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A Study on Attitude of Fireworks Manufacturers in Sivakasi Towards Eco-friendly Fireworks

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Abstract

Sivakasi is known throughout the world for fireworks production. Low rain fall and a dry climate prevailing in this area contribute to unabated fireworks production. Sivakasi supplies firecrackers and sparkers for all important ceremonies. For the color effect of fireworks, toxic heavy metals like barium, aluminum, lead, mercury salts, antimony, copper, and strontium can be used in firework compositions. The smoke from fireworks consists mainly of fine toxic dusts that can easily enter the lungs. They are more harmful to the society as they pollute our environment which affects the infants, children, pregnant women, patients and senior citizens. Fireworks fallout can contaminate water supplies and residue on the ground can be carried away by rain and end up in our lakes, rivers, or oceans. The noise from fireworks exceeds 140 decibels that scares pets and wildlife like birds, animals etc. For a long time, these consequences were not considered. Now-a-days modern developments in pyrotechnics are aimed at the use of nitrogen-rich compounds that burn cleaner and produce less smoke. These environmentally friendly fireworks could also offer better color quality and intensity than traditional fireworks. Keep in mind the responsibility towards the society, the fireworks manufacturers would adopt their production strategy towards eco-friendly fireworks. This study covers the awareness, acceptability and adaptability of eco-friendly fireworks among fireworks owners in Sivakasi.

Key words: *conventional fireworks, eco-friendly fireworks, pyrotechnics, firework compositions, multiple chemical sensitivity.*

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1. INTRODUCTION

Sivakasi is known throughout the world for fireworks production. The town is located at 9.28' North latitude and 77.48' East longitude. It has an average elevation of 101 metres (331 feet). It was given the nickname "Kutty Japan" by Jawaharlal Nehru as it possesses multifarious industries like Fireworks, Match Factories, Off-set litho presses which provide employment opportunities to a large mass of people in and around the city. Sivakasi experiences dry and pretty hot weather throughout the year. The town gets scanty rainfall during the monsoon. As low rain fall and a dry climate prevailing in this area contribute to unabated fireworks production, Sivakasi is more suitable for fireworks production. There are around 700 fireworks industries producing fireworks products in Sivakasi. Sivakasi supplies firecrackers and sparkers for all over India for Diwali, Christmas, Ramzan and other important ceremonies. This industry has huge turnover of around ₹1000 crores (around 200 million dollars) per year with exports from Sivakasi accounting for ₹.5 crores. Sivakasi contributes to 90% of India's total fireworks production and ranks as one of the highest Tax payer towns in India. The Fireworks industries in Sivakasi contribute ₹35 crores and ₹15 crores as central excise and state excise duties, respectively. But most of us are not aware of the environmental impact of burning fireworks. For the color effect of fireworks, toxic heavy metals like barium, aluminum, lead, mercury salts, antimony, copper, and strontium can be used in firework compositions. Outdated heavy metals that have been used in the past include rubidium and cadmium. The smoke from fireworks consists mainly of fine toxic dusts (particulate matter) that can easily enter the lungs. This represents a real threat for people with asthma or multiple chemical sensitivity (MCS). Smoke from fireworks combustion may contain a mixture of sulfur-coal compounds, traces of heavy metals, and other toxic chemicals or gases. Fireworks fallout can contaminate water supplies and residue on the ground can be carried away by rain and end up in our lakes, rivers, or oceans. Usually noise at 85 decibels or above can damage hearing. The noise from fireworks exceeds 140 decibels that scares pets and wildlife like birds, animals etc. Accidents can occur if fireworks are handled carelessly during sale and use. They are more harmful to the society as they pollute our environment which affects the infants, children, pregnant women, patients and senior citizens. The flashing displays can harm the environment and pose risks to human health. For a long time, the consequences of this were not considered.

Now-a-days modern developments in pyrotechnics are aimed at the use of nitrogen-rich compounds, i.e. eco-friendly fireworks that are perchlorate-free and contain about one-tenth the amount of barium in traditional fireworks. Researchers recently developed new pyrotechnic formulas that replace perchlorate with nitrogen-rich materials or nitrocellulose that burn cleaner and produce less smoke. At the same time, these nitrogen-rich formulas also use fewer color-producing chemicals, dramatically cutting down on the amount of heavy metals used and lowering their potentially toxic effects. Some of these fireworks are already being used at circuses, rock concerts, and other events. These environmentally friendly fireworks could also offer better color quality and intensity than traditional fireworks. Keep in mind the responsibility towards the society, the fireworks manufacturers would adopt their production strategy towards eco-friendly fireworks. The objective of the study is to exhibit the attitude of fireworks manufacturers towards eco-friendly fireworks. This study covers the awareness, acceptability and adaptability of eco-friendly fireworks among fireworks industries in Sivakasi.

