

Analysis Of Safety Climate In Fireworks Industries In Tamilnadu

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Abstract— Fireworks industries are more dangerous when compared to any other industries. Fire and explosion are common causes of the accidents in fireworks industries. The aim of the study was to analyse the accidents and find out the causes and give remedial measures to prevent the accidents. One hundred and twenty seven persons were died and sixty nine persons were injured in fireworks industries accidents during the period from 2010 to 2012. The result of the analysis shows that the workers are unaware of the dangers in the chemicals they are handling. Unsafe acts and unsafe conditions are the main reasons for the accidents.

Index Terms—Accident, fireworks, explosion, chemicals

1 INTRODUCTION

Fireworks industries are mostly located in and around sivakasi, in virudunagar district of tamil nadu. about 90% of fireworks are produced in sivakasi area. climate in virudunagar district is very hot and dry in most of the months which is required for the production of fireworks. the people in this area have no other occupation than working in the fireworks industries, hence cheap labour is available. there are 983 fireworks factories giving direct employment to about 70000 workers and about 100000 indirect employment such as paper tube making, box making etc.

Explosive chemicals, flammable materials are used in the fireworks to create the display of light, noise and smokes. During the production of the fireworks more chances of accidents can take place when compared to any other manufacturing industries. The reason is more chemicals are manually handled during the production of Fireworks. Most of the factories are located in the very remote areas and the peoples working in the factories are illiterate. So to reduce the risk of the accidents safety norms are to be maintained strictly in the workplaces. The Factories Act 1948 and the Explosives Act are enforced in the fireworks industries. Effective implementation of the acts and the periodic inspection of the factories can also reduce the accidents.

¹Ioannis A.Papazoglou, et al found that a set of basic frequencies and failure probabilities along with associated uncertainties have been determined for all initiating events and protective measures. These frequencies are then modified to express the plant specific condition. This new set of frequencies is then used to establish an overall explosion frequency. This frequency along with the set of accident sequences provides a quantitative as well as qualitative assessment of the level of safety of the specific facility.

²J.Sales, et al in his study states that accepting the consequences of a chemical accident have a greater cost than the investment required for preventing them. He also suggests that the importance is focused on achieving a deep knowledge of the chemistry involved in a process.

³Arieh Gavious, et al in their study suggest that a reliable evaluation can help locating the workstations that requires much consideration and investment in safety measures. They mentioned that the risk evaluation can help managers to plan correctly the investment in safety measures. ⁴M.N.Vinodkumar, et al conclude that benchmark scores for each safety climate factor with which organization or even individual departments can be compared based on factor scores obtained by collecting responses using the instrument developed. Another study by ⁵T.A.Kletz he pointed out that if accident occurs we do not let others learn from our experience and also forget the lessons learned and allow the accident to happen again. ⁶S.Carol, et al in their studies found that the accidents involving explosions are more severe than those involving flammable or toxic substances and accidents in underdeveloped or developing countries are more severe than those that occur in technologically most advanced countries. This substantiates the risk planning policies in place in developed countries. ⁷Kirsten Jorgensen in his study finds that to reach the goal towards a higher level of safety, we need to promote a better safety culture between people, both the employees as well as the employers, managers, constructors, producers who each have to integrate safety in each responsibility. It is necessary to develop communication strategies and information methods to create motivation and consciousness at these groups. ⁸Palle Haastrup, et al had analysed

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the accidents to explore systematic ways to address the problem of how many accidents involving hazardous materials actually occurred in Europe and to make a realistic estimate. ⁹Sekar, et al conducted the survey in 93 fireworks industries, which aimed at studying the status of working environment, type of construction and other social factors of fireworks industries. The survey concludes with the recommendation for the construction of an explosion resistant industrial estate for the fireworks industries with necessary infrastructure facilities for rehabilitation of unauthorized industries, considering the explosion hazards and the Socio-economic and environmental factors. In another report published by the State Administration of Work safety subordinated by State council, China, the occurrence of accidents can be associated with risk factors from multiple perspectives such as workers, occupational environment, social environment, natural environment, regulations and injury objects. They concluded that strength of supervision and adjustment of public health policy are needed in China to decrease the occurrence rate of fatal accidents. ¹⁰Zhang Guoshum studied the causes of fire explosion accidents. He pointed out the person in charge did not strictly enforce the laws and paid no attention to safety regulation. He also suggested that potentially dangerous factors must be recognised clearly and be corrected clearly. He emphasize on the safety means can be formulated and problem can be resolved to meet the demands of the standard safety condition. ¹¹R.Larduer et al finds that current analysis of human behavior in incident investigation is often relatively superficial, thus minimum opportunity to improve human performance and prevent incident recurring.

