A LABORATORY PREPARATION OF A MATCH-IGNITED EXPLOSIVE BANGER (KNOCK-OUT, FLASHING FIRE WORKS OR SKY ROCKETS)

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Abstract

In the manufacture of match-ignited explosive banger or knockout, fireworks formulars were made by mixing potassium chlorate, Barium Chlorate, Red gum, Charcoal and Dextrin in the appropriate quantities. The above stated mixtures were, then, put into a hollow card-board-rolled cylindrical structure with 0.9g of gunpowder, after one end of the structure has been sealed with a mixture of cement and sand. The 0.8g match head which is a mixture of Animal glue, sulphur, potassium chlorate, calcium carbonate, diatomaceous earth, fine silica, Potassium dichromate, and, a water soluble dye is, then, used to seal the other opening of the cylindrical structure. After completing the processes involved, the explosive banger was then ignited, with an initial sparkling flame. It generated into an explosion, confirming that the experimental manufacture was successful.

Keywords: Match-ignited, explosives and propellants, knockout, banger, detonation.

Introduction

Many professional chemists and Chemical Engineers tend to view the subject of explosive and propellants from their end-use effects which are frequently spectacular and dramatic. In their manufacture, continuous processes are replacing batch ones for nitration, emulsification and gelatin with improved uniformity of product and lower cost. Recent advances in computer-controlled processing have found many applications in manufacturing (Austin, 1998; Kirk, 1999).

Commercial explosives are essential to such industries as mining and quarrying, construction, geophysical exploration and metal cutting and forming. Major engineering jobs such as the construction of tunnels and dams would be impossibly expensive without explosives.

An explosive mixture of sulphur, charcoal and saltpeter called black powder was known to the Chinese centuries ago. Its use in propelling missiles was demonstrated shortly after the year 1300. The discoveries of nitroglycerin and nitrocellulose shortly before 1850, and the invention of dynamites and the mercury fulminate blasting cap, soon after, were epochal events of the high explosive era (Bauer, 2000).

The demand for more powerful and uniform propellants for the space program offered a recent new challenge. In times of war, increased quantities are required; for example, roughly 3 x 10^9kg was manufactured in the U.S. by January 1940, and in 1982, industrial and commercial use was 1.6 x 10^9kg.

Explosive materials include explosives, blasting agents, detonators, slurries, water gel, pellet powder, black powder to mention but a few. Black powder has been the preferred blasting agent because it is less shattering in its effects (Cook, 2002). It is an intimate mixture of KNO3, sulphur and charcoal in the approximate proportions of 75: 15: 10. About 50% of the products of combustion are solids giving their flames as great igniting power which are undesirable where combustible gases or solids are present, but useful for igniting propellants (See Fig. 1).

Table 1: Characteristics of Burning and Detonation

Characteristics	Burning		
	Fuel	Propellants	Explosive detonation
Typical Material	**Coal - Air**	**Propellants**	**Explosives**
Linear reaction rate m/s	**10^{-6}**	**10^{-2}**	**2 - 9 x 10^3**
Type of reactions	**Oxidation-reduction**	**Oxidation reduction**	**Oxidation reduction**
Time for reactions completion, S.	10^{-1}	**10^{-3}**	**I?**
Factor-controlling rate	**Heat transfer**	**Heat transfer**	**Shock transfer**
Energy Output 2/g	**10^4**	**10^3**	**10^3**
Power output, W/cm²	**10**	**"To**	**~To**
Most Common initiation mode '	**Heat**	**Hot particles and gas**	**High temperature-high pressure shock waves**

Pressure developed MP_a	**0.07-0.7**	**$0.7 - 7 \times 10^2$**	**$7 \times 10^J - 7 \times 10^4$**
Uses	**Source of heat and electricity**	**Controlled gas pressure, guns, rockets.**	**Brisance, blast, munitions, civil engineering**

Source: James (2000)

Explosives are used wherever very rapid rates of energy application and high pressures are essential and are employed to produce high-intensity shock waves in air, water, rock and metal; for blastering, cratering, mining and other civil engineering purposes, for metal forming, cutting and fragmentation, in shaped charges and many specialty devices acquiring high rates of energy transmission, and for the initiation of detonation phenomena. While propellants on the other hand, are used wherever a readily controllable source of energy is required for periods of time ranging from milliseconds in guns to seconds in rockets. See Fig. 1 (Davis, 2000).

The terms burning and deflagration are used synonymously to describe propellant performance and to contrast it with the very much more rapid, violent and destructive action associated with the explosion on detonation of explosives.

