

Fire investigators should carry a supply of various evidence containers, including both one-quart and one-gallon clean, unused metal evidence cans, or the equivalent, in which to store residue samples. A good practice is to seal a one-quart evidence can and place it inside a one-gallon evidence can. Then, seal the one-gallon can before placing the cans in your vehicle. This saves space and prevents contamination. Seal the can with only hand pressure to eliminate contamination from outside vapors. Open the cans just prior to physically collecting the sample at the collection site.

- When evidence is expected to be subject to analysis, as in an arson investigation, it is necessary to be able to establish that the item seized is the same item that was analyzed. Consider the following advice from Melville, *Manual of Criminal Evidence,* Second Edition, Denver D.A. office:

  "*Whenever any piece of evidence must be passed from hand to hand to set up the chain of evidence in a case, it is essential that every person who has anything to do with the matter must be prepared to testify as to*

  1) when and how such piece of evidence came to him,
  2) what he did with it while it was in his possession, and
  3) when, why, how and to whom he delivered it."

Extraction Techniques

There is no single best extraction method for the analysis of fire debris. Selection of an extraction technique is dependent on a variety of factors, many of which are beyond the control of the examiner. The ideal extraction technique would be sensitive yet nondestructive – that is, it would not fundamentally alter the evidence in such a way that it could not be retested. It should allow for the extraction process to recover any ignitable liquid of interest from the debris, but should minimize the recovery of chemicals related to the substrate or its combustion and pyrolysis products.

1. Solvent extraction

The technique of solvent extraction is based on one of the simplest and most well known chemical principles: like dissolves like. The technique of solvent extraction requires that the analyst use an appropriate solvent to dissolve any ignitable liquids that may be present in the sample being tested. It is a simple, quick, inexpensive, and uncomplicated technique that requires little in the way of equipment and has long been applied to the analysis of fire debris for the recovery of accelerants. Solvents are selected based on their ability to recover common ignitable liquids. Because the most frequently encountered accelerants are composed of hydrocarbons derived from crude oil, nonpolar solvents are most effective. Commonly used solvents include pentane, carbon disulfide, diethyl ether, and chlorinated solvents.

Solvent extraction offers several **advantages** to the fire debris analyst.

- It can take only minutes to perform, allowing the analyst to begin the instrumental portion of the analysis nearly immediately.
- It also offers the distinct advantage of minimal discrimination in extracting residue from the sample matrix.
- The solvent extraction method recovers all miscible components of the ignitable liquid residue more or less equally. This allows for the extract to better represent the actual composition of the ignitable liquid residue present in the sample matrix.

Solvent extraction offers some **disadvantages** as well.

- It can often require fairly substantial amounts of hazardous solvents, which can pose risks to health and safety.
- In addition, this technique, although sensitive, is less sensitive than some of the available techniques.

- It often requires concentration of the extract, which may result in the loss of the more volatile ignitable liquid components and the concentration of low-level impurities present in the solvent.
- It often co-extracts substantial amounts of matrix-related components.

