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ANALYSIS OF FIREWORK'S COMPOSITION OF DIFFERENT BRANDS

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ABSTRACT

The research investigations with a similar aim of evaluating components present in fireworks and establishing their composition, which is then compared to specifications, are examined in this article. This study is required since illegal manufacturing, unintentional fires, arson, and other crimes are on the increase. It is essential to inspect the fireworks to decide whether or not were manufactured according to standard procedure that follows concentrates on the numerous instrumentations and colorimetric measurements that are used to identify the exact structure and percentage ratio of distinct fire crackers. Electron Microscopy, and Potentiometry are the most frequently utilized instruments. They're utilized to figure out things like anions, cations, other metals, organic compounds, resins, and so on. Various brands of firecrackers from various manufacturing companies were acquired and examined in the experiments described below. Despite the high incidence of explosive injuries in India, few research on the quality assessment of fire crackers have been conducted in the nation. The majority of the study has been done on events that have happened in the United States. It is essential that more study into explosions, explosives, and explosive debris be done in order to assist in the investigation of these occurrences. Researchers will establish if any heavy explosive material is utilized to enhance the efficacy of the fire crackers, which may be as strong as a bomb.

KEYWORDS: *Analysis, Blast Particles, Chemical, Composition, Consumer Fireworks, Explosives, Fire Crackers, Methods, Powder, Pyrotechnic, Research.*

INTRODUCTION

Forensic chemistry is an area of study concerned with the use of chemical evidence in judicial processes. It is mainly focused with the research of various chemicals. Petroleum oil analysis, fire residue analysis, explosive residue analysis, cement analysis, and so on. The most frequent type of evidence discovered in blasting instances is explosive remnants. Every substance or system that releases a large quantity of quickly spreading gas in a short period of time is considered explosive. It is categorized into three categories: electrical, chemical, and nuclear. Mechanical explosives, as their name suggests, go through a physical action that causes them to explode (e.g. explosion of a container which fills with compressed air). It is less frequently employed in mining. The second type is a nuclear explosion, which is defined by a prolonged nuclear reaction that is both immediate and fast, releasing large amounts of radiation (e.g. In petroleum extraction purposes). Much of the time, individuals come across chemical explosives that are dependent on a chemical reaction that produces the explosion[1].

Chemical explosives may be split into two categories: (1) detonating explosives and (2) deflagrating explosives. Detonating explosives are defined by fast decomposition and high pressure generation, while deflagrating explosives are characterized by rapid burning and low pressure output. Any normally deflagrating explosives may be made to explode under such

conditions, such as the usage of large quantities and a high degree of confinement. Main and secondary detonating explosives are the most frequent subcategories. Primary explosives explode when they are ignited by a source of fire, such as a flame, a spark, an impact, or another mechanism. A detonator is used for secondary explosives, and it may also act as a booster in certain circumstances. Depending on the conditions of usage, a few explosives may be both main and secondary[2].

They explode at speeds ranging from 3000 to 9000 M/S, making them detonating or high explosives. Primary and secondary explosives are the two kinds of explosives that are usually categorized depending on their sensitivity[3].

1. *Primary Explosives:*

They are extremely sensitive to mechanical stress, friction, and heat, and may either burn rapidly or explode as a consequence. For example, mercury fulminate and lead azide.

2. *Secondary Detonators:*

They're also known as base explosives since they're resistant to stress, friction, and heat. They may require a main explosive to explode at times. For example, High Melting Explosive (HMX), and so forth.

The phenomena of deflagration leads deflagrating or low explosives to ignite at a subsonic speed. In contrast to other high explosives, it burns extremely fast. The deflagration speeds vary from a few millimeters per second to 400 meters per second. They are frequently employed as propellants. For example, smokeless powder and gun powder. Pyrotechnics is one of the most frequent kinds of deflagrating explosives. Since it is focused on the deflagration phenomena, it works. There are combinations of various chemicals intended to produce heat, sound, light, steam, smoke, or a combination of these effects via self-sustaining exothermic reactions. Military pyrotechnics and firework compositions are among them. This are produced under quality control or with a legal license[4].

