Development and use of explosives over the past century

Government, Army

The history of explosives and propellants, also known generally as ‘ energetic materials’ began with the material known as gunpowder or black powder, whether the intended use was for civil applications such as rock blasting, military uses in demolition, shell filling (bursting charges) and construction projects, or military and civilian propellant charges for short guns, pistols, rifles or artillery. The individual inventor of black powder will undoubtedly forever remain unknown, but numerous writers such as Drinker (1878), Munroe (1888), Marshall (1915), and Davis (1941, 1943), described what is known about its development and evolution.

Until the discovery of nitrated explosive compounds such as nitrocellulose by schonbein and Bottger (independently of one another) and nitroglycerin by Sobrero (all occurring in 1846), the only explosive available for any purpose was black powder. 1) Solid (particulate) propellants; 2) Military explosives; 3) Commercial explosives. Propellants Propellants may be granular, solid, or liquid. The primary focus was on granular (particulate) material since they are the most commonly encountered by the forensic chemist.

Solid propellants are deflagrating materials designed to accelerate a projectile from its position of rest at the breech of a weapon to its full velocity as it exits the tube or barrel. In the ideal (and designed for case), the complete consumption of the propellant and the exit of projectile occurs at the same instant. Propellant gains are thus chemically formulated and physically designed to achieve this end. The gains burn particle to particle at speeds below the speed of sound in the material: this defined the word ‘

deflagrating’. Historically such materials have been termed progressive powders.

In addition to burning particle- to- particle burns from its free surface inward or, in the case of perforated grains, also from the free surface outward. This characteristic enables the propellant designer to size and configure the grains or particles to be totally consumed at the optimum instant. Propellant gains may be found in multitude of shapes and sizes, as might be expected given the varieties of weapons and desired pressures and projectile velocities. Black powder Black powder is the mixture of three components, generally (and originally) charcoal, sulfur, and potassium nitrate.

These are typically in the ratio of 15: 10: 75. Many variations to that ratio have been used: Cundill (1889) lists over 20 varieties, many with sub – varieties. Most of the differences, however, are insignificant. The one major development in the past 100 years is the use of sodium nitrate in some black powder grades. Black powder has an inherent drawback as a military propellant due to the fact that it produces a solid reaction product. Because of this, a dense black cloud is produced upon firing weapon is readily apparent, and after a number of rounds are fired the volume of battlefield smoke leads to confusion and general chaos.

For this reason the development of the ‘ smokeless’ propellant charge was an objective of every governments weapons laboratory. Upon the discovery of the nitration reaction this research intensified. Smokeless powder The early history of the nitrated carbohydrates, which includes the 1833 discovery of nitro-starch (called xyloidine by its discoverer, Braconnot) and guncotton, called pyroxyline or pyroxyle be the chemist Pelouze, is thoroughly covered by Devis (1941).

Guncotton, nitrocellulose of high nitrogen content (13. 35% to 13. 45%), was the first nitrated material to be tried as a replacement for black powder, but it was too prone to accidents. However its military use continued after it was found that the newly –invented mercury fulminate blasting cap would cause compressed guncotton to detonate, leading to its application as a demolition charge and shell filling. Its use was rather short lived, however due to the introduction of picric acid.

Research was continued on nitrocellulose of lower nitrogen content as a propellant material, and the first good smokeless riffle powder was produced by Vielle in 1886, for the French Government. This was nitrocellulose with either alcohol, kneaded in bread making type machine, rolled out into thin sheets, and then cut into small squares and dried (Military Explosives, 1924). This was a ‘ single base’ smokeless powder (nitrocellulose only). In 1888 Nobel invented a powder called Ballistite, which was a low nitrated nitrocotton gelatinized with nitroglycerin: which came to be known as; double base’ powder.

In the same year Cordite (given that name because it was extruded in the form of cord or ribbon), a mixture of high nitrated guncotton, nitroglycerine, and Vaseline, gelatinized by means if acetone was developed by an English Committee. (Marshall, 1915) Later ‘ triple base’ smokeless powder were developed, containing nitro guanidine in addition to the nitrocotton and nitroglycerin of typical double base powders. Triple base powders were cooler-burning than the single or double base materials and use was mainly restricted to large caliber weapons.

Developments in smokeless powder since those early days had been primarily to improve stability, decrease the erosion of the barrel of the weapon, control pressures, decrease smoke output (‘ smokeless’ powders are smokeless in comparison to black powder, but still produce visible smoke), and to decrease the muzzle flash from a firing weapon. The geometry of powders may include flakes, tubes, cylinders, sticks, flattened balls, or spheres. Military Explosives As black powder was the first propellant, so it was the first military explosive too.

It was used for shell filling, demolition, and military construction projects from the earliest times up until the invention of nitroglycerin. Military explosives as discussed here are those used as the shell filing or ‘ bursting charge’ in artillery round and those explosives used for demolition charges. Military construction projects typically use commercial-type explosives, except in field-expedient situations. The brief use of guncotton as a military explosive was noted above. Trinitrotoluene (TNT)

During and after World War I the explosive trinitrotoluene (TNT, $C_7H_5N_3O_6$) became the dominant shell filling and demolition charge material. TNT has the advantage of being very easy to cast, since it has a wide spread between its melting and decomposition temperatures. One disadvantage is its extreme insensitivity. In the order to conserve TNT for small caliber shells in World War I, a mixture of TNT and ammonium nitrate (‘ amatol’) was developed. It was specified for use only in shell of $. 7-inch to 9. 2-inch diameter (Crowell, 1919) but in actual practice it was used in all sizes.

