Benzoates in Fireworks

1.0 History of Fireworks

Many historians believe that fireworks originally were developed in the second century B.C. in ancient Luoyang, China. It is believed that the first natural "firecrackers" were bamboo stalks mixed with potassium nitrate, sulphur and charcoal to produce a black, flaky powder – the first “gunpowder” that when thrown in a fire, would explode with a bang because of the overheating of the hollow air pockets in the bamboo. Fireworks made their way to Europe in the 13th century and by the 15th century they were widely used for religious festivals and public entertainment.

2.0 Problems faced due to fireworks

2.1 Air Pollution

The bright colours and effects in fireworks are produced by a cocktail of chemicals. Fireworks emit light, heat and sound energy along with carbon dioxide and other gases and residues. The exact emissions will depend on individual the firework, but as gunpowder is a main component, sulphur compounds are emitted, along with small amounts of particulates, metal oxides and organic compounds (which can include minute amounts of polycyclic aromatic hydrocarbons, dioxins and furans). Approximately 5 -14% of dioxin emissions are produced around Deepawali festival in India. Current research indicates that deposits of pollutants from fireworks do not pose a risk to soil or water.

2.2 Noise Pollution

Bursting Fireworks not only cause pollution but also it creates noise pollution too. According to a report of the ministry of environment and forest, an increasing trend of noise pollution has been observed in the major cities of the country. To regulate and control noise pollution, the government has issued various notifications under the Environment (Protection) Act, 1986. The Supreme Court, in September 2001, passed an interim order to comply with the notification of the ministry, issued on October 5, 1999, to control noise emitting from fire crackers. The noise shall not exceed 125 dB(AI) and 145 dB(C)pk.

2.3 Dry Waste

Fireworks also bring waste like papers, plastics; firework covers which put additional burden on existing waste management systems of the government.

2.4 The Perchlorates problem

Perchlorates, ClO4 - make excellent oxidizers: high oxygen amount, good stability, low cost, good reactivity with fuels, great for producing red and green colours.

Problem: high stability of perchlorates means that they persist in the environment much longer and are currently linked to thyroid disorders, replacing iodide (I) in the body. Alternatives are being explored, such as nitrates for commercial fireworks and periodate (IO4 -) etc.

3.0 Use of Benzoate in Fireworks

Using benzoates in fireworks provides safer alternatives to existing chemicals used in fireworks. Use of Benzoates as a colouring agent in fireworks was discussed by D.Bleser in 1989 (D. Bleser, "New Electric Purple," American Fireworks News, No. 89, 1989). In this discussion, D.Bleser recommended use of Benzoates in fireworks based on its ability to serve as both colour agent element (Cu, Sr, Ba) and fuel (benzoate).

For example, while using colouring agent copper (II) carbonate in fireworks, it is only the copper that is useful in producing colour. Large amount of fuel is required to burn copper (III) carbonate to free copper from its carbonate ion. In addition, the flame temperature is lowered, which in turn results in less coloured light output.

It would be preferred if the copper could be made available without having to pay the full energy cost of freeing it from the carbonate ion. One way to do this is to chemically combine copper with a fuel such as the benzoate ion. Then, when the fuel is consumed, copper will be left over and ready to make the blue color

4.0 Benzoate Salts Available

Dr. J. Pharmachem Pvt. Ltd., manufacturers several benzoates salts suitable for fireworks. Most of these benzoate are available in fine powder form (D 100 less than 100 microns) and low moisture (less than 0.5%) making these benzoates ideal for dry mixing (without grinding) ready for use in fireworks.

Benzoate	Appearance	Colour
Aluminium Benzoate	White powder	White and silver sparkles
Barium Benzoate	White powder	Green Colour
Calcium Benzoate	White powder	Orange Colour
Copper Benzoate	Blue powder	Blue Colour
Lithium Benzoate	White powder	Red Colour
Potassium Benzoate	White powder	Whistling Effect
Sodium Benzoate	White powder	Gold Or Yellow Colour
Strontium Benzoate	White powder	Red Colour
Zinc Benzoate	White powder	To create smoke effect

4.1 Examples of benzoate salts in fireworks

ROUND STARS AND SHELLS - B15

Ingredients	% Composition
Ammonium perchlorate	40.0
Potassium perchlorate	20.0
Copper oxychloride	16.0
Red gum	8.0
Potassium benzoate	6.0
Hexamine	5.0
Parlon	2.5
Saran	2.5
TOTAL	**100**
Dextrin	+4.0

B16

Ingredients	% Composition
Ammonium perchlorate	82.0
Copper benzoate	18.0
TOTAL	**100**
Dextrin	+5%

NEW BLUE

Ingredients	% Composition
Ammonium perchlorate	82
Copper benzoate	18
TOTAL	**100**
Bind with 1% nitrocellulose and make pumped or cut firework stars	

NEW ELECTRIC PURPLE

Ingredients	% Composition
Ammonium perchlorate	68
Copper Benzoate	8
Strontium Carbonate	12
Magnalium, 200-400 mesh	5
Hexamine	7
TOTAL	**100**
Dextrin	5%
By adding 5% potassium dichromate and 1% boric acid the side reactions were prevented.	

ROCKET PROPELLANT (WHISTLING) (A)

Ingredients	% Composition
Potassium perchlorate (fine mesh)	64
Potassium benzoate	32
Iron oxide (Red)	1
Petroleum jelly	3
TOTAL	**100**

ROCKET PROPELLANT (WHISTLING) (B)

Ingredients	% Composition
Potassium perchlorate (fine mesh)	76
Potassium benzoate	23
Iron oxide (Red)	1
TOTAL	**100**
Petroleum jelly	+2.5

MATRIX COMET

Ingredients	% Composition
Potassium chlorate, passing 200 mesh	50
Barium benzoate, passing 100 mesh	23

Barium carbonate, passing 200 mesh	10
Exfoliated mica, pass 80 mesh, hold 120 mesh	10
Bentonite clay - wyoming, passing 200 mesh	6
Guar gum fine WW250F, passing 200 mesh	1

Catalyst (Zinc Oxide, Aluminum Oxide, Magnesium Oxide, Bismuth Trioxide/Copper Chromite / Copper Oxide (black) / Copper Oxychloride)

References

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