Pyrotechnics include fire crackers, which are one of the most popular kinds of pyrotechnics. It is a lightweight explosive device that is mainly used to create sound and light effects for different festivities. The explosive ingredients are mixed together in precise combinations and wrapped in paper or cardboard containers. It comprises of a combination of oxidizers such as sodium nitrate, potassium chlorate, and other inorganic explosive products (charcoal, aluminum powder, and so on). They blend different color-producing compounds, such as metal salts, into these goods. Binding agents like dextrin, as well as stabilizers like linseed oil and boric acid, are employed[5].Carbon, oxidizer, colorants, binder, and stabilizer are the five basic components of fire crackers. The self-burning fuel that generates light and heat. Oxidizers are devices that supply oxygen to assist in the combustion of fuel. Colorants are typically strontium, sodium, or other chloride salts. Binder is the material that ties the pellet together[6].

LITERATURE REVIEW

T. Baran pointed to the fact that there have been created sophisticated instruments and methods for identifying both military and non-military (mining, pyrotechnic) explosives. The physical and compound trustworthiness of follows, as well as the impacts of exterior upgrades and different foundation materials on follows, have all been examined. For hazardous and pyrotechnic chemicals, shading testing and naming methods have been established. These methods and processes may be used to detect unstable materials (military, mining and pyrotechnic) (military, mining and pyrotechnic). On account of pyrotechnic unstable material dependent on accumulation on the surface, it is possible to choose: (a) a strategy for mixing sensitive substances; and (b) an oxidizing specialist and flammable substance[7].B. Glattstein*et al.*presented in the article that a

method for detecting and identifying match head remnants in IED post-explosion debris has been found. The method involves visual microscopic inspection, Scanning Electron Microscopy/ Energy-Dispersive Spectroscopy (SEM/EDS), and spot tests for elemental Sulphur and chlorate ion. The technique was used in 13 detonated pipe bomb incidents. In twelve of them, match head fragments were found and identified[8].

FORENSIC SIGNIFICANCE

There are various kinds of fire crackers that is examined in the text is briefly covered below are given below:

1. Rocket:

Outside, one side-loaded rocket tubes are brought in and filled with gun powder wet with water using a drift hammer. The tube in question is filled with fuse that has been chocked. The straw sticks are then attached. Color tablets and the sound shell are placed in the top part of the channel. After that, it was numbered.

2. Flower pots:

This is constructed with paper cone tubes. There is a 5 kg: 1.5 kg: 4 kg: 3 kg mixture of barium nitrate, saltpeter, aluminum chips, and aluminum powder.

3. Sparkles:

In wooden boxes, the sparkles were bundled with a copper-coated thread. The chemical makeup is 8 kg: 1.2 kg: 1.3 kg: 3.6 kg: 1.1 kg (barium nitrate, aluminum powder, dextrin, iron fillings, gum, and water) (barium nitrate, aluminum powder, dextrin, iron fillings, gum, and water). To prevent unpredictable reactions, 1 percent boric acid is added. To prevent rusting and interactions with other chemicals in the wet stage, the iron dust is coated with linseed oil or tar. Wet mixing is done with a wooden rod and a hand. The wet chemicals are combined and then poured into the dipping tray. The wire is poured into the frame and gently dipped. Drawn and placed in an inclined wooden rack, it is allowed to fly 3 to 4 meters, enabling the surplus chemicals clinging to the wire to descend and the frames to be set on a table to extract the excess chemical at the head. After that, the frame is dried in a drying chamber. To obtain the required thickness, repeat the procedure 2 to 3 times[9].

4. Chinese crackers:

The factory gets different kinds of paper tubes in hollow metal rings, each containing 500 to 600 tubes with one side sealed with dirt. The tube rings in question are brought to the white powder filled chamber. The white powder mixture is put into the containers, and the rings that hold the tubes are shaken until they are all sealed. The surplus powder in tubes and the amount of powder in each tube are thus readily drained by dexterous movement of the worker's hands and wrists. Clay is used to plug and tube that has been partly filled with powder and has enough empty space at the top for the fuse. The above-mentioned rings are subsequently transferred to a processing plant. Again, non-ferrous sticks or nails are used to punch the holes that lead to the tube. After it dried, the crackers were braided together using yarn. After then, it was numbered[10].