2. OBJECTIVES OF THE STUDY

1. To exhibit the attitude of fireworks manufacturers towards eco-friendly fireworks.
2. To study the awareness, acceptability and adaptability of fireworks manufacturers towards eco-friendly fireworks.
3. To find out the difficulties in shifting from conventional fireworks to eco-friendly fireworks.
4. To provide fruitful suggestions to offer eco-friendly environment.

3. NEED OF THE STUDY

The impact of burning fireworks is most harmful to the society as they affect our environment. It results in water pollution, air pollution and noise pollution. Accidents can occur if the fireworks are carelessly handled during their sales and uses. Keep in mind these adverse impacts, the fireworks manufacturers would shift their production strategy from conventional fireworks to eco-friendly fireworks. This study focuses on the awareness, acceptability and adoptability of fireworks manufacturers towards eco-friendly fireworks.

4. SCOPE OF THE STUDY

The current study titled "The Attitude of Fireworks Manufacturers in Sivakasi towards Eco-Friendly Fireworks" has covered the awareness, acceptability, adaptability and willingness of fireworks manufacturers towards eco-friendly fireworks. It also exhibits the additional investment and the time required for adopting the production strategy of eco-friendly fireworks. The current study also points out the problems and difficulties in shifting from conventional fireworks to eco-friendly fireworks.

5. RESEARCH METHODOLOGY

The current study has been conducted in descriptive nature. The primary data has been collected through the pre-defined, well structured questionnaire. 20 samples have been selected through convenience sampling method. The statistical tools like Percentages, Mean, Standard Deviation and Rank Matrix Data Analysis method are used in this study.

6. CONVENTIONAL FIREWORKS

Conventional commonly include potassium perchlorate to speed up the fuel-burning process. Typical pyrotechnics function by burning, so their basic chemical components consist of an oxidant and a fuel. Black powder, the original pyrotechnic, blends potassium nitrate oxidizer with charcoal and sulfur fuel.

Pyrotechnical materials contain an oxidizer and a reducing agent; depending on the application, binding material, propellant charges, coloring agents and smoke- and sound-producing agents can be added.

Fireworks traditionally have included potassium perchlorate as the oxidizer, a material that provides the oxygen that fireworks need to burn. Pyrotechnics contain other ingredients, such color-producing heavy metals, with a similar potential.

7. ILL EFFECTS OF CONVENTIONAL FIREWORKS:

Conventional fireworks are not friendly to the environment or our health. The burning of the metal salts in fireworks releases ultraviolet light which increases ozone pollution, according to a

study by the Jawaharlal Nehru University in India. When fireworks are set off, they release heavy metals like **lead, chromium, carbon monoxide, and sulfur oxides**.

Pyrotechnics might be beautiful to watch, but their environmental- and human-health implications are far from pleasant. When a firework or other pyrotechnic is set off, it releases a whole cocktail of poisons damaging to humans and the environment: heavy metals like lead, barium and chromium, chlorates, dioxins, smoke and particulates, carbon monoxide, and nitrogen and sulfur oxides.

Traditional fireworks are normally made using charcoal and sulphur fuel, a perchlorate oxidiser to help with burning, plus binders, colourants and propellants. When ignited, the pyrotechnics are spectacular, but they emit large amounts of smoke, unused perchlorates and metal by-products from the colourants, all of which are contaminates.

Perchlorate, is an environmental pollutant with potential adverse effects on people and wildlife. Perchlorate has been identified as a potential human health hazard causing thyroid damage. Perchlorate, accumulated in the soil, air and water, will cause thyroid damage. Pyrotechnics also contain color-producing heavy metals, such as barium and copper, which have also been linked to toxic effects. Fireworks produce a lot of smoke, when they are burnt. Apart from being a source of toxic fumes, the smoke also causes great discomfort. People suffering from asthma and other respiratory conditions have no other choice but to stay indoors during Diwali. They are unable to go outside for fear of any of the smoke getting into their lungs and triggering an attack.

