

# Enhancing The Safety Aspects In A Fireworks Industry To Improve Productivity

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**Abstract-** Fireworks Industry plays a vital role in the Economic growth of the country. In India , Sivakasi which is located in Virudhunagar District Tamilnadu has the high production of fireworks. Yearly Tons and Tons of Crackers has been manufactured and distributed across the country. Every year in such industries several fire accidents are happening and this affects heavy production loss and human loss. My project deals with decreasing such accidents and improving the productivity. To Improve such productivity in my project I am using the BRAINSTORMING method as my tool. The major purpose of using this tool is that it deals with the interaction between the workers, management and the speaker. The manufacturing process in the firework industries involves the workers handling various chemical manually. This study deals with analysis of past incidents of fireworks industry. Almost 90% of the workforce has no formal education and lack of knowledge about the chemicals used in the manufacturing of fireworks and only limited research makes the fireworks a high hazardous area. This study involves Job Safety Analysis (JSA) of most hazardous operation of aerial fireworks manufacturing.

**Keywords-** Fireworks, Brain Stroming , Fire Accidents, Job Safety Analysis.

## I. INTRODUCTION

The project study is carried out in the fireworks industry called Sri Ramajeyam Fireworks which is located in Sivakasi, Virudhunagar District, Tamilnadu. This Industry Focus on Manufacturing Various Fireworks products. Every year the produces tons and tons of different types of crackers. This project is all about reducing fire accidents in such industry and improving the productivity percentage. Basically Fire works are low explosive pyrotechnic devices used for entertainment purpose. Basically fireworks makes four primary effects Noise, Light, Smoke, Floating Materials. The most important objective of this project is to identify the main cause of the fire accidents happening in the firework industry and to suggest suitable morale of the employee in the workplace. Therefore in this paper lets discuss about the major cause and the solution of the fire accidents in the fire works industry which will help them in improving their production and reducing the human loss.

## II. LITERATURE REVIEW

Literature review from the existing body of knowledge has provided the following:

[1]. The sonic effect produced by fireworks is largely dependent upon the chemical composition of the mixtures and the particle size. This means that the larger the particle size, the more quantity of powder mixture is to be used. Therefore, a high quality product which can produce the expected noise level with lesser quantities of chemicals is a major challenge faced by the pyrotechnic industry. This can be achieved in one or two ways, namely, by changing the chemical composition or, by changing the particle size.

[2].Explosions in fireworks manufacturing facilities pose a major threat to society. Several accidents during processing, storage and transportation have been reported in Indian fireworks manufacturing units. In this paper, an analysis of 70 case histories of fatal accidents reported during 1994 - 2006 in Tamil Nadu, India is presented. In the fireworks industry, most of the fatal 10 accidents occurred in the mixing and filling process. Mechanics and chemical reactivity are key contributors to accidents.

[3].Most of India's firework products are manufactured in Sivakasi, a town in the Virudhunagar district in Tamil Nadu. Firework industries manufacture with manual handling of various chemicals. Risk assessment plays a vital role in preventing accidents. So to evaluate the hazards in the firework industries, Risk Assessment for Safety and Health and Chemical Health Risk Assessment techniques can be adopted. These techniques are associated with safety and health risks.

[4].A combination of temperature, pressure and humidity cause explosions during chemical mixing, drying, and pellet making. The ANN model proposed predicts accidents and the sessions of accidents (FN/AN) based on atmospheric conditions. This prediction takes values from historical accident data due to the atmospheric conditions of Sivakasi during 2009-2021. In the development of ANN model, FeedForward Back Propagation (FFBP) with the Levenberg-Marquardt function has been employed with hidden layers of 5 and 10 to train the network. The performance accuracy of both

hidden layers is evaluated and compared with other models like Support Vector Machine (SVM), Random Forest (RF), and K-Nearest Neighbor (K-NN).

[5]. Festivals are colorful with fireworks, but they are more at risk of fire and explosion. This is due to the highly reactive chemicals involved in fireworks manufacturing. An analysis of past fireworks industry incidents is presented in the study. Fireworks pose a high level of hazards due to the fact that 90% of the workforce does not have formal education, a lack of knowledge about the chemicals used in the manufacturing of fireworks, and a lack of research. Job Safety Analysis (JSA) of aerial fireworks manufacturing's most hazardous operations is the subject of this study.

[6]. The fireworks industry provides employment for thousands of people in TamilNadu, particularly in the south. The firework units 11 use various flammable chemicals such as Sulphur, Gun powder mixture, Aluminium powder, Potassium Nitrate, Barium nitrate, Strontium nitrate, Charcoal etc. Which are prone to fire and explosion due to their inherent properties. Fire safety assessments of fireworks units are therefore of utmost importance.