DISCUSSION

1. Analysis of Consumer Fireworks:

Pyrotechnic reagents and formulations may be examined utilizing a number of analytical techniques. They've provided us a lot of information regarding the properties, compatibility, robustness, and behavior of highly energetic materials. Thermal activity, boiling plus melting points, decay temperatures of compound elements, or reaction besides combustion temperatures for pyrotechnic configurations can all be determined using heat flow calorimetry (HFC), thermal

gravimetric analysis (TGA), differential thermal analysis (DTA), as well as differential scanning calorimetry (DSC). Physical properties like particle size and shape, that are important for pyrotechnic combinations, have been investigated using various techniques like X-ray scattering besides electron microscopy. All of these trials are useful in creating dependable and effective formulations, as well as enhancing system management and pyrotechnic mixture storage. There is a need for efficient, fast, and precise analytical techniques that can be utilized on a regular basis in forensics. In forensic laboratories, there are a number of analytical techniques that may be used to analyze explosive materials. Until date, many forensic labs have examined consumer fireworks using a variety of techniques based on the Technical Working Group for Fire plus Explosions (TWGFEX) Examinations guidelines for forensic identification of integral explosives besides post-blast explosive remnants. Several inquiry articles have been published that offer fundamental information regarding consumer fireworks analysis. As a consequence, scientists describe and critically evaluate the main methodological techniques utilized to date for market fireworks research in this article.

2. Colorimetric Tests:

Colorimetric studies may be used to gather qualitative information about fireworks or their remnants. Although they have low accuracy plus dependability, installation is easy and convenient, offering read simply. Colorimetric measures are also utilized in certain quantitative methods. Chapman, for example, developed and tested two quantitative methods in 1997, one to quantify the quantity of Sulphur alongside other to determine chlorate amount in integral consumer firecrackers. Pyrotechnic mixtures using chlorate besides Sulphur are banned in the United Kingdom as well as other countries, and their control is essential. As a consequence of their usage in identifying instruments that do not meet the rules, quantitative methods were suggested to be employed routinely to control firework composition resulting in a large number of measurement mistakes. The accuracy of the measurement relies homogeneity of the mixture. Furthermore, each analytic must be analyzed using a separate instrument.

3. Instrumental Analysis:

Researchers can only identify a few studies that involve instrumentation techniques for fireworks research, and that is also in Spectroscopy plus scanning electron microscopy (SEM) are the most frequently utilized approaches:

3.1.Electron Microscopy:

Post-blast pieces from consumer firecrackers exhibit a spheroid morphology similar to bullet remnants. As a consequence, just like proofs, SEM plus energy dispersive X-Ray spectrometry (SEM-EDS) method may be used to examine pyrotechnic pieces. Several writers have tried to explain the composition besides basic sketch of component part from pyrotechnic combinations with industrial firecrackers since then. Looked studied post-blast pieces from common market firecrackers, three distinct coloured firecracker, as well as four flash powders formulas in 2001. Based upon the structure of the novel powder then whether it is ignited confined or unrestrained, the author addressed morphological and elemental differences in particles. The post-blast particles in the seven compounds were irregular except spheroid. Furthermore, the basic configuration of the post-blast bits was found to be similar to that of the original material in the majority of the tests. However, certain components of the original combination are not present in the spheroid post-blast bits, according to some experiments. Phillips suggested that the differences in mineral composition may be the consequence of different pyrotechnic product reactions and vaporization temperatures.

They provided additional information regarding how the particle's spheroid shape and size may vary. They also examined the spontaneous quantitative changes in compound components found

in post-blast bits compared to pre-blast bits from commercial fireworks flash plus black powders. Some chemical components discovered in the unreacted structure of flash powder were missing in distinct post-blast bits, or peak sizes varied, as in Sulphur, chlorine, or potassium. The absence of reaction gases was attributed for the differences. Any chemical molecules interacted to create new ones, for as Sulphur to sulfur-dioxide gas. The identification of components in post-blast pieces may also be affected by the compound's melting and boiling temperatures, according to the authors. They also addressed the issue of context pollution in identifying post-blast pyrotechnic remnants and provided suggestions on how to enhance the analyses' accuracy. SEM-EDS is a helpful tool for identifying the basic organization of pyrotechnics quickly and with a high degree of accuracy in the study of pre-blast as well as post-blast particles.