Experiment ***Materials***
(Reagents)

Animal glue, water soluble dye, potassium dichromate, sulphur, fine silica (sand), diatomaceous earth, Potassium chlorate, calcium carbonate were used for the match head, while, potassium chlorate, barium chlorate, charcoal and dextrin were used for the pyrotechnic explosive. ***Equipment***

Beakers, Spoon, Weighing balance, mortar and pestle, Measuring cylinders, stirrer were used, ***Procedure***

Cardboard papers were rolled into a thin hollow cylindrical structure with the aid of a pen or a pencil. A mixture of cement and sand was, then, poured in to seal one end of the hollow-cylindrical structure and was allowed to dry for a day. 2.0g of pyrotechnic explosive was weighted out in a weighing balance and poured into the hollow structure (See Figs 2 and 3). 0.9g of gunpowder was also measured out in a measuring cylinder and poured into the fabricated structure. A 0.8g of match head as, then, used to seal the opening from which it can be ignited or initiated. The whole package was then allowed to dry after which it was initiated at the match head. The whole processes were repeated for times.

In the packages done, the quantity of pyrotechnic explosive and quantity of gunpowder were varied with the match head being constant. On initiation, the results were all taken down.

A test of the produced match-ignited explosive (knock-out) was carried out by igniting the product at the match filled head. A sparkling flame was produced which burns down to the gun powder section and consequently and spontaneously heated up the pyrotechnic explosive, thus setting up an explosion which shattered or destroys the hollow cylindrical structure into pieces.

Precautions

(1) The cement/sand mixture used in sealing must be allowed to dry to enhance an effective compression cum explosion.

(2) Light sealing materials or particles must be avoided as they are often thrown out during explosion.

(3) To explode the package, it must be done out-doors, or must be thrown at a considerable distance from whoever that is detonating it.

Results

The results obtained are shown in the Table 2, the quantity of match head in all the specimen remained the same.

Explosive Ratio = Quantity of Pyrotechnic explosive
Quantity of Gunpowder

0.2 = 0.606 0.61g

Table 2: Material Composition of the Test Specimen of the Fabricated Single Bang Knockout with the Quantity of the Match Head Held Constant

Specimen	Time of Explosion	Quantity of Gunpowder	Quantity of Pyrotechnic Explosive	Explosive Ratio	Result and Comments
Specimen A	**3 mins.**	**0.24g**	**2.0g**	**8.33**	**A less effective pop sound was observed with the match head thrown out leaving behind a thick dark ash without burning the package. The match head was, however, not**
Specimen B	**4 mins**	**0.3g**	**1.6g**	**5.33**	**A louder sound was observed than the first one with a fast throwing out of the match head burning parts of the package leaving behind a thick dark ash with little smoke coming out of the sealed end province that it had poor sealing the match head was,**
Specimen C	**2 mins**	**0.8g**	**0.4g**	**0.50**	**A bright burning of flame burnt for 2 minutes before it exploded sending out the match-filled head with a pop sound; no smoke from the sealed end; with a thick ash residue; however, the match head was not**
Specimen D	**1 min.**	**0.33g**	**0.2g**	**0.61**	**A powerful explosive sound was observed and heard shattering the whole package giving out a thick smoke.**

Discussion

From the Table 2, it could be seen that an increase in the quantity of gunpowder with a small explosive time of 1 - 2 minutes gave a product with a very good explosive characteristics. It could, also, be seen that an increase I the explosive time with a reduction in the quantity of gun powder produced a less effective pop-sound product but with the performance not comparable with that obtained from using a greater quantity of gun powder (See Fig. 4).

Gunpowder is an essential part of the formulation because it stimulates the burning cum explosion: compact or tight sealing enhances strong explosion.

General Characteristics

Exothermic oxidation - reduction reactions provide the energy released in both propellant burning and explosive detonation. These reactions are either internal oxidation-reductions, as in the decomposition of nitroglycerin and pentacrythritol tetranitrate, or reactions between discrete oxidizers and fuels in heterogeneous mixtures such as RDX and aluminum or ammonium perchlorate and a hydrocarbon fuel (Warren, 1994).

An activation energy of 125 - 250 kj/mol (10-60 Kcal/mol) is usually required to initiate the reaction. Once initiated, the heat evolved is sufficient to cause the reaction to continue and become self-sustaining. Most explosives and propellants are organic compounds or mixtures of compound that contain carbon, hydrogen, oxygen and nitrogen (Warren, 1994).

The most common gaseous products of the oxidation-reduction reactions are hydrogen, water, carbon monoxide, carbon dioxide and nitrogen. Other products depend on the reactants, explosives and propellants involved.

The specific stimulus that triggers an explosive depends on the material involved and the system environment. In most cases, the ultimate cause of the decomposition is heat. Gun and rocket propellants are initiated by igniter compositions that produce hot gases and solids at relatively low pressures while explosives are detonated by high-pressure shock waves.

Mechanical impact, frictional forces, electric discharge and other sources of heat may also act as an initiating stimulus. The minimum quantity of energy required for initiation has a characteristic value that depends on the chemical characteristics of the material and its physical properties, including geometry, mas, density, the degree of confinement, the rate at which energy is lost, the environment in which the energy released occurs and the type of initiating stimulus provided (Raidt, 2001; Urbanki, 2001).