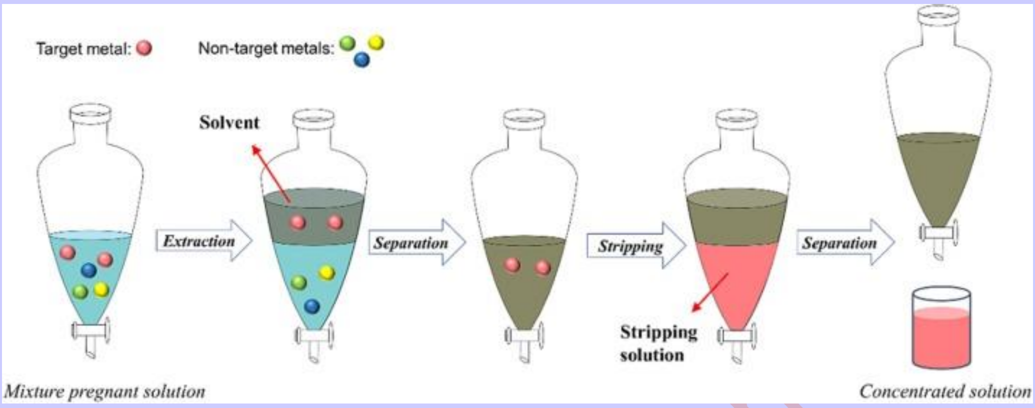


Fig. 2 Solvent Extraction Method

2. Headspace sampling

Like solvent extraction, the technique of headspace sampling is quick and simple, easy to perform, and requires minimal equipment. The technique of headspace sampling relies on the physical property of the volatility of ignitable liquids. Volatility refers to a liquid's tendency to have a rich vapor phase, and to evaporate readily. In headspace sampling, the sample of fire debris may be heated in order to enrich the vapor above the sample, or it may be done at ambient temperature. To perform the technique of headspace sampling, a portion of the vapors above the sample of fire debris is removed, and directly introduced to the instrument being used for analysis – generally, the gas chromatograph (GC).

The headspace sampling method offers several **advantages** as a method for the recovery of ignitable liquids.

- The application of the technique is rather simple; there is no special equipment needed, other than a suitable syringe for collecting and introducing the sample.
- No solvents are used, thereby offering two advantages: there are reduced health, safety, and environmental hazards, and there is no added solvent, which may interfere with the products being recovered from the sample matrix.

- Because this sampling method only removes a relatively small portion of the headspace vapors, the evidence is essentially unchanged and the technique is considered to be nondestructive.
- Headspace sampling can provide important information about some types of samples; however, because of its inability to recover the full range of commonly encountered ignitable liquids, it should not be used as the sole sampling technique.

The **disadvantages** associated with the method are

- Only a small portion of the headspace vapors being sampled is that this technique offers no means of concentrating low levels of ignitable liquids. Therefore, it is one of the least sensitive techniques still in modern use.
- The headspace technique is also not suitable for the recovery of all types of ignitable liquids.
- Because it is based on the collection of vapors, this technique may be useful for lighter (more volatile) ignitable liquids, but will not efficiently recover all classes of ignitable liquids, such as those classified as heavy or medium.

3. Passive adsorption (passive headspace concentration)

The most commonly used extraction method for the recovery of ignitable liquids from fire debris is that of passive adsorption according to reports from recent proficiency tests and a survey of practitioners. This method involves concentrating vapors from the headspace of a sample within a closed system onto a suitable adsorbent, then desorbing the recovered species. Activated charcoal, also referred to as active carbon, is the most commonly used adsorbent, and is generally desorbed via solvent. Other adsorption-based methods exist including solid phase microextraction (SPME) and those that utilize an adsorbent. To use this technique, adsorbent in an appropriate form is placed in the sample container along with the fire debris, and the container is usually heated for a period of time. This is the adsorption period in which vapors present in the sample container become adsorbed onto the activated charcoal. Following the adsorption period, the adsorbed compounds are eluted – or removed – from the charcoal with solvent. While many solvents have been researched for this application, the most important factors to consider are miscibility and the solvents affinity for adsorption sites. Because of these factors, carbon disulfide is commonly used, although other solvents such as pentane, diethyl ether, and methylene chloride have also been used in this application. The activated charcoal needs to be in such a form that it can be relatively easily manipulated so that it can be placed in and removed from the container. In addition, the active sites on the charcoal must be accessible to the headspace vapors in the can.

The **advantages** offered by this technique are

- It is suitable for recovering a fairly broad range of ignitable liquids.
- This method can also recover very volatile ignitable liquids, which can be detected and identified via GC-MS when instrument parameters are set to collect data prior to the elution of the solvent.
- Passive adsorption offers is that it requires relatively little examiner time. Fire debris samples can be batched and extracted simultaneously, with the majority of the extraction time being unattended.
- This technique allows for concentration of vapors onto the charcoal, and elution generally occurs with a minimal volume of solvent, so it is also one of the most sensitive techniques available.
- Studies have shown that in all but the most extreme situations, this technique can be repeated numerous times, with no significant change in the extracts obtained; therefore, it may be considered nondestructive in that it does not permanently alter the parent evidence.

All of these factors lead to the passive adsorption method being one of the most efficient of the available techniques.