3.2. Atomic and Molecular Spectroscopy:

Utilizing atomic fluorescence spectroscopy and inductively-coupled plasma (ICP) spectroscopy, researchers evaluated six integral consumer firecrackers widely available. The objective of the study was to investigate how consumer fireworks lead to cumulative emissions of ecologically hazardous components. Aluminum, barium, magnesium, and potassium, among other metallic elements, were utilized in considerable amounts. There were also trace amounts of zinc, iron, strontium, plus copper. Trace quantities of zinc plus calcium are detected. They inquired of providers of a range of goods that were near to category 1, 2, and 3 firecrackers. Utilizing two dissimilar types of end plugs plus three kinds of cardboard tubes, powders composed of barium nitrate-aluminum and potassium perchlorate-aluminum together with different disposable explosive substances were produced. The oxidizing metal ions in the combinations is evaluated using atomic emission spectroscopy (AES). They found a significant connection among the grade of metallic compounds in pyrotechnic mixtures besides the manufacturer's recommended %. According to many recent research, vibrational spectroscopic techniques may be utilized to evaluate volatile mixtures. According to Castro, Raman as well as the Fourier-transform infrared (FTIR) methods are helpful for detecting the molecular structure of consumer firecrackers. They utilized FTIR and Raman spectroscopy to investigate several supposedly customer as well as putatively spectacular firecrackers, using SEM-EDS as a backup equipment. Shellac, titanium pieces, nitrocellulose, besides different nitrates, among other things, are computed in solid combinations. Raman examination of particles from different samples showed molecular spectrum relating to barium nitrates, potassium, plus strontium that were among the greatest frequently used oxidizers. Raman was utilized to detect nitrate compounds because the wavenumber of every nitrate salt was dependent upon the positive-ion. Significant pyrotechnic elements, on the other hand, were not estimated by a single technique.

3.3. Separation and Coupled Techniques:

Aimed at the research of components present in active or explosives substances, separation methods have subsequently been utilized widely to separate and determine inorganic ions in aqueous extracts from inorganic explosive remnants. Single capillary-zone electrophoresis (CZE) along with Ultra Violate-Visible is detection that was used to test consumer fireworks (as stated specifically).

3.4. Potentiometric:

For the determination of perchlorate, proposed an ion-selective, simple, and cost-effective potentiometric method. They looked at pyrotechnic combinations like flares, propellants, and other concoctions. They claimed that their method did not outperform further reference titrimetric systems for perchlorate proposed in 1966 then again in 1969. In addition, this procedure took a long time and needed a large quantity of sample. Scientists do not advocate this method for repeated labor for these reasons, notably because sample quantities plus time are important in forensic research. However, researchers include it in the journal article since it is the lone

potentiometric method that has been discovered too far for the reliable identification of customer firecrackers post-blast and pre-blast, which is currently utilized for scientific casework. While people highlight the use of potassium nitrate as well as potassium perchlorate as oxidizers plus magnesium plus aluminum as fuels, pyrotechnic compositions come in a broad variety of flavors.

This is the most popular technique for studying the structure of firecrackers. These offer a lot of information about the methods and their efficacy. Pyrotechnic formulations typically utilize inorganic or organic compound fuels and oxidizers to produce optical, auditory, thermal or automated special effects like light, loud noise, smoke, colour, plus motion. Pyro-technic combinations were used to consume in the industrial plus military sectors, and they contain ammunition, signaling, including instructive goods. In the citizen sector, they were utilized to make firecrackers for entertainment displays. Any mixture or equipment designed to produce visible or loud effects via burning that fits the criteria of "proficient or show firecrackers" or "customer firecrackers" is called fireworks. Fireworks, whether professional or exhibition, are enormous items that are frequently seen during festivals and festivities. Trained people treat and ignite them. Customer firecrackers are small firecrackers that utilize combustion to produce effects like noise, sparks, smoke, flames, besides colour. They typically have fewer volatile features than competent goods. Customer firecrackers were marketed to the ordinary people then were used at weddings, festivals, and other special events.