[7]. Workers in the fireworks industry are physically and mentally disadvantaged because of hazards in and around the working environment. These hazards cause injuries/fire accidents due to carelessness of workers and poor maintenance of rules and regulations by management. Primary data were collected from 451 workers in 25 fireworks industries randomly. A structured questionnaire was developed to measure safety culture in the fireworks industry. It measures dimensions like work environment, worker awareness, process, governance and safety satisfaction. This instrument is tested for the removal of items in terms of stability by various statistical tests like reliability and validity. This is done in statistical software like SPSS and AMOS.

[8]. In the field of IOT, fire-fighting, fire monitoring and safety management system are an important applications. In order to develop IOT-based fire safety in the firecrackers industry, various sensors will be placed for monitoring the environment. A fire alert is given if any of the sensor nodes detect abnormalities in environmental parameters and water is sprayed over the area once the fire has been triggered by the Arduino microcontroller.

[9]. Fireworks are composed of flammable and explosive materials. During manufacture, transportation, and related processes, these materials are susceptible to static electricity, impact, friction, and explosion degradation, causing fire- and explosion-related accidents. Sorbitan monooleate (SPAN-80)

is a widely used emulsifier in emulsion explosives. This study used differential scanning calorimetry and thermogravimetric analysis to characterise the propellant reaction kinetics in fireworks. It explored the safety effects of emulsifiers on propellants. Additionally, the intensity of the thermal decomposition reaction of the propellant after adding 12 drops of the emulsifier was compared.

[10]. The present investigation attempts to analyze factors indicating the health and safety of employees in the firework and fireworks industries. Fireworks industry is a flourishing industry in Tamil Nadu, India especially in the Sivakasi district. In the fireworks industry, employees face a great deal of risk to their safety and well-being. There have been a lot of health afflictions due to air quality. The firework industry is required to implement more safety measures due to the high-risk nature of fireworks work.

[11]. Despite the fact that manufacturing firecrackers is one of the most hazardous fields in manufacturing, the prevention and mitigation programs provided by the Philippines are weak and obsolete in the area. Hence, this study focused on the welfare of factory workers. The study also provided general prevention and mitigation programs for manufacturing firecrackers. These prevention and mitigation programs resulted in a reduction of 56.15 percent in RPNs. Through the phases of Identify, Analyze, Assess, Prevention, and Mitigation, the reduction was achieved.

### III. METHODOLOGY

- Ñ Analysing the previous year production data
- Ñ Finding the major cause of the previous accidents
- Ñ Finding the solution to avoid these kind of accidents
- Ñ Having an interaction with the workers about the proposed solution
- Ñ Executing the process and motivating the workers
- Ñ Conclusion and Calculating the production rate after our execution

The Study has been carried out in Six phases :

*Phase 1 : Analysing the previous year Production data*

Product	Average production (in lks)	Production done in 2022 (in lks)	Estimating production in 2023 (in lks)	Production Improvement in percentage
Atom bomb (multiple size)	2	1.7	1.8	1.1
Chakri (multiple size)	1.75	1.47	1.6	1.1
Bullet Sparkles (multiple size)	3	2.3	2.5	1.1

*Phase 2 : Finding the major cause of the previous accidents*

The majority of the work in the fireworks industry is performed by human labor, and workers are hired from all of the industry's communities. The main line of work for such folks is producing fireworks. There have been more workplace fire accidents in recent years, which has resulted in significant productivity losses and fatalities. The primary cause of these incidents is failure to adhere to safety standards and laws. According to the investigation, the filling and mixing portions of the pyrotechnics sector were where the majority of tragic accidents had place. The main causes of accidents are discovered to be chemical reactivity and mechanical consequences.

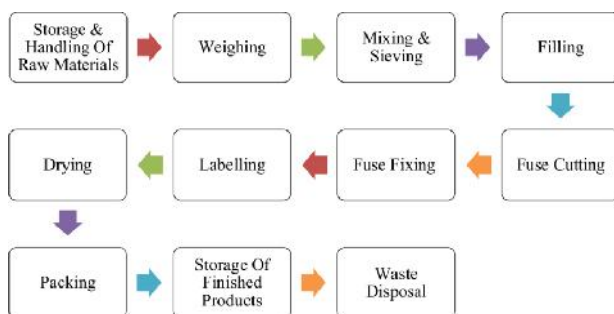


fig : Crackers Manufacturing Process

*Phase 3 : Having an interaction with the workers*

**Brainstorming Method :** A way of creating ideas and exchanging knowledge to address a specific business, technical, or safety challenge, brainstorming encourages

participants to think freely. In companies with an unstructured organizational structure, brainstorming sessions are frequent. When it comes to idea generation, traditional hierarchical organizations favor a top-down strategy. The advantages of brainstorming meetings, however, are appreciated by firms that like to get everyone on the same page.