But so far no study has been conducted in the fireworks industries located in Tamilnadu. In this paper the author have analysed the accident causes for the last 3 years. So this analysis will be useful to fireworks industries to avoid the accidents due to unsafe acts and unsafe conditions

2 PROCESS IN FIREWORKS INDUSTRIES

The raw materials used in fireworks industries are classified into different categories. They are oxidizing agents, fuels, colouring materials, adhesives, stabilizers, substances which increases or decreases the speed of combustion, boosters, substances which control the combustion etc. The different chemicals are used in the manufacture of fireworks. They are Aluminium powder, Magnesium, Potassium Nitrate, Barium Nitrate, Barium Carbonate, Strontium Nitrate, Sodium Nitrate, Sulphur, Iron chips, Red Phosphorus, Lead oxide, Charcoal, Dextrin, Hexamine etc. These chemicals are hazardous in nature.

Different chemicals like fuels, oxidizers, boosters are used to manufacture the crackers. These chemicals are mixed in required proportion manually. No machines are used in manufacturing of fireworks. Depend upon the types of fireworks the mixed chemicals are filled into the paper tubes. The chemical mixture is handled manually in the factory. So there is a chance for impact, friction and static electricity charges and they will lead to the accidents in the fireworks industries. Charcoal, other chemicals and water are made into paste and is applied on cotton wicks. After drying the wicks are

cut to required size and fitted on the crackers. Then fuses are inserted and allowed to dry. Usually drying should be done in the platform located in the industry. This drying is done in the open place. So there is a possibility of dust accumulations and overheating which may lead to accidents. During the seasonal times the production of the crackers will be more. So there is a possibility of drying the crackers in the open floor itself.

Fireworks after drying are packed manually. These packed materials are stored inside the factory place called the "magazine". The goods are shifted from the magazine to warehouses by means of trucks. Suitable precautions should be taken to avoid accidents during the loading process. Careless handling, impact on over loading and dragging of materials may lead to accidents.

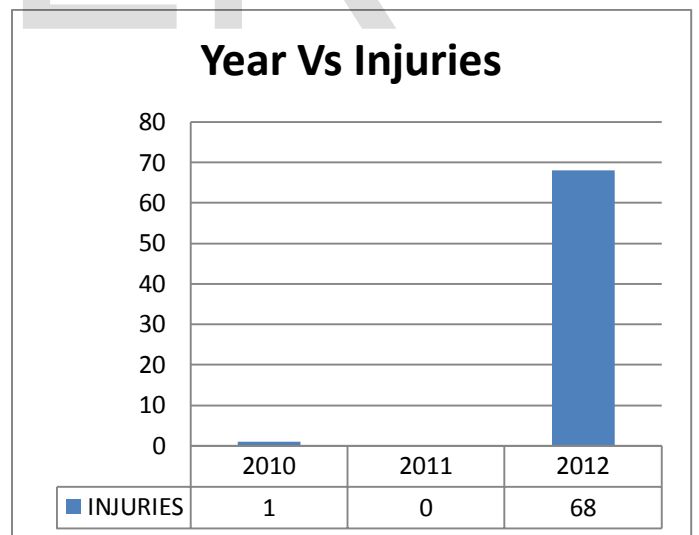
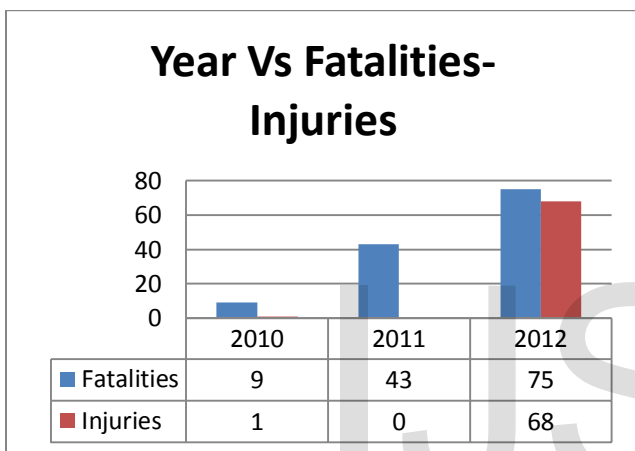
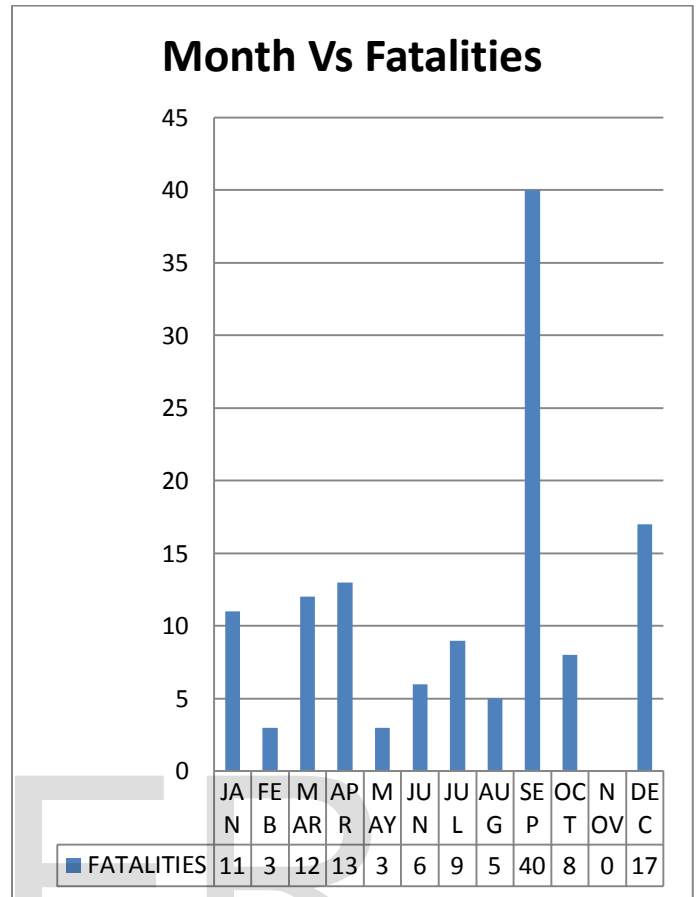
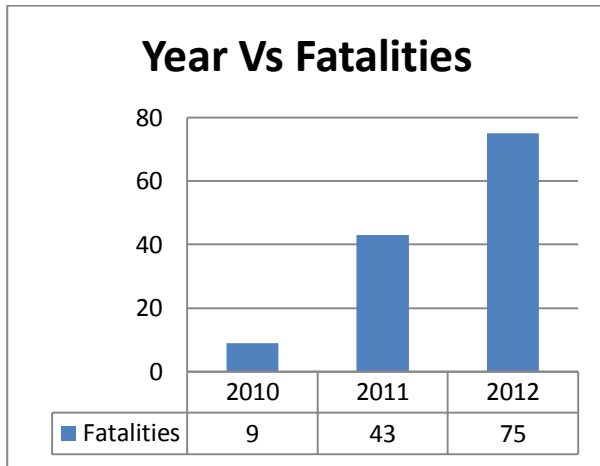
3 VARIOUS PROBABLE CAUSES OF ACCIDENTS