As with every technique, however, there exist some **disadvantages**.

- The cost per sample is relatively high compared with other sample preparation methods.
- Samples that are extremely concentrated may saturate the available active sites, which lead to the phenomenon of displacement.

4. Dynamic adsorption (dynamic headspace concentration)

The technique of dynamic adsorption relies on the same basic principles as the passive adsorption extraction method. Versions of a dynamic adsorption method have been applied in the petroleum industry and in environmental and industrial hygiene applications. Dynamic adsorption was in common use for the extraction of ignitable liquid residues from fire debris for a long time prior to being almost completely replaced by the passive technique. The dynamic technique is still considered an acceptable method for the extraction of fire debris for the recovery of ignitable liquid residues for Separation and Concentration of Ignitable Liquid Residues from Fire Debris by Dynamic Headspace Concentration. Like the passive technique, the dynamic method of extraction relies on the adsorption of vapors onto a suitable material, most commonly charcoal, and their subsequent elution via solvent. The critical difference between these two techniques is that while the passive method uses a closed system, the dynamic system uses a system in which air or an inert gas is forced through the sample container.

Advantages:

- This technique offers the capability of recovering a broad range of ignitable liquid residues with very good sensitivity.
- Unlike its passive counterpart, however, a complete extraction – from adsorption to elution – can often be done in less than an hour.

Disadvantages:

- The time conducting this extraction is much more labor-intensive than the longer time spent completing the passive extraction.
- Whereas the passive extraction requires minimal examiner time during its approximately 16 hr extraction process, and allows for sample batching, the dynamic extraction process requires the examiner to be present and attending the dynamic extraction.
- In addition, this method cannot be feasibly automated and is not amenable to batching numerous samples.

5. Solid phase microextraction (SPME)

The most recent extraction technique to be added to the fire debris analyst's toolbox is that of SPME. It is a relatively new technique that has been used in a variety of other separation applications, as well as in the extraction of ignitable liquids from fire debris Extraction by SPME most commonly involves the exposure of a fiber bearing an adsorptive coating to the headspace above a sample, which may be heated or held at ambient temperatures. Less frequently, the SPME fiber may be immersed directly into an aqueous liquid. Following this adsorption step, the fiber is then thermally desorbed directly into the instrument being used for analysis. In this application, polydimethylsiloxane (PDMS) is most commonly used.
The application of SPME for the recovery of ignitable liquids from fire debris offers many advantages.

- It is both quick and easy to perform.
- Extraction times for SPME are typically in the range of 5–20 min.
- The process is relatively simple. Because of the quick and simple nature of this technique, instrumental analysis can begin with 20 min of beginning the examination, thereby allowing for very rapid results. The SPME fiber is small, and has relatively few adsorption sites.

- This means that the recovered sample is most often only a small portion of the ignitable liquid residue vapors present in the can, so the extraction may be conducted repeatedly, without significantly altering the sample.
- Because this technique will not fundamentally change the primary sample so that the sample can be subjected to retesting, it may be considered a nondestructive technique, which is an important advantage for any technique with forensic implications.
- Another advantage of this technique is that it does not require use of a solvent in the desorption phase.
- Lack of solvent offers several advantages. There is a significantly lower health and safety risk when no solvent is used, and there are no expenditures for the purchase or disposal of solvents.
- In terms of analytical advantages, the lack of solvent means that there is no concern with a solvent masking a component of an ignitable liquid that may co-elute with the solvent, or that may be lost within the solvent front.
- This allows SPME to be effectively applied to cases in which there may be very volatile ignitable liquid residues.

As a result, this technique is also one of the most sensitive techniques.

Disadvantages

- There is no way to preserve a portion of the sample for later reanalysis, which may be problematic for forensic cases.
- The purchase of several SPME assemblies is necessary for the efficient processing of forensic casework, which requires an initial one-time expenditure.
- The cost and fragility of the fibers may be considered to be a disadvantage.