Fireworks also bring with them a lot of noise. Diwali favorites like the 'Laxmi bomb' produce a sound of 100 decibels when they are burst. In comparison, any sound beyond 50 decibels is classified as being noise. The noise produced by crackers is extremely hazardous to health. Sudden noise can cause temporary hearing loss. Extended exposure could lead to permanent hearing loss. Crackers burst indiscriminately cause disturbances in sleep. This can be especially upsetting to people who require undisturbed rest like babies and elderly people. Noise also frightens children and household pets, causing them to experience anxiety.

Most fireworks are made by factories which employ children as labourers. These young children are forced to handle the toxic substances that go into these crackers. As a result, they contract diseases associated with these substances. Due to lack of medical aid, many of these children do not live beyond their teenage years.

Asthma attacks have been known to increase in communities following fireworks displays due to thick, particulate-heavy smoke. Many chemicals, like barium and antimony, have been shown to have dangerous affects on the lungs, heart, and stomach. Perchlorate, oxygen-rich molecules that allow the fuel in fireworks to burn, disrupts thyroid endocrine systems and reproduction in wildlife and is listed as a drinking water contaminant by the US Environmental Protection Agency.

The formulation of oxidizers, propellants, fuels and colouring agents in fireworks leaves behind smoky combustion products those fall from the air into nearby soil and water. Some of the metals that make fireworks colourful may also be poisonous when heated. Fireworks contain toxic heavy metals that are linked, not only to air and water pollution, but also to cancer and respiratory problems. In order to overcome the problems of conventional fireworks, it is necessary to create awareness about the significance of eco-friendly environment.

8. ECO-FRINDLY

The word 'eco-friendly' refers to not damaging to the environment or directed at preventing environmental damage. It also refers to designed to cause as little harm as possible to the environment. In other words, humans taking good care of the environment in which they live.

9. ECO-FRINDLY FIREWORKS

Scientists are now creating fireworks made of chemicals that don't pollute the atmosphere. These environmentally friendly fireworks could also offer better color quality and intensity than conventional fireworks. Environmentally friendly fireworks have been developed to reduce the amount of atmospheric pollution produced.

Eco-friendly fireworks have a clean burning, nitrogen-based fuel. This means a perchlorate oxidiser is not needed and because there is little smoke, only small amounts of metal salts are needed to produce the brilliantly coloured flames.

Eco-friendly Fireworks made with nitrogen-rich materials are less toxic and smoky. It replaces carbon-based fuels with nitrogen-based ones, so that perchlorates become unnecessary. This has the welcome side-effect of reducing the amount of smoke produced, which means that 10x less barium needs to be used.

Replacing the barium with boron would cut the amount of toxic material released by fireworks. This is particularly important in places where displays take place every day, such as at theme parks, where the compounds can accumulate.

Unlike traditional pyrotechnics, which get their energy from oxidizing carbon or metal fuels, high-nitrogen materials store their energy in their N–N and N–H bonds. "When they give off their energy, it's not an oxidizing process. Instead, the molecules release energy as they break up into N_2 and H_2. Very little carbon is present in these nitrogen-rich molecules, he continues, so much smaller amounts of oxidizers, such as perchlorate, are needed.

Less carbon and less perchlorate also mean less smoke. With less smoke to obscure color, pyrotechnic makers can cut down on the amount of coloring agent they need in a firework or flare. In a traditional pyrotechnic blend, the coloring agent can account for as much as 20–30% of the mixture by weight. In a high-nitrogen pyrotechnic formulation, the colorant makes up just 2–5 wt % of the blend.

Nitrogen-rich pyrotechnics also offer chemists the opportunity to combine the metal coloring agent and fuel in a single compound. The high-nitrogen compounds readily associate with popular colorant metals, such as strontium or copper.

The class of nitrogen-rich pyrotechnics does not offer only environmentally friendly combustion products; they often offer better color quality and intensity than conventional mixtures. Nitrogen-rich propellants demonstrate improved performance and burn smoke free.

The new pyrotechnic formulas replace perchlorate with nitrogen-rich materials or nitrocellulose that burn cleaner and produce less smoke. At the same time, these nitrogen-rich formulas also use fewer color-producing chemicals, dramatically cutting down the amount of heavy metals used and lowering their potentially toxic effects. Some of these fireworks are already being used at circuses, rock concerts, and other events. The big challenge in developing these "eco-friendly" pyrotechnics is making them as cost-effective as conventional fireworks while maintaining their dazzle and glow.