For the same reason of conserving TNT, nitro starch explosives were used very successfully in that war for hand grenades and trench mortar shells (Williams, 1920). Tetryl Tetryl (2, 4, 6-trinitrophenyllmethylnitramine, N-2, 4, 6-tetra-nitro-N-methyl aniline, or picrylmethyl nitramine) was used in military boosters, but has generally been replaced by materials such as RDX and HMX. The ‘ tetrytols’ are mixtures of tetryl and TNT, which were utilized in boosters, demolition charges, shells, and shaped charges. The TNT generally ranged from 20 to 35 percent of the mixture.

An advantage of tetrytol is that it allows the casting of the explosive into munitions rather than requiring pressing. It is also more powerful than TNT, but not as sensitive as tetryl alone. RDX and HMX Between the world Wars a number of explosives were developed, and after the start of the second war a vast amount of explosives research took place. One of the most important and useful military explosive is RDX (an acronym for ‘ Research Department Explosive’), which was discovered in 1899, but not used until World War II.

It is also called cyclonite, hexagen, and cyclo-trimethylenetrinitramine. HMX was another explosive used for military applications during and after World War II. The initials are said to stand for “ High Melting Explosive’, although other sources for the acronym are sometimes cited. It is also called cyclo-tetramethylenetetranitramine or octogen. (Beveridge 1-4) Blasting and Use of Explosives Only authorized persons can handle and use explosives. No person using explosives is allowed to be under the influence of alcohol or drugs.

Nothing which could be an ignition source, such as matches, open flames, or smokers, is to be around explosives. Accountabilityis required to assure that explosives are under the care of a qualified person. All blasting aboveground is done between sunup and sundown and, when blasting is done, blasters are to take special precaution near public utilities, around transportation conveyances, and near public areas to assure safety and mitigate any damage. Care must be taken to assure that accidental premature ignition does not occur from stray electrical sources or radio transmitters.

The blaster is to be considered a competent person in the use and care of explosives, and have experience with the type of blasting methods being used. The transportation of explosive and blasting materials must conform to the department of Transportation regulatory provisions. Drivers of trucks containing explosives and blasting equipment must be licensed and should be in good physical and mental condition. No blasting materials are to be transported with other cargo and blasting caps are not to be transported in the same vehicle as other explosives.

These vehicles should be marked with a placard signifying “ Explosives” and have a fully charged fire extinguisher. (Reese, Edison 648) Different uses of an Explosive Blasting is extremely important both to mining and the world economy. The saying is often used, “ If it can’t be grown it has to be mined,” however if the ground is too hard to be mechanically mined economically, it has to be blasted. Certainly many materials, such as iron, copper and concrete to name but a few would be significantly more expensive if it weren't for explosives and our ability to easily drill holes to use these explosives efficiently.

Shock wave compressiontechnologyis not only a means of extremely high-pressure generation, but also a means of extremely high-temperature production in solids. When dynamite shock load is applied to solids by means of explosive and high-speed impact, the shock pressure and the shock temperature generated depend on the shock load and the density of the solid. Between 1985 and early 1991, there were 182 incendiary or explosive devices planted in Great Britain by animal-rights activists.

This number accounted for approximately 50 percent of all explosive devices planted in all of Great Britain, making it numerically a larger problem in Great Britain than incidents attributed to the provisional Irish Republican Army. However, the majority of these devices were far less sophisticated and far less dangerous than the PIRA devices. In 1980 in Great Britain, the first use of high explosives by animal-rights terrorists took place. These acts appear to have been perpetrates by a small group, which had obtained a high explosive used both in military operations and in commercial applications, such as quarries.

First it was used against the staff restaurant at Bristol University, where a 5-puound bomb was set off about midnight, wrecking about two floors of the building. More recently in 1990, the same explosive was used presumably by the same group in two car bobs. In one case, a passing infant was severely wounded. Conclusion During the past centuries, it has been proved that there is a beginning international acknowledgement of the future need for demolition of plants and buildings. There is also evidence of an increasing interest in demolition techniques and the re-use of building materials.

There are literally hundreds of different types of explosives, varying from black powder used in pipe bombs (still a favorite of domestic bombers), to dynamite sticks, and from blocks of TNT to plastic explosives that can be molded into diverse forms, including thin sheets. A dozen or so of the most notable explosives are used by the terrorists. Of particular note are the explosives RDX and PETN which, together with plastic and other fillers, compose many plastic explosives such as Detasheet and SEMTEX.

Explosives are mostly harmful (destructive) but on the other hand in many cases they are useful (constructive) too. Doctors, Engineers use explosives in a constructive way while at the same time criminals and terrorists use explosive in the destructive way. There are many uses of explosives such as Mining, Pyrotechnics, Building Demolition and even Construction. Explosives are also used in Carve Mount Rushmore, Avalanches and are used in backcountry for Trail Maintenance. Explosive are used in Medicines to break-up kidney-stones.

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