The Factories Act 1948 gives guidelines for safety in the fireworks industries. It does not allow the usage of electricity inside the factory. The act gives the guidelines to good housekeeping, protective clothes, employment of women and the precaution to be taken in connection with the manufacture of fuses used in crackers. Some of the human errors which lead to accidents in fireworks are:

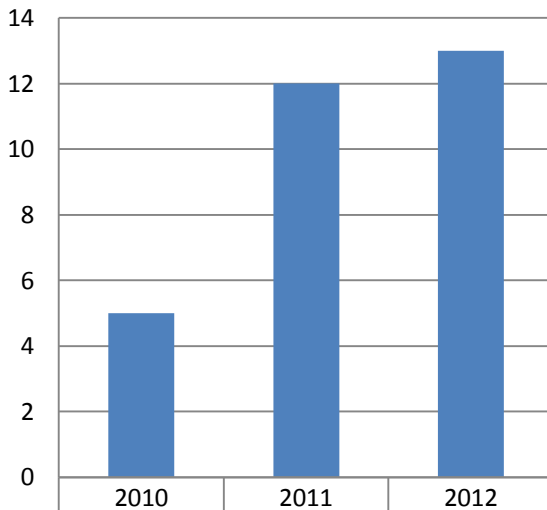
- i. Rough handling of chemicals
- ii. Worker carrying huge quantity of chemicals at a time
- iii. Overloading of chemicals during the filling process
- iv. Unsafe disposal of unused chemicals
- v. Spilled chemicals are not cleaned at once
- vi. Usage of iron knives for fuse cutting
- vii. Drying of crackers in the ground
- viii. Workers are allowed to work other than the shed
- ix. Usage of banned chemicals such as potassium chlorate
- x. Manufacture of unauthorized crackers
- xi. Usage of plastic sheets
- xii. Obstructions for free movement of workers and transportation of chemicals

4 DATA COLLECTION

The accident data are collected from the Chief Inspector of Factories, Chennai for the period 2010 to 2012. The number of fatalities during the period was 127 which involve 30 factories. The data are analyzed and the results were presented in the chart form.