Some of these nitrogen fireworks are already being used in circuses, concerts and other events. Conventional fireworks draw their energy from the oxidation of carbon. Clean fireworks, on the other hand, would get energy from the high temperatures that occur with the formation of nitrogen-rich compounds. Some possible compounds could be tetrazoles and tetrazines, which are made of four nitrogen atoms and either one or two carbon atoms, respectively.

To produce different colors, chemists could use aminotetrazole salts with specific non-toxic metals. For example, lithium, sodium, potassium, rubidium and cesium result in red, orange, violet, purple, and pink flames, respectively. Somewhat ironically, the most difficult color to produce with "green" fireworks is green. The researchers are looking into green-burning salts based on copper compounds. But the biggest challenge will likely be selling the fireworks at a competitive price.

The next generation pyrotechnics will exploit the high heats of formation of nitrogen-rich compounds rather than drawing energy from the conventional oxidation of a carbon backbone. Such metastable or unstable compounds release their energy of formation as they decompose explosively without producing smoke.

The new class of nitrogen-rich pyrotechnics offers not only environmentally friendly combustion products but the colours are often richer and more intense. Environment friendly firework products can be produced by using more nitrogen rich compounds which changes the chemistry of the product making it safer with better colour quality and better intensity than the regular fireworks.

10. ANALYSIS AND FINDINGS

1. There were 20 fireworks manufacturers participated in this study. 40% of the respondents invested above Rs. 50 Lakhs in their concern. 90% of the respondents are involved in exporting of Fireworks to foreign countries. The annual turnover of 45% of the respondents is above Rs. 20 lakhs. Around 100-150 products are produced by 45% of the respondents. 100% of the respondents are having awareness with eco-friendly fireworks. 70% of the respondents are having awareness about eco-friendly fireworks through Fireworks' Association Meetings. 60% of the respondents are having higher level of willingness in making self-awareness towards eco-friendly fireworks. 100% of the respondents are informed that the eco-friendly product viz., Paper Magic is produced in their concerns. 100% of the respondents are interested in adopting the eco-friendly technology in the near future. 100% of the respondents are possible to convert the production of firework from conventional to eco-friendly. 40% of the respondents informed that 1-3 years will be required to adopt eco-friendly technology totally. 50% of the respondents expected that 5 – Rs. 10 Lakhs of additional investment to be needed for producing eco-friendly fireworks in their concerns. (Table 1)

TABLE-1

S.No.	Respondents Profile	Classification	Frequency
1	Amount of capital invested (in Rs.)	Below 10 Lakhs	0 (0%)
		10 Lakhs - 20 Lakhs	1 (5%)
		20 Lakhs - 30 Lakhs	2 (10%)

		30 Lakhs - 40 Lakhs	3 (15%)
		40 Lakhs - 50 Lakhs	6 (30%)
		Above 50 Lakhs	8 (40%)
2	Average amount of annual turnover (in Rs.)	Below 5 Lakhs	1 (5%)
		5 Lakhs - 10 Lakhs	2 (10%)
		10 Lakhs - 20 Lakhs	8 (40%)
		Above 20 Lakhs	9 (45%)
3	Number of Varieties of fireworks products produced	Below 50	3 (15%)
		50 - 100	4 (20%)
		100 - 150 Lakhs	9 (45%)
		Above 150	4 (20%)
4	Awareness of eco-friendly fireworks among fireworks manufacturers	Yes	20 (100%)
		No	0 (0%)
5	The sources from which fireworks manufacturers get awareness	Newspaper	0 (0%)
		Trade Journals	3 (15%)
		Association Meetings	14 (70%)
		Conferences	3 (15%)
		Media	0 (0%)
6	Willingness in adopting the eco-friendly technology in the near future	Yes	20 (100 %)
		No	0 (%)
7	Estimated time requires to adopt eco-friendly technology in the future totally	Below 1 Year	8 (40 %)
		1 – 3 Years	8 (40 %)
		3 – 5 Years	2 (10 %)
		Above 5 Years	2 (10 %)
8	Additional investment to be needed for producing eco-friendly fireworks	Above 10 Lakhs	4 (20 %)
		5 – 10 Lakhs	10 (50 %)
		Below 5 Lakhs	6 (30 %)

Source: Primary Data

2. Among the reasons for the refusal of converting the production of fireworks from conventional to eco-friendy, Lack of technical know-how tops the list with the minimum score of 45 followed by Huge investment (47), Changing customers' taste and preferences (50) and Risk of marketability (58). (Table 2)

