

II Forensic Investigation of Explosion

A. Explosives and Explosions

1. The Chemistry of Fire

a. Explosions are similar to combustion, the only difference is the speed (rate) of the reaction. Explosions are extremely fast, producing large amounts of gas, building up high pressure.

(1) Detonation occurs so fast, oxygen in the air cannot be used for the reaction. So many explosives must have their own source of oxygen, called oxidizing agents.

Ex) black powder - a mixture:

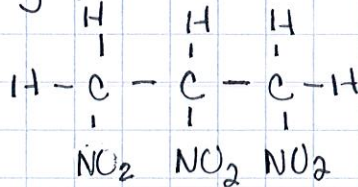
75% potassium nitrate (KNO_3)

15% charcoal (C)

10% sulfur (S)

when ignited, the oxygen is liberated & combines to form $CO_2(g)$ which builds up lots of pressure.

nitroglycerin



oxygen is embedded w/ one molecule

2. Types of Explosives

a. Low explosives

(1) decompose at relatively slow rates, less than 1000 m/s, called deflagration - generate low-intensity pressure wave that can disrupt the surroundings

(2) when confined to small spaces, can explode w/ lethal force

(3) Types

(a) black powder -

(i) one of two most widely used explosives

(ii) accessible to the public &/or relatively easy to make

(iii) mix of KNO_3 , C, & S - see above

- unconfined: it just burns

- used in safety fuses - black powder infused cord that burns slow enough to allow people enough time to leave site.

- (b) smokeless powder
 - (i) other most widely used explosives
 - (ii) made of nitrocellulose (single-base powder) or nitroglycerin mixed w/ nitrocellulose (double-base powder)

pic p5b2

- (c) Chlorate mixtures
 - (i) $KClO_3$ + sugar
 - + C
 - + S
 - + starch
 - + P
 - + mg filings

- (d) Gas-Air Mixtures
 - (i) only works w/ the flammable range of fuel-air concentrations
 - Ex. gasoline 1.3-6% natural gas 5.3-13.9%

b. High Explosives

blw 1000 m/s - 8500 m/s

- (1) decompose at relatively large rates, greater than 1000 m/s, called detonation - accompanied by a violent disruptive effect & an intense, high-speed pressure shock wave

(2) do not have to be contained to cause damage

- (3) primary explosives - a high explosive that is easily detonated by heat, shock, or friction as blasting caps
 - (a) used to detonate other explosives thru a chain reaction, referred to as primers

pic p5b4

- (b) lead azide
 - lead styphnate
 - diazodinitrophenol

- (4) secondary explosives - a high explosive that is relatively insensitive to heat, shock, & friction, normally burn rather than detonate in small quantities in open air

pic p5b5

- (a) dynamite - also known as modern straight dynamite is rated by the weight % of nitroglycerin in the formula - nitroglycerin, pulp, $NaNO_3$, & $CaCO_3$ stabilizer
 - Ex 40% str dynamite 60% str dynamite

all but disappeared from industrial explosives market.

(blasting power is not directly proportional to %)

- (b) ammonium nitrate explosives (NH_4NO_3) - mix oxygen-rich NH_4NO_3 with a fuel to form a low cost, stable explosive

straight dynamite - 1st made in 1867 w/ Kieselguhr, a type of earth

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- (i) water gel - resembles gel-toothpaste
 - water-resistant → good in wet conditions
 - NH_4NO_3 & NaN_3 gelled w/ guar gum & mixed with a combustible material like Aluminum (fuel)
- (ii) emulsion explosives - have 2 distinct phases - an oil phase & a water phase
 - a droplet of supersaturated solution of NH_4NO_3 surrounded by a hydrocarbon fuel.
 - typical emulsion is water, 1 or more inorganic nitrate oxidizers, oil, & emulsifying agents, & micron-sized glass, resin, or ceramic spheres - *microspheres* / *microballoons*
- (iii) ANFO - NH_4NO_3 soaked in fuel oil
 - inexpensive → form of fertilizer
 - easy to handle & safe
 - wide applications in the mining industry
 - 1993 - NYC World Trade Center bombing
- (iv) TATP - triacetone triperoxide
 - homemade explosive used as an improvised explosive by terrorist organizations in Israel & other middle Eastern countries
 - prepared by reacting acetone & H_2O_2 in the presence of an acid catalyst, like HCl.
 - friction & impact-insensitive & extremely powerful when confined.
 - 2005 London transit bombings
- (v) military High Explosives
 - RDX - most popular & powerful, usually in the form of a pliable plastic, C-4
 - TNT - trinitrotoluene - "military dynamite"
 - ↳ produced & used in large-scale during WWII
 - ↳ wide application in shells, bombs, grenades, demolition explosives, & propellants.
 - ↳ contains no nitroglycerin
 - ↳ rarely encountered in bombings in US.
 - PETN
 - ↳ used for small-caliber projectiles & grenades.
 - ↳ used commercially as a detonating core in a detonating cord (primacord) - connects a series of explosive charges so they all blow at one

building implosions →

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commonly,

(4)

(vi) Detonators - blasting caps made of copper or aluminum cases filled w/ lead azide as an initiating charge & PETN or RDX as a detonating charge. Set off by a burning safety fuse or an electrical current
- Homemade bombs are usually initiated w/ an electrical blasting cap wired to a battery

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