Information from smoke staining

Smoke staining is an important indicator in fire investigations, as it provides information about fire behavior, progression, and possibly even origin. Here's how smoke staining is analyzed and used in fire investigations:

1. Identification of Fire Patterns

Smoke staining can reveal where the fire started and how it spread. Fire often leaves V-shaped patterns on walls or surfaces, pointing to the origin.

Smoke staining can help determine airflow patterns during the fire, showing how heat and smoke moved throughout the space.

2. Determining Fire Duration and Intensity

The amount and thickness of smoke deposits can indicate how long the fire burned. Heavier staining often points to prolonged exposure to smoke or more intense burning in a particular area. The chemical composition of soot can provide clues to the materials burned. For instance, plastics produce oily, black soot, while wood produces lighter, flaky soot. Analysis of these differences can give insights into the materials involved.

3. Clues about Ignition Sources

Concentrated smoke staining near an ignition source, like electrical outlets, switches, or appliances, may indicate the source of ignition. Objects that shielded surfaces from smoke and heat leave behind "shadows." These shadows reveal the position of items before the fire, helping to reconstruct the scene and potential sources.

4. Intentionality and Potential Accelerants

In cases of arson, accelerants are often poured in irregular or splash patterns. The smoke staining can sometimes reveal these patterns, especially if accelerants leave distinctive residue. Accelerants often cause faster smoke spread, and the staining may reflect this through more extensive coverage in a shorter time, differing from a natural fire progression.

5. Environmental Influences on Smoke Staining

The presence of open doors, windows, or ventilation systems affects smoke movement, often causing specific staining patterns or uneven distribution. In outdoor fires or partially open structures, wind can affect smoke direction, creating unique staining patterns. Forensic teams can study these for clues about the fire's origin and path.

6. Documentation and Legal Relevance

Investigators document smoke staining with photographs and sketches to analyze patterns in court.

Smoke staining is often used in conjunction with other fire debris analysis to support findings about fire origin, intent, and the materials involved. Smoke staining analysis offers crucial information that can reveal a fire's path, duration, and whether accelerants were used, making it a vital component of fire investigation.

Explosive

It is defined as any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i.e., with substantially instantaneous release of gas and heat

Classification of Explosives

Low explosive (LE): It is an explosive material that can be caused to burn when unconfined.

- Burn rapidly but do not detonate (subsonic combustion).
- Deflagration process with reaction rates below the speed of sound.
- Pressure wave is mild and sustained.

Examples: Gunpowder, smokeless powder, fireworks.

High explosive (HE): It is an type of explosive material that undergoes **detonation**, a rapid chemical reaction that propagates through the material at a **supersonic speed** via a shockwave. This reaction releases a large amount of energy in the form of heat, gas, and pressure within microseconds. Examples: TNT, RDX, PETN.

High explosives can further be classified as

- *Primary Explosives*: Extremely sensitive to heat, friction, and impact (e.g., lead azide, mercury fulminate).
- *Secondary Explosives*: Less sensitive but more stable; require a detonator (e.g., TNT, RDX, PETN).
- *Tertiary Explosives*: Require extreme conditions to detonate (e.g., ANFO).