Design thinking includes brainstorming. It is applied during the brainstorming stage. The fact that design teams can grow in any direction makes it very popular. Teams can use lateral and unconventional thinking to find the best answers to any design problem, even though they have rules and a facilitator to keep them on course. By brainstorming, people can consider a wide range of angles—the more, the better—instead of merely investigating traditional methods and encountering the corresponding challenges. Teams are more likely to come up with preliminary suggestions that they can subsequently develop into potential solutions when they work in a judgment-free environment to identify the true dimensions of a problem. In his 1953 book, *Applied Imagination*, marketing CEO and brainstorming's "inventor" Alex Osborn highlighted the subtleties of creative problem-solving. In brainstorming 17, we target a design issue and generate a variety of alternative solutions. We approach the issue from every conceivable perspective by not only drawing from our own thoughts but also taking into account and expanding upon those of colleagues.

**BRAINSTORMING RULES :**

Establishing ground rules for what is and isn't permitted during a brainstorming session is one of the finest ways to position yourself and your team for success. Fortunately, when he first developed the idea, Osborn did most of this work for you. He used brainstorming in his own advertising firm and discovered the following guiding principles:

**Rule 1: During the session, come up with as many ideas as you can.**

However contradictory it may seem to most of us, brainstorming is more about quantity than quality. People are more open to sharing thoughts that they may normally dismiss as unimportant or excessive when the goal is to collect as many ideas as possible.

**Rule 2: It is not permitted to criticize concepts.**

This is also referred to as non-evaluation; it's also a fundamental idea in the Atlassian Open philosophy. Simply generating ideas is what brainstorming is all about; it's not

about evaluating them right away. Because there isn't quick feedback, people are freer to express their thoughts without worrying about rejection or failure.

**Rule 3 : Bold and ambitious concepts are encouraged.**

You want individuals to think broadly when brainstorming. This principle—also referred to as "freewheeling"—was created for precisely that reason. People are more likely to think creatively

when they are aware that doing so is encouraged rather than just permitted.

**Rule 4: Building on other concepts is welcomed.**

And last, there's the idea of "piggybacking." Participants in brainstorming sessions are invited to build on one other's ideas, but criticisms are not permitted. As a result, there is a greater sense of collaboration, which helps good ideas go even farther.

**Safety Requirements that are noted after the interaction with the workers :**

- Many Accidents were happened in the Warehouse
- Waste Disposal should be done properly.
- Emergency treatment should be given at the time of Breathing problem.
- Water tanks should be kept in proper places.
- Chemical particle size should be reduced.

*Phase 4 : Executing the Process and motivating the workers*

**Factory Pictures**



**Proposed Safety Measures that is to be done after Brainstorming session :**

- Workers using safety wears while entering into the warehouse.
- A proper Emergency breathing kid should be kept

- Water tanks should be placed in a proper place to make use of it easily.
- Size of the chemical used for filling should be reduced.
- A rubber sheet is placed on the floor of the work space to avoid sparkles.

#### FIRE SAFETY SUIT :

A firefighter or volcanologist can wear a fire proximity suit, also known as a silvers, silver bunker, or asbestos suit, to protect themselves from extremely high temperatures. The four layers of the turnout gear are made up of 93% meta-aramid, 5% para-aramid, and 2% antistatic characteristics. The turnout gear must include a helmet, fireman boot, jacket, pants, hand gloves, and balacava.



#### RUBBER SHEET :

A Rubber Sheet is placed on the floor of the work place which may not cause any sparkles during production. The rubber sheet is of 40mm width and it is covered as of the room size.



#### FIRE EXTINGUISHER SHOWER



These units combine a full-service fire truck with a shower unit. The bathing facilities have a first aid recovery station, and the firefighting supplies are kept in a separate compartment. To lessen the impact of accidental chemical exposure, backup facilities like emergency showers and eyewash stations are essential. Emergency showers can also be used to flush pollutants from clothing or put out clothing fires. Fire suppressants like aqueous film forming foam (AFFF) are used to put out flammable liquid fires like fuel fires. AFFF is frequently employed in fire fighting apparatus, shipboard and land-based facility fire suppression systems, and fire training facilities. These kind of shower will be easy for the spread of extinguisher gas to the entire room while fire accidents.

#### IV. CONCLUSION

After following the above safety precaution the workers are been motivated to work regularly without any fear of fire accidents happened before. This also helps the production house to improve their production percentage and helps to reduce fire accidents.

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