Explosives and propellants are often ranked in order of their sensitivity and response to a specific stimulus in a given environment. Explosives commonly require some stimulus like a spark or

blur to spur or provoke the liberation of energy but the stimulus which "set-off" the explosive do not contribute to the energy of the explosive (Davis, 2003).

Recommendations

(1) The work can be improved by using electrical agitator in mixing and grinding, and, a desiccator in drying.
(2) Charcoal can be sourced locally for the production of a match-ignited explosive banger.
(3) The variations in the quantity of gunpowder and quantity of pyrotechnic explosive used in each package should as well be looked into.
(4) A considerable distance should be maintained away from the detonating package so as not to cause eardrum damage.
(5) The potassium chlorate and sulphur bought from the chemical shop, should be checked before use for potency to avoid using fake chemical reagents.

Conclusion

Based on the facts and information presented in the previous sections, the following conclusion can be made:

When the match-filled head is removed, there would be no explosion since the gunpowder will not be initiated. However, the gunpowder will burn but without an explosion.

When the banger is turn open or exposed, it will still burn but without an explosive sound. This could be attributed to the lack of compression or heat.

A match-ignited explosive can be formulated with the necessary reagents in the correct proportions.

A mixture of cement and sand when used in sealing can give a product with good explosive characteristics. After explosion, the whole package becomes shattered and can't be used for another explosion.

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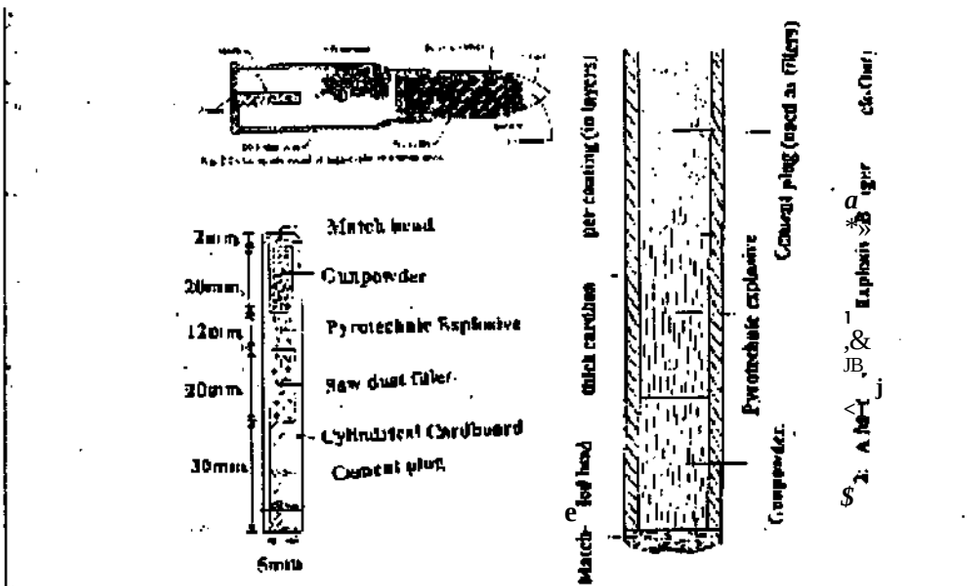
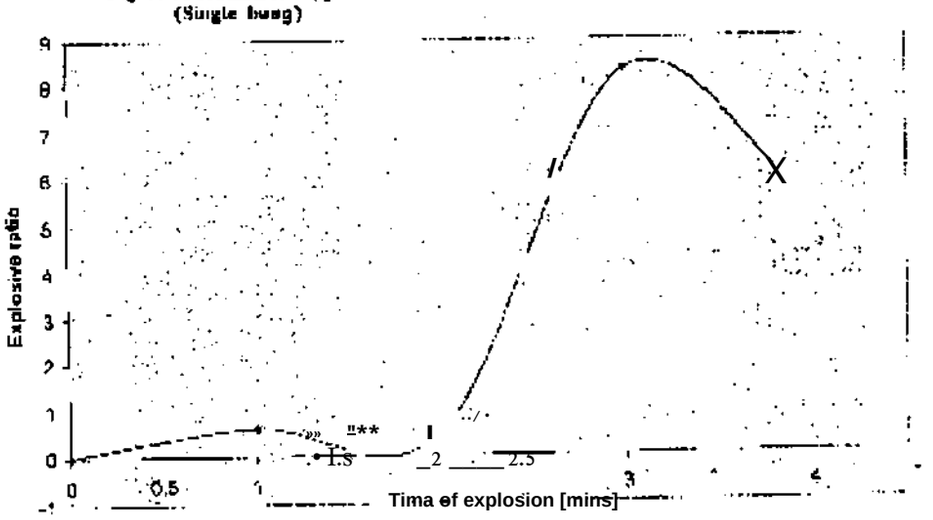


Fig. 3: A commercial type German Knock-Out (Single bang)



F(g.4:Explosive ratio nreus cxploalon time for 1 single hnng knock-out, match huad being car slant