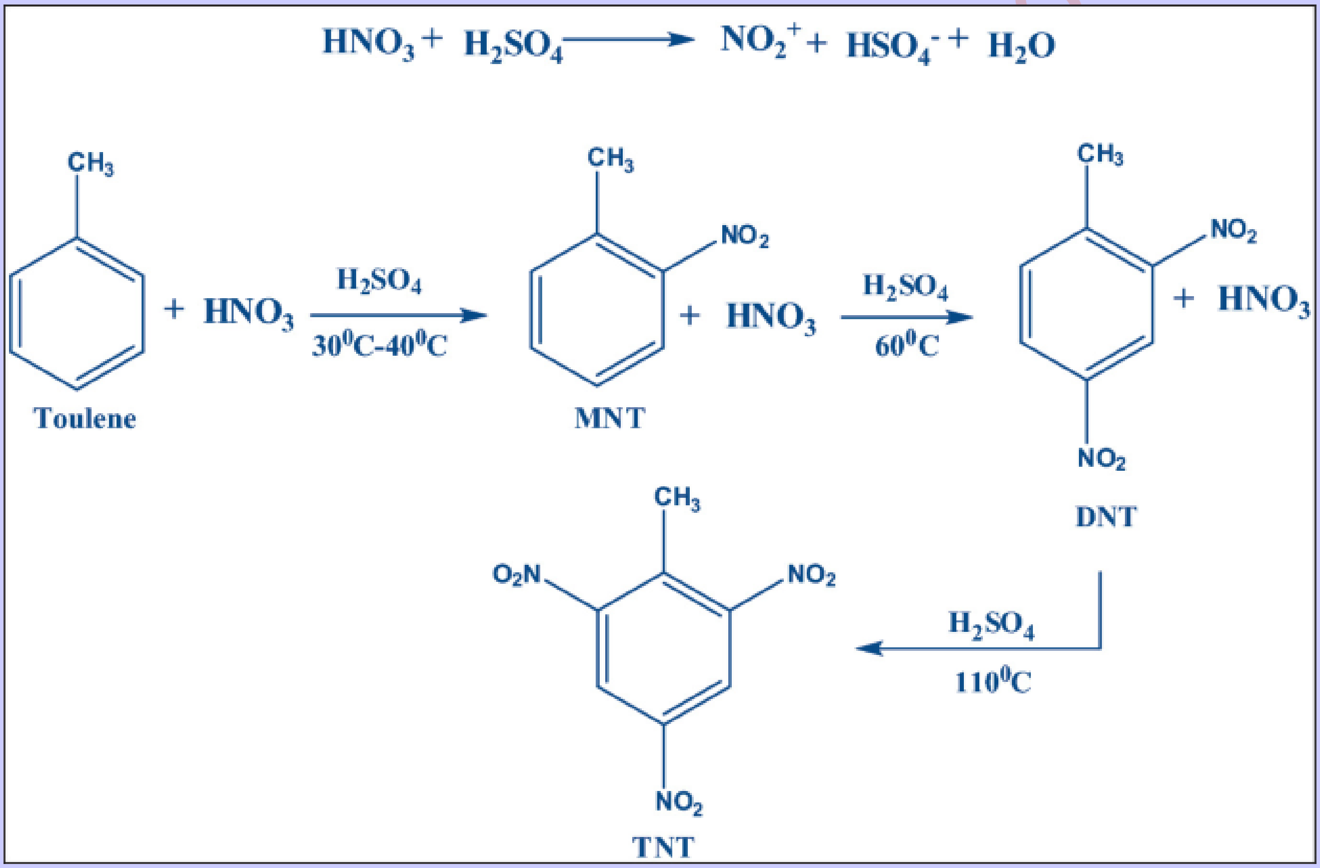
Synthesis and Characteristics of TNT, PETN, and RDX

1. **Trinitrotoluene (TNT)**: The process can be carried out in three steps or continuously. The Bofors-Norell process is one method

that involves continuous nitration of toluene or mononitrotoluene (MNT) to TNT, and continuous crystallization from dilute nitric acid.

The synthesis of trinitrotoluene (TNT) is a multi-step process that involves the nitration of toluene with nitric acid and sulfuric acid:

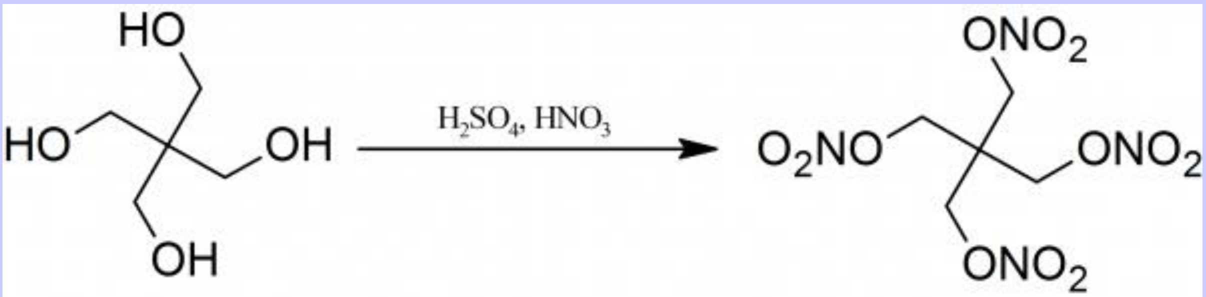
- Mononitrotoluene (MNT): Toluene is nitrated with a mixture of nitric and sulfuric acid to produce MNT.
- Dinitrotoluene (DNT): MNT is separated and then renitrated to produce DNT.
- TNT: DNT is nitrated with an anhydrous mixture of nitric acid and oleum to produce TNT.