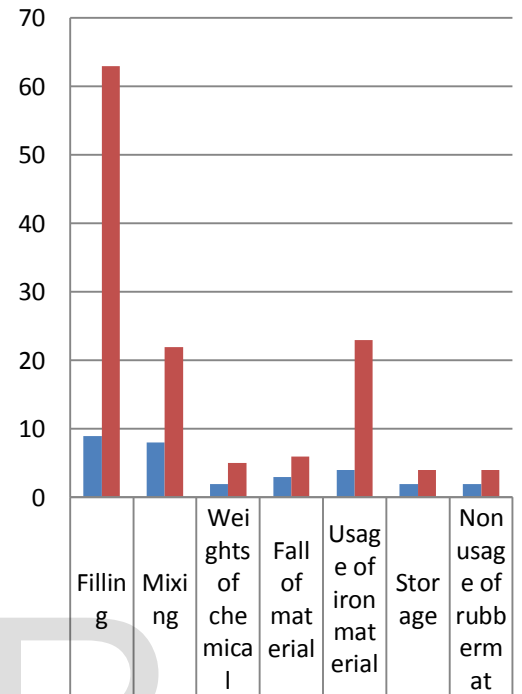


Year Vs Factory Involved in accidents



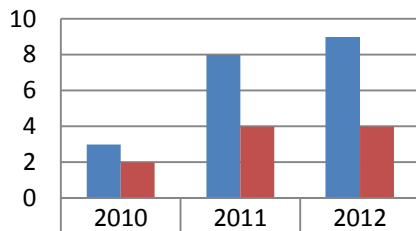
■ FACTORY INVOLVED	5	12	13
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Process Vs No. of Factories- No. of Fatalities



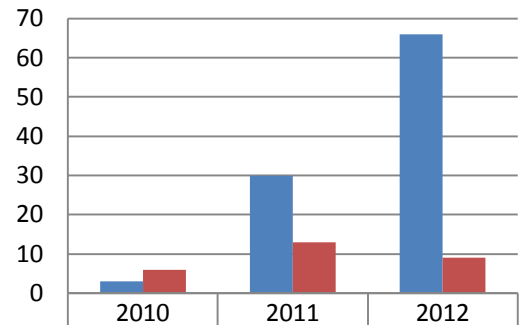
■ NO.OF FACTORIES	9	8	2	3	4	2	2
■ NO.OF FATALITIES	63	22	5	6	23	4	4

Causes Vs No. of Accidents



■ Unsafe Act	3	8	9
■ Unsafe Conditions	2	4	4

Causes Vs Fatalities-Year



■ Unsafe Act	3	30	66
■ Unsafe Conditions	6	13	9

5 DISCUSSION

In the fireworks industries all processes are carried out manually. Labours are handling chemicals in the powder form. Most of the accidents are occurred due to the mishandling of chemicals and carelessness of the workers. If any type of friction is occurred then it leads to the accidents or explosion.

In fireworks industries most of the accidents are occurred during the making of fancy type crackers because in this type the chemicals are mixed with water and make slurry and this will decompose in time. So correct drying time and ventilation shall be maintained to avoid the heat accumulation. Even small negligence will leads to accidents.

A statistics shows that out of 30 accidents 20 accidents are caused by the unsafe act of the workers and remaining 10 accidents are caused by the unsafe conditions in the factory.

Due to unsafe act 99 workers were died and 28 workers were died due to the unsafe conditions in the factory. It shows that the workers are not educated about the safe method of work.

It should be noted that out of 127 fatalities 63 fatal were in the process of filling. It reveals that the workers are unaware of the dangers in handling the chemicals.

In India Diwali is the popular festival and the festival is celebrated all parts of India by bursting the crackers. The festival is celebrated during October to November. So to meet the demand of the crackers the production of the crackers will be more in the month of September. In this month the climate is very hot. So there are more chances of accidents and violation of safety rules will be there at that time.

The data shows that 40 fatalities are in the month of September. So in that time more inspection should be made by the enforcement authorities to eliminate the unsafe conditions and unsafe acts.

6 SAFETY CLIMATE TO PREVENT THE ACCIDENTS

The various safety climate to prevent the accidents are listed below

- i. Use proper personal protective equipment
- ii. Doors shall be open outwards
- iii. Floors should be covered with rubber mat
- iv. Distances between mixing and filling sheds shall be 18 meters
- v. Drying should be done in the platform
- vi. Never drag the materials inside the factory
- vii. Only required quantity of chemical mixture should be placed in the workplace
- viii. Minimum qualification for the foreman should be prescribed
- ix. Number of supervisors shall be at the rate of one for every twenty workers
- x. Supervisors should have the minimum qualification

7 CONCLUSION

In order to create the safety climate, it is essential that the management should have the commitment to establish safe work

environment. The management must give top priority to safety than the production. At the same time the workers also have the commitment towards safety. They should follow the safety rules and regulations. Safety education to worker and effective safety training will reduce the accidents. Similarly the enforcement authorities should enforce the act rigorously to prevent the accidents. They should also guide the management the workers in safe method of work during inspection. This will give impact on the safety conscious of the management as well as the worker.

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