So, whilst the use of fireworks is growing rapidly, it is critical to ensure that the design and manufacture of fireworks is carried out in accordance with industry standards, and that no illicit activities are taking place, so for the insularity review of each fire cracker manufactured by various manufacturing firms. So, the instrumental analysis and colorimetric methods that may produce the correct result of each variable present and its quantification are explicitly mentioned in this report.

Colorimetric scanning for cations and anions, as well as different equipment such as electron microscopy, atomic spectroscopy, potentiometric, and so on, was utilized to accurately concentrate and isolate the elements. It influences the amount and quality of fireworks. Since there are few works on fireworks, the quantity of information accessible is restricted; nevertheless, in this work, they show the research methods interpretation in the most comprehensive manner possible. In my view, early research methods, such as fundamental tests performed for cations and anions, should be included since it would help those people who lack equipment or who are working on a limited budget. If the preliminary analysis portion is included, it would offer a great incentive for someone to perform analysis in a restricted laboratory environment.

CONCLUSION

The various approaches, such as instrumental analysis and colorimetric methods, were explored based on the findings. Colorimetric measurements are useful for narrowing down samples, but they do not provide precise quantification of the components present. As a result, more research in this area is needed to increase the efficacy of such experiments. Instrumental analysis is typically used for detailed analysis, but it is not something that can be done on a regular basis. It is more expensive, because it necessitates more experience and ability. The SEM-EDS technique is useful for determining the elemental composition of preserved objects and post-blast particles. Atomic spectroscopy is an excellent instrumentation method for determining the presence and quantities of metals, among other things. These methods assist us in determining the precise structure and ratio of the fireworks composition. The importance of the analysis process, according to forensic scientists, is paramount. The molecular compositions of preserved consumer fireworks have been detected using FTIR and Raman techniques. Since only perchlorate can be determined with the potentiometric methods that have been established so far, they are inefficient for laboratory study of consumer fireworks. The approaches described above are more precise and descriptive

quantitative and qualitative processes, and they both aid in the standardization of fireworks. Each methodology has specific elements, and the end outcome is a combination of each technique's outcomes, which enhances the analyzing process. Researchers will primarily concentrate on a few experiments that have already been performed on the basis of a related topic concerning fire cracker research.

REFERENCES

1. S. M. Danali, R. S. Palaiah, and K. C. Raha, "Developments in pyrotechnics," *Defence Science Journal*. 2010, doi: 10.14429/dsj.60.333.

2. S. M. Mannan, "Regulations under Explosives Rules, 2008 - Present scenario," *J. Mines, Met. Fuels*, 2016.

3. B. Berger, "Parameters influencing the pyrotechnic reaction," 2005, doi: 10.1002/prep.200400082.

4. "THE EXPLOSIVES ACT.," *The Lancet*. 1897, doi: 10.1016/S0140-6736(00)31442-8.

5. J. J. Sabatini, "A Review of Illuminating Pyrotechnics," *Propellants, Explosives, Pyrotechnics*. 2018, doi: 10.1002/prep.201700189.

6. R. G. Parker, M. O. Stephenson, J. M. McOwen, and J. A. Cherolis, "Analysis of Explosives and Explosive Residues. Part 1: Chemical Tests," *J. Forensic Sci.*, 1975, doi: 10.1520/jfs10249j.

7. T. Baran, "Identification of explosive materials," *Forensic Sci. Int.*, 1990, doi: 10.1016/0379-0738(90)90152-O.

8. B. Glattstein, E. Landau, and A. Zeichner, "Identification of Match Head Residues in Post-Explosion Debris," *J. Forensic Sci.*, 1991, doi: 10.1520/jfs13157j.

9. G. P. Pan, "Development and innovation of pyrotechnics in China," *Hanneng Cailiao/Chinese J. Energ. Mater.*, 2010, doi: 10.3969/j.issn.1006-9941.2010.04.020.

10. G. B. Pulpea, "Aspects Regarding The Development Of Pyrotechnic Obscurant Systems For Visible And Infrared Protection Of Military Vehicles," *Int. Conf. KNOWLEDGE-BASED Organ.*, 2015, doi: 10.1515/kbo-2015-0123.