TNT is a yellow, odorless, explosive substance that's used in military and industrial applications. It's used in shells, grenades, bombs, and for underwater and industrial blasting.

2. **Pentaerythritol Tetranitrate (PETN):** PETN is a well-known chemical compound that is often used in making explosives. PETN is prepared by the reaction of nitric acid with

pentaerythritol ($C_5H_{12}O_4$). Pentaerythritol is a commonly used alcohol in varnishes and paints. The reaction takes place in chilled conditions so that PETN can precipitate out.After its precipitation, PETN is filtered, washed, dried, and undergoes recrystallization resulting in a colorless crystalline material. PETN is stored in a mixture of alcohol and water.

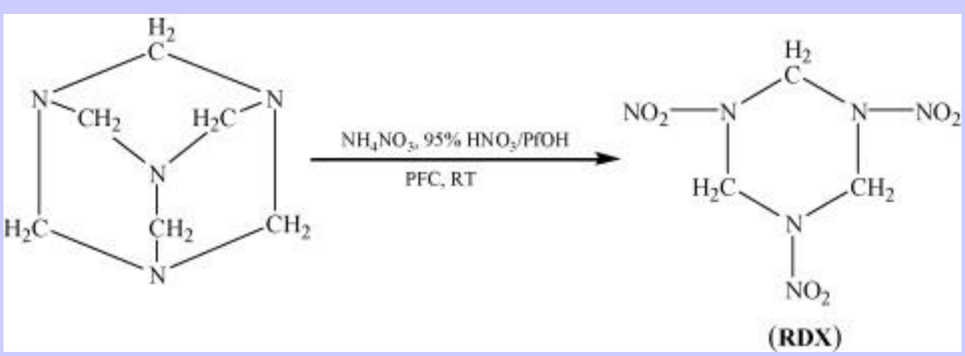


Pentaerythritol PETN

PETN is a white crystalline powder with a melting point of 141 °C. PETN is used in many commercial and military explosives, as the primary ingredient in detonating fuses, and as a component in some plastic explosives. It is also used to treat chronic cardiac insufficiency.

3. RDX

The full form of RDX is **R**oyal **D**emolition e**X**plosive. It is synthesized through the nitration of hexamine under controlled conditions. Hexamine is treated with concentrated nitric acid (HNO_3), sometimes in the presence of acetic anhydride as a dehydrating agent. The nitration process converts the hexamine into RDX through the substitution of nitro groups ($-NO_2$).



It is a white crystalline solid having melting point ~204°C. RDX is used as a base charge for detonators, or mixed with other explosives to create bursting charges for aerial bombs, mines, and torpedoes. RDX is also used as an ingredient in plastic explosives. It can be used as a propellant or gunpowder.

Mechanism of Explosion Process

An **explosion** occurs when a material undergoes a rapid chemical or physical reaction, releasing a large amount of energy in the form of heat, gas, and pressure. This process is typically initiated by an external energy source (e.g., a detonator) or a catalytic reaction.

Steps in the Explosion Process:

1. **Initiation**: It requires an energy source (e.g., a detonator or a spark) that initiates the explosive reaction. In high explosives, the reaction begins with the formation of a shockwave that propagates through the explosive material.
2. **Propagation**: The explosive material undergoes rapid decomposition or detonation after initiation. The detonation front travels at supersonic speed, breaking molecular bonds, releasing energy, and forming high-pressure gases.
3. **Detonation**: **Detonation velocity** is the speed at which the chemical reaction front moves through the explosive material, usually in excess of the speed of sound (greater than 1,000 m/s). This creates a **shockwave** that can cause significant destruction due to the rapid release of energy.
4. **Expansion**: The hot gases produced during the explosion expand rapidly, causing a rise in pressure and a sudden release of energy in the form of a blast wave. The energy dissipates in the surrounding area, causing the destruction of objects and structures.
5. **Completion**: The explosive reaction completes, leaving behind fragments, gases, and other byproducts such as unburned explosives or residues.