TABLE-2: Rank Matrix score

Factors / Rank	Lack of technical know-how	Huge investment	Changing customers' taste and preferences	Risk of marketability
I	3	9	8	0
II	18	6	0	16
III	24	0	18	18
IV	0	32	24	24
TOTAL	**45**	**47**	**50**	**58**

Source: Primary Data

3. 100% of the respondents agreed that the main obstacle in making green pyrotechnics is cost. (Table 3)
4. 95% of the respondents agreed with the following statements:
   - Eco-friendly fireworks reduce the amount of smoke produced.
   - These environmentally friendly fireworks could also offer better color quality and intensity than conventional fireworks.
   - The class of nitrogen-rich pyrotechnics offers not only environmentally friendly combustion products, but better color quality and intensity than conventional mixtures.
5. 90% of the respondents agreed that eco-friendly fireworks are aimed at the use of nitrogen-rich compounds. (Table 3)
6. The Mean value of 9.67 shows that 90% of the respondents are agreed with the statement *"Eco-friendly fireworks are aimed at the use of nitrogen-rich compounds"*. The Mean value of 6.00 shows that 50% of the respondents are disagreed with the statement *"Customers would expect eco-friendly fireworks more"*. The Mean value of 6.00 shows that 45% of the respondents are disagreed with the statement *"Green Fireworks technology is very difficult in producing eco-friendly fireworks"*. (Table 3)

TABLE 3

S. No.	Attitude Variables	Mean	Standard Deviation
1	Eco-friendly fireworks reduce the amount of smoke produced.	9.83	9.29
2	Eco-friendly fireworks are aimed at the use of nitrogen-rich compounds	9.67	8.60
3	Researchers recently developed new pyrotechnic formulas that replace perchlorate with nitrogen-rich materials or nitrocellulose that burn cleaner and produce less smoke	9.33	7.79
4	Fireworks made with nitrogen-rich materials are less toxic and smoky.	9.00	7.00
5	These environmentally friendly fireworks could also offer better color quality and intensity than conventional fireworks.	9.83	9.29
6	The main obstacle in making green pyrotechnics is cost.	10.00	10.00
7	The class of nitrogen-rich pyrotechnics offers not only environmentally friendly combustion products, but better color quality and intensity than conventional mixtures.	9.83	9.29
8	Eco-friendly fireworks protect our environment	7.00	1.00
9	Customers would expect eco-friendly fireworks more.	6.00	2.58
10	Eco-friendly fireworks are not harmful to the children, patients and senior citizens.	7.83	3.10
11	The big challenge in launching these "eco-friendly" pyrotechnics into the sky is making them cost-competitive with conventional fireworks while maintaining their dazzle and glow.	8.83	5.74
12	Green Fireworks technology is very difficult in producing eco-friendly fireworks.	6.00	1.83
13	Perchlorate, a potential human hazard causing thyroid damage used in conventional fireworks has not been used in eco-friendly fireworks.	5.50	3.30
14	Eco-friendly fireworks don't cause any kind of serious mishap like burns and fires. They can be used in indoor parties and functions also.	8.83	5.85
15	Fireworks based on the principle of vaccum pressure attracted the mass and used in various functions.	6.17	1.34
16	Eco-friendly fireworks contain 10 times less barium than the conventional fireworks.	9.00	7.00
17	Eco-friendly fireworks will definitely cost more but some extra money can pave its way for better and healthier air in the future.	8.00	3.56
18	Heavy metals are used to produce the pretty colors typically associated with the Eco-friendly fireworks.	8.17	4.14

Source: Primary Data

11. UGGESTIONS

- It is suggested that the role of Newspaper, Internet and Media shall be enhanced in creating awareness of eco-friendly fireworks among the fireworks manufacturers.
- The public may be educated about the impact of fireworks in affecting the environment and the adverse effects of climate change and global warming. It paves the way to consume the eco-friendly fireworks rather than conventional fireworks.
- The government may introduce the subsidies, incentives, relaxations etc for the effective implementation of eco-friendly fireworks production strategy made by the fireworks manufacturers.
- Arranging the training programme for educating the eco-friendly technology in the production of fireworks will help the fireworks manufacturers to implement the eco-friendly technology in their concerns quickly.

12. CONCLUSION

It is the responsibility of each fireworks manufacturer and customer to take care of our environment. The ill-effects of global warming and climate change can be drastically reduced with the adoption of production and consumption of eco-friendly fireworks. At this moment, proper guidance, encouragement and support of the government and policy makers are essential to implement the eco-friendly technology in the field of fireworks industries not only to save the environment but also to provide green atmosphere to the generations to come.

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