Blast Waves

A **blast wave** is a high-pressure wave that propagates outward from the point of an explosion. It consists of a **shock front** that travels at supersonic speed and is followed by a less intense negative pressure phase.

Searching the Scene of Explosion

Post-explosion investigations are critical to understand the cause of the explosion and gather evidence. The process of searching the scene of an explosion involves several careful and systematic steps.

1. **Safety First**: Ensure that the area is secure and free from further hazards (e.g., secondary explosions, collapsing structures). Protective gear (gloves, masks, and suits) should be worn by investigators to avoid contamination or exposure to dangerous residues.

2. **Initial Survey**: Conduct a preliminary survey to assess the scale of the blast and identify any immediate hazards (e.g., fire, unexploded ordnance, toxic gases). Take general photographs of the scene, noting key features like the blast center, debris patterns, and visible damage.

3. **Identify Blast Effects**: Look for physical indicators of the blast, such as the presence of craters, burn marks, and scattered debris. Record the direction of the blast wave based on the damage pattern and the location of the explosion's epicenter.

4. **Secure the Scene**: Isolate the area and prevent contamination of evidence. Ensure that all individuals involved in the investigation are authorized and trained to handle explosive evidence.

5. **Systematic Search**: Perform a detailed search for specific evidence, including remnants of explosive devices, residues, and materials that could explain the cause of the explosion. Look for items like detonators, bomb fragments, or unexploded ordnance.

Post-Blast Residue Collection and Analysis

Collecting and analyzing residues after an explosion is crucial for identifying the explosive used, determining the source of the explosion, and conducting forensic investigations.

1. Collection of Residues:

- **Handling of Samples**: Use clean tools (e.g., tongs, brushes) to collect samples from the scene. Prevent contamination by wearing gloves and using sterile containers.
- **Collection Areas**: Focus on areas near the explosion epicenter, surfaces exposed to the blast, and any nearby unburned material or fragments.
- **Types of Samples**: Collect dust, soil, debris, and any remaining traces of explosives from walls, floors, or nearby objects.

2. Residue Analysis:

- **Chemical Analysis**:
  - Use techniques like **Gas Chromatography-Mass Spectrometry (GC-MS)**, **Liquid Chromatography-Mass Spectrometry (LC-MS)**, and **Ion Chromatography** to detect explosive residues such as TNT, PETN, or RDX.
- **Spectroscopy**:
  - **Fourier Transform Infrared Spectroscopy (FTIR)** and **Raman Spectroscopy** are used to identify specific explosive molecules and their chemical composition.
- **Microscopic Examination**:
  - **Scanning Electron Microscopy (SEM)** can reveal detailed traces of explosives and their physical properties.
- **X-ray Diffraction (XRD)**:
  - Identify crystalline residues of explosives like TNT or other high-energy compounds.

3. DNA/Trace Evidence:

- Search for fingerprints, clothing fibers, or other trace evidence that might link a suspect to the explosion.

4. Documentation and Chain of Custody:

- Document all steps of residue collection and analysis in detail to maintain an unbroken chain of custody for legal and forensic purposes.

The **investigation and analysis of an explosion scene** are crucial for understanding the cause, reconstructing events, and gathering evidence to identify those responsible. A thorough scene investigation helps pinpoint the **type of explosive used**, its placement, and the mechanism of initiation, providing valuable insights into whether the explosion was accidental or intentional. Proper analysis of blast effects, debris patterns, and residue aids in determining the direction and intensity of the explosion, this is vital for understanding its impact and preventing similar incidents in the future. Additionally, forensic evidence collected at the scene, such as explosive residues, device fragments, or biological material, can link suspects to the event and support legal proceedings. Effective scene investigation also ensures the safety of responders, protects evidence from contamination, and upholds the integrity of the investigation, ultimately contributing to public